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Scarcity in COVID-19 vaccine supplies reduces perceived vaccination priority and increases vaccine hesitancy

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Abstract

In two experimental studies, we tested the effect of COVID-19 vaccine scarcity on vaccine hesitancy. Based on extensive scarcity literature, we initially predicted that high (vs. low) scarcity would increase demand for vaccines, operationalized as one's willingness to receive a vaccine. Contrary to this prediction, Study 1 showed that scarcity of vaccines *reduced* participants' sense of priority which, in turn, also *reduced* their vaccination intentions. Trust in doctors moderated the effect of perceived vaccination priority on vaccination intentions such that for individuals with high trust in doctors, reduced perceived priority did not reduce their vaccination intentions as much. Study 2 replicated these effects with a more general population sample, which included at-risk individuals for COVID-19 complications. At-risk participants (vs. low-risk) had higher perceived vaccination priority, but describing vaccine doses as scarce reduced vaccination intentions similarly across both groups. Moreover, Study 2 demonstrated that compassion for others is a boundary condition of the effect of vaccine scarcity on vaccination intentions. For participants with high compassion, scarcity reduces willingness to receive a vaccine; for participants with low compassion, scarcity increases their willingness to be vaccinated. Our results suggest that health policymakers need to deemphasize the scarcity of vaccines to increase vaccine acceptance.

KEYWORDS

at-risk populations, compassion, COVID-19, scarcity, trust, vaccine hesitancy, vaccination intentions

1 | INTRODUCTION

The COVID-19 pandemic will be remembered as a global crisis that forever changed how we understand public health, economic activity, and individual choices. It has impacted numerous important issues for marketers and policymakers, including—but not limited to—healthcare access and utilization, the efficacy of public health campaigns, and economic activity, as many consumers forwent in-person shopping (Das et al., 2021).

While behavioral measures were effective short-term fixes to slow the virus, the distribution of effective vaccines emerged as the only long-term solution to curb the pandemic (WHO, 2020).

However, even with the unprecedentedly fast development, COVID-19 vaccines doses are still insufficient to meet global demand and will be so for the foreseeable future (Torjesen, 2021), as experts estimate 12 billion doses are needed to achieve population immunity (CEPI, 2020; Kim et al., 2021). Consequently, health officials worldwide are making difficult but necessary decisions about whom to vaccinate first (Williams et al., 2021), both globally (Liu et al., 2020) and locally (Persad et al., 2020). Prioritization and scarcity of doses may affect how people perceive these vaccines, with significant consequences for vaccine acceptance.

This study aims to investigate the effect of vaccine scarcity on one's willingness to receive a vaccine. Because vaccine acceptance is ultimately an individual's choice, understanding hesitancy is imperative for successful vaccination campaigns. Our work contributes to improving public health policy communications by leveraging and adapting our existing knowledge in behavioral theories to the unique characteristics of the current pandemic. We expect our findings to aid policymakers in this pandemic and beyond, as vaccine hesitancy is a perplexing and growing issue worldwide (WHO, 2019).

In two experiments, we show that the predictions from extant marketing literature (i.e., that product and resource scarcity increase demand) do not apply in this context. Instead, scarcity reduced willingness to receive a vaccine because it lowered people's perceived priority of receiving the vaccine—that is, one's urgency or importance to undergo this medical intervention. Moreover, because individuals seek the expertise of their doctors when making personal health decisions, high trust in doctors can counteract the detrimental effects of low perceived priority when deciding whether to be vaccinated.

Conversely, our second experiment reveals that scarcity of vaccine doses may dissuade compassionate individuals from accepting the vaccine. This illustrates how scarcity can have disparate impacts on acceptance depending on personal predispositions, adding to the scant but growing literature showing the interplay between scarcity and individual differences (Das et al., 2018; Kraus & Callaghan, 2016; Ku et al., 2012; Piff et al., 2010; Roux et al., 2015). Some of these findings indicate that resource (e.g., monetary) scarcity can increase prosociality (see Elbaek et al. [2021] for a review). We contribute to this literature by looking at the interplay between product scarcity and prosociality, which has not been addressed extensively. Indeed, when COVID-19 vaccines are presented as scarce, compassion for more vulnerable individuals can discourage some from accepting the vaccine for themselves because they believe others need it more.

2 | THEORETICAL BACKGROUND

2.1 | Scarcity

Consumers face scarcity when they have restricted access to or lack the products or resources necessary to meet their needs and desires (Hamilton et al., 2019). Consumers can experience two main types of scarcity: (i) product scarcity (i.e., lack of access to goods or services for purchase, whether at the individual product level or at the category level), and (ii) resource scarcity (i.e., lack of financial means or time necessary to acquire desired products; Hamilton et al., 2019). Moreover, product and resource scarcity can manifest at the micro-level, macro-level, or both, affecting individuals, groups of consumers, or whole geographical areas (Cannon et al., 2019; Hamilton et al., 2019).

Product scarcity can occur in the marketplace due to increased demand, reduced supply, or both. For example, during the pandemic, many consumer goods such as toilet paper became scarce due to higher demand, even though supply was fairly undisrupted (Kirk & Rifkin, 2020). Other goods, such as video game consoles, experienced both increased demand, as individuals were forced to stay home during the lockdown, and reduced availability due to supply chain issues (Schreier, 2020).

Sometimes, companies use scarcity to generate more interest and higher willingness to pay for limited products (i.e., product/marketing scarcity; Roy & Sharma, 2015), a common strategy for luxury goods. When consumers experience product scarcity (e.g., stockouts, limited availability), the demand for the scarce product increases (Lynn, 1991).

Contrary to our video game example, several product and service categories are considered necessities. Therefore, an abundant supply of these goods is required for societal well-being. One such category is health services and products, including vaccines. Unfortunately, due to limited production capacity or supply chain disruptions, essential products can at times be insufficient to meet demand. This was the case, for example, in the US flu vaccine shortage of 2004–2005 (Hinman et al., 2006). Presently, the world faces a critical COVID-19 vaccine shortage (Minoja, 2021). Therefore, an important and timely question is whether the scarcity of this essential health product can affect individuals' attitudes towards and demand for vaccines.

Much of the literature would suggest that scarcity of products (e.g., Inman et al., 1997; Lynn, 1991; van Herpen et al., 2009) and scarcity of resources (e.g., Cannon et al., 2019; Sharma & Alter, 2012) increase consumer demand. Several characteristics of scarce goods that increase demand apply directly to vaccines: they are manufactured by few companies and supply is limited. However, vaccines are traditionally sourced and distributed by governments, healthcare providers, the World Health Organization, or other multilateral organizations that control access (gatekeepers). Gatekeepers directly control access to a resource, deciding who can or should get the resource. In healthcare systems, gatekeepers are individuals, institutions, or systems that determine who access care and under what conditions (Sripa et al., 2019; Vedsted & Olesen, 2011). The individual is not in a position to decide without first going through the gatekeeper. Thus, by the nature of the power dynamic, one transfers decision-making responsibility to the gatekeeper. Therefore, in a vaccination context, public demand will also be contingent on access and not only on personal needs. Having a gatekeeper may diminish an individual's sense of personal responsibility for vaccination, reducing vaccination intentions.

Interestingly, a study conducted during the 2005 flu vaccine shortage—that is, a context of vaccine scarcity—reported decreased demand for 24% of surveyed respondents, compared with increased demand for only 3% of respondents (Brewer & Hallman, 2006). Yet, to the

best of our knowledge, there is no experimental evidence showing contexts in which product scarcity decreases demand. Importantly, behavioral researchers recently suggested that policymakers leverage the scarcity of vaccine doses to increase COVID-19 vaccination rates (Wood & Schulman, 2021). However, if scarcity has the opposite effect on demand in this context, public health campaigns should deemphasize scarcity.

2.2 | Vaccine hesitancy

The issue of restricted access to vaccines due to shortages is compounded by vaccine hesitancy, "an attitudinal continuum, capturing doubts regarding the safety, efficacy, necessity and general advisability of vaccination for oneself and one's family" (Browne, 2018, p. 2540). Hesitancy is a multifactorial and complex phenomenon (Salmon et al., 2015) that varies across individuals, groups, contexts, and specific vaccines (Larson et al., 2014). It invariably contributes to delaying or refusing available vaccines (MacDonald, 2015), decreasing population-level vaccine uptake (Dubé et al., 2013; Götz et al., 2021). Vaccine hesitancy is on the rise, and the World Health Organization has declared it one of the ten major global health threats (WHO, 2019), as it increases the risk of outbreaks and epidemics of vaccine-preventable diseases (Dubé et al., 2013).

Although often used interchangeably, hesitancy differs from vaccine skepticism, which involves distrust in vaccines in general (Browne et al., 2015; Peretti-Watel et al., 2015). Those hesitant demonstrate different attitudes, cognitions, and behaviors than "anti-vaxxers" (around 5% of the population; Leask et al., 2012) and often still accept vaccinations, albeit sometimes on a delayed schedule (Benin et al., 2006). For COVID-19 vaccines, a large portion of the population is taking a "wait and see" approach (Hamel et al., 2020; Lazarus et al., 2021). While different from refusal, delaying vaccination nevertheless has the same short-term negative impact on population immunity.

Compared with other vaccines, vaccine hesitancy toward COVID-19 is high (Hamel et al., 2020). A multi-country study revealed that 45.1% of respondents showed different levels of hesitancy (Lazarus et al., 2021). Although COVID-19 vaccine hesitancy might be decreasing, a substantial proportion of the population still experiences it (Buttenheim, 2020), and hesitancy may undermine efforts to curb the spread of COVID-19 and return to a full-functioning society. Individuals who are hesitant about the COVID-19 vaccine express general vaccine hesitancy concerns, such as opposition to pharmaceutical companies, and COVID-19 vaccine-specific concerns, such as short development time (Chaney & Lee, 2021). Nonetheless, vaccine acceptance is the only viable pathway to exit the pandemic (Bartsch et al., 2020), especially since eradicating the virus is seen as increasingly unlikely (Mandavilli, 2021).

Hesitancy creates a paradoxical situation for policymakers: while vaccines are increasingly available (at least in countries that secured a larger supply of doses), individuals still need to accept them (as, at this point, vaccine mandates and other stronger measures such as vaccine passports only affect a small part of the world population). Given the importance of getting individuals to accept the vaccine, we explore the effect of scarcity on willingness to receive a vaccine via perceived priority to the self, considering three potential moderators: trust in healthcare providers, objective medical risk, and compassion.

2.3 | Perceived priority

In this pandemic, priority has at least two potential meanings: who gets access to vaccines and individuals' perceived urgency or importance of being vaccinated. Public health decisions have focused on the first definition (e.g., US states developed their own priority lists, starting with healthcare workers and seniors; CDC, 2021). We focus instead on the second definition of priority, which pertains to individuals' own assessment of priority: a "sense of urgency" or interest in self-care (Barron, 1980; Lacy et al., 2004; Mitchell & Selmes, 2007). The sense of the importance of medical interventions for oneself is core to patient health priorities (Wensing et al., 1998) and the health belief model literature (Rosenstock, 1974). Notably, the perceived importance of expected health intervention outcomes drives adherence to recommended behaviors (Orji et al., 2012).

We thus define the perceived priority of COVID-19 vaccination as the individual's internal sense of the importance of getting the vaccine for oneself, which ultimately drives one's vaccine acceptance. Scarcity may decrease priority because it injects a sense of complication into the medical decision-making process (Bayu et al., 2016). For preventative care, even relatively minor inconveniences can cause patients to delay care, essentially moving the health care service further down their to-do list. Moreover, individuals do not have to directly experience complications or inconveniences to change their sense of priority regarding the health intervention. For example, patients may reschedule or indefinitely postpone appointments if they learn that the doctor's office has a long wait time (i.e., scarcity of doctor's availability; Green et al., 2014). Scarcity may impact an individual's perceived priority even more, as vaccine benefits do not accrue only to the individual but also to the community.

Nevertheless, if priority is low, individuals may still follow medical guidance if a convenient opportunity arises. For this reason, vaccinations have been conducted in nonclinical locations. For example, Maryland's GoVax campaign offered shots at a seaside bar, incorporating a health intervention into a previously planned activity—a trip to the beach (Heim, 2021). By meeting people at a convenient place and time with an abundance of vaccines, the barrier of low perceived priority can be overcome.

Hence, priority for oneself is related to but distinct from the willingness to accept a medical intervention, such as vaccination. Consider a person who believes receiving a COVID-19 vaccine is a high priority for their health. This person may still experience barriers to receiving the vaccine, such as an inability to find transportation to the vaccine site, decreasing their willingness to be vaccinated. Thus, while perceived priority of vaccine to the self is a precursor of

willingness to receive a vaccine, other factors are important drivers of vaccine acceptance, including trust in healthcare providers, medical risk, and compassion for others more vulnerable to the disease.

2.4 | Factors influencing vaccine acceptance: Trust, risk, and compassion

Trust in healthcare providers improves several health outcomes, including adherence to prescribed treatments and continuity of care (Dugan et al., 2005), perceived communication quality (Finkelstein et al., 2020), and patients' attitudes toward and acceptance of vaccines (Benin et al., 2006; Casiday et al., 2006). Moreover, trust in institutions is vital for successful crisis responses (Cairney & Wellstead, 2021). Such trust can drive the acceptance of interventions that respond to a present emergency, including vaccine acceptance (Unicef, 2020).

From a public health standpoint, the importance of trust in doctors for medical care and treatment outcomes emanates from particularities of healthcare services: they are a credence good, whose quality patients cannot fully evaluate due to lack of expertise (Darby & Karni, 1973). Therefore, patients who trust their doctors are willing to follow their advice even when the underlying reasoning is not fully understood. Conversely, patients who do not trust doctors are more likely to delay preventative care (Musa et al., 2009).

Medical risk also impacts vaccine prioritization and acceptance. Seniors or those with chronic health conditions (e.g., lung diseases, diabetes, cancer; CDC, 2020) are more at risk of developing severe COVID-19. Higher medical or perceived risk increases individuals' likelihood to engage in actions that reduce their risk, including the acceptance of vaccinations (Caserotti et al., 2021). Past health problems and ongoing chronic conditions can increase individuals' vigilance to health-related threats (Asmundson & Taylor, 2020).

Living with an underlying health condition changes how individuals view the world and perceive danger, especially in the context of healthcare, where stressors and health concerns take on even more importance (Park, 2010). Therefore, framing the COVID-19 vaccines as a scarce resource may be an effective communication strategy to increase perceived vaccination priority to the self and willingness to receive a vaccine among people with high risk for severe COVID-19, while it may decrease the priority and willingness to receive a vaccine among those at lower risk.

In the context of vaccinations, individuals may be compassionate and consider the benefits to the broader community, not only to themselves. *Compassion* is the ability to understand or be aware of the suffering of others and the need to act to end that suffering (Crawford et al., 2013; Von Dietze & Orb, 2000), and is a common foundation for cooperation in communities (Gintis, 2000). It motivates individuals to behave altruistically (Henrich, 2004) toward specific individuals and more abstract others (Neff & Pommier, 2013). Therefore, compassion for others is a predictor of adherence to many prosocial behaviors, including vaccinations (Bodelet et al., 2020).

But if vaccines are scarce, individuals with compassion for others vulnerable to the disease may have a lower willingness to receive a vaccine, because accepting the vaccine may make them believe that someone more deserving does not get access. Indeed, previous research has shown that individuals engage in more selfish behaviors when they are reminded of resource scarcity (vs. abundance), but this resource scarcity effect is not observed among individuals with more prosocial tendencies (Roux et al., 2015). In addition, if individuals can use prosocial behaviors as status signals, then resource scarcity also promotes prosocial behavior (Kraus & Callaghan, 2016; Roux et al., 2015).

A similar sentiment in the context of scarce COVID-19 vaccines may also cause individuals to think of others and determine that "others need it more"—either because other individuals are sick or sicker than themselves or because these individuals are not able to stay home to avoid the virus (Appiah, 2021). These reports suggest that product scarcity can also make people act more prosocially, a possibility that was not directly addressed in the scarcity literature. Importantly, compassion for others should not change the effect of scarcity on the perceived priority of the vaccine to the self, that is, compassion does not make one feel that the vaccine is less important to them, but instead that it is more important for others. We next summarize our research hypotheses and provide an overview of our empirical approach.

3 | OVERVIEW OF HYPOTHESES AND STUDIES

In two experiments, we tested the effect of vaccine scarcity on one's perceived priority and willingness to receive a vaccine. Study 1 was conducted with a student sample, while Study 2 was conducted with a more general adult population, specifically sampled to vary in health risk (i.e., presence vs. absence of a pre-existing medical condition). Sample characteristic details and means of dependent measures by condition are available in the Supporting Information (Tables S1 and S2).

The extant literature on marketing and psychology mainly focused on the effects of resource scarcity (e.g., financial means, usually incidental or unrelated to the consumption domain being investigated) or product scarcity (i.e., the effects of scarcity of specific products or product categories and its integral effects on related consumption). Here, we specifically considered the effect of vaccine scarcity (i.e., integral, product scarcity) on vaccination acceptance. Following most of the findings from the scarcity literature, we originally predicted that vaccine scarcity would increase product demand, namely one's willingness to receive a vaccine. We pre-registered Study 1 initial hypothesis, protocols, and analyses plan (https://osf.io/fmbd6?view_only=fedb46dc45144f12b45157e324b1309e). As Study 1 results were opposite to our prediction, we revised our theorizing and developed a new set of hypotheses that we pre-registered and tested in Study 2 (https://osf.io/4gsda?view_only=75236c2e76294db994641ea526598b22). We predicted

that scarcity of COVID-19 vaccines would decrease willingness to receive a vaccine due to a decrease in one's perception of priority in receiving the vaccine. Stated formally:

H1: Vaccine scarcity reduces perceived priority and willingness to receive a vaccine.

Additionally, we predicted that participants' trust in doctors (Studies 1–2) would moderate the effect of priority on willingness, and health risk would moderate the effect of scarcity on priority (Study 2). Thus:

H2: The effect of perceived priority on willingness to receive a vaccine is moderated by trust in doctors, such that it is smaller for participants who trust doctors more.

H3: High (vs. low) medical risk increases (decreases) perceived priority when vaccines scarcity is high (vs. low).

We also expected (see exploratory items on pre-registration) that other factors could impact the effect of scarcity on willingness to receive a vaccine, including altruistic feelings such as compassion for those most vulnerable to COVID-19 (Study 2). Because altruistic individuals may feel compassionate towards others more vulnerable to COVID-19, they may have a lower willingness to receive a vaccine in conditions of vaccine scarcity, so that more deserving others can be vaccinated first. Thus:

H4: High (low) compassion for others decreases (increases) willingness to receive a vaccine when vaccines are scarce.

4 | STUDY 1

4.1 | Methods

Participants (17 revoked consent, final $N = 342$ U.S. students, $M_{age} = 20.6$, $SD_{age} = 1.65$, 52% female, see MDA Table S1) completed the study between October 5–16, 2020, when no COVID-19 vaccines were yet available to the public.

This study employed a 2 (scarcity: high vs. low) between-subjects design. Participants read the following scenario (high scarcity condition is bracketed):

> "Imagine that a vaccine for COVID-19 was approved for distribution within the population. Vaccine manufacturers were working around the clock to produce enough vials so that everyone can be vaccinated now *[as soon as possible, but there are still not enough vaccines for everyone]*. Your area has plenty of places offering vaccines for all individuals who want to get it now. *[Your area has very few places offering vaccines at this point, and priority has been given to at risk groups.]* You just received a notification from your doctor that their clinic can finally offer you the vaccine next week. You need to decide now if you will call and book the appointment."

We then measured participants' willingness to receive a vaccine ("How likely are you to be vaccinated?", from 0 = *Highly unlikely* to 100 = *Highly likely*), their perceived priority to receive the vaccine ("How much of a priority would it be for you to get the vaccine?", from 0 = *Not at all a priority* to 100 = *High priority*), how risky they considered the vaccine to be (from 0 = *Not risky at all* to 100 = *Highly risky*), and the expected protection conferred by the vaccine (from 0 = *Not protective at all* to 100 = *Highly protective*). Participants completed a 7-item trust in healthcare providers scale (responses from 1 = *Strongly Disagree* to 7 = *Strongly agree*, $\alpha = 0.82$, sample item: "Doctors are extremely thorough and careful," Dugan et al., 2005), and a vaccine skepticism measure ("I am skeptical about vaccines in general," from 1 = *Strongly Disagree* to 7 = *Strongly agree*). Participants reported demographic information, subjective risk perceptions, political orientation, and adherence to prevention behaviors (full questionnaire available in the Supporting Information).

4.2 | Results

A MANOVA revealed that scarcity did not affect perceived risk or protection associated with the vaccine ($Fs < 1$), but—contrary to our original expectations—it reduced participants' willingness to receive a vaccine (High scarcity: $M = 60.12$, $SD = 33.63$; Low scarcity: $M = 70.43$, $SD = 32.43$, $F(1, 340) = 8.33$, $p = 0.004$, $\eta_p^2 = 0.024$) and the perceived priority to receive the vaccine (High scarcity: $M = 49.26$, $SD = 34.10$; Low scarcity: $M = 61.66$, $SD = 32.78$; $F(1, 340) = 11.75$, $p = 0.001$, $\eta_p^2 = 0.033$). A posttest with participants from the same population revealed that they interpreted priority as the importance of getting the vaccine to self, and not as the prioritization of specific groups determined by healthcare systems or officials (see Supporting Information).

4.2.1 | Exploratory analyses: Moderated mediation

We tested whether perceived priority mediated the effect of scarcity on willingness to receive a vaccine, and whether trust in doctors moderated this effect (see Figure 1), using a bootstrapping approach to assess the significance of the indirect effects at differing levels of the moderator (Hayes, 2017, model 15). Because general vaccine skepticism relates to a more stable individual attitude toward vaccines (Browne, 2018), we included it as a covariate (the coefficients and full model do not change significantly without the inclusion of this covariate, see Supporting Information for the results without the covariate). Scarcity (contrast coded: −0.5 = Low, +0.5 = High) reduced perceived priority to be vaccinated ($\beta = -13.72$, $SE = 3.40$, $t(339) = -4.04$, $p < 0.001$), while perceived priority increased willingness to receive a vaccine ($\beta = 0.75$, $SE = 0.03$, $t(335) = 23.59$, $p < 0.001$; see Table 1 and H1). Trust in doctors significantly predicted willingness to receive a vaccine ($\beta = 8.62$, $SE = 1.72$, $t(335) = 5.03$, $p < 0.001$), and significantly moderated the effect of

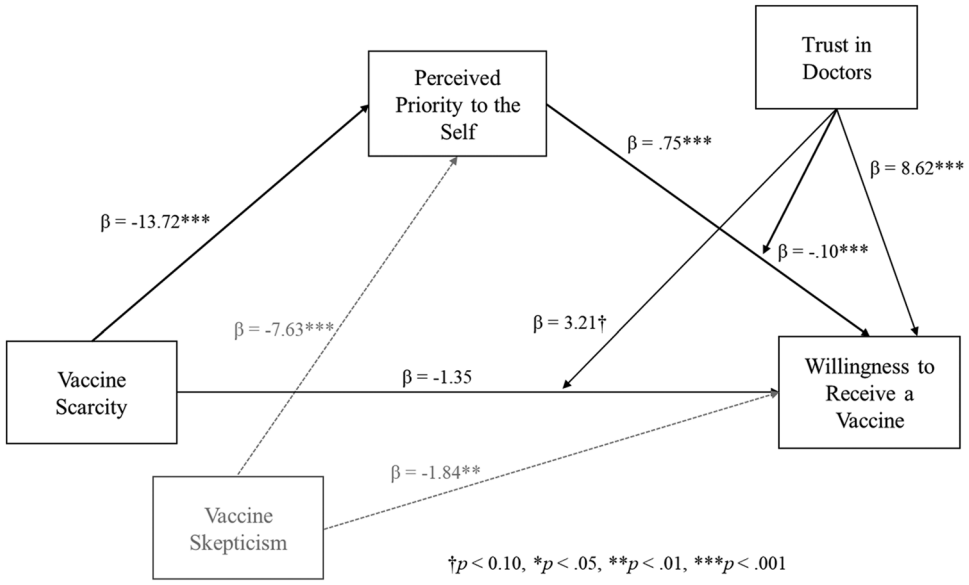


FIGURE 1 Effect of vaccine scarcity on willingness to receive a vaccine, mediated by perceived priority to the self and moderated by trust in doctors (Study 1)

TABLE 1 Study 1 Conditional Mediation Model – Unstandardized OLS regression coefficients with confidence intervals (standard errors in parentheses) estimating perceived priority to the self and willingness to receive a vaccine. Trust in doctors is mean-centered, vaccine scarcity is contrast coded (−0.5/+0.5)

	Stage 1: Perceived priority to the self		Stage 2: Willingness to receive a vaccine	
	β	C.I.	*β*	C.I.
Scarcity	−13.72 (3.40)***	−20.4095, −7.0334	−1.35 (2.03)	−5.3521, 2.6531
Perceived priority to the self			0.75 (0.03)***	0.6879, 0.8131
Trust in doctors			8.62 (1.72)***	5.2484, 11.9992
Trust in doctors × Perceived priority			−0.10 (0.03)***	−0.1543, −0.0492
Scarcity × Trust in doctors			3.21 (1.90)†	−0.5292, 6.9535
Vaccine skepticism	−7.63 (1.11)***	−9.8143, −5.4369	−1.84 (0.71)**	−3.2430, −0.4461
Intercept	75.77 (3.42)***	69.0493, 82.4841	29.06 (3.13)***	22.9086, 35.2169
	R^2 = 0.15, p < 0.001		R^2 = 0.71, p < 0.001	

Note: N = 342; Standard errors in parentheses; Index of moderated mediation: 1.396 (0.50), C.I.: 0.5517, 2.5201; †p < 0.10; **p < .01; ***p < .001.

perceived priority on willingness to receive a vaccine (β = −0.10, SE = .0.03, t(335) = −3.81, p < 0.001; the moderated mediation was significant: coefficient = 1.40, 95% CI = 0.5517, 2.5201; 10,000 bootstrap samples; see H2).

The *conditional indirect effect* of scarcity on willingness to receive a vaccine via priority was strongest in those with low trust in doctors (β = −11.61, SE = 2.84, 95% CI = −17.3274, −6.1237) and weakest in those with high trust in doctors (β = −8.78, SE = 2.22, 95% CI = −13.3739, −4.5581, see Figure 2 and H2). This means that scarcity reduced one's priority and, subsequently, willingness to receive a vaccine more among those with low trust in doctors than those with high trust in doctors. The *conditional direct effect* of scarcity on willingness was not significant in the full model (t < 1). The simple mediation model is also significant (see Supporting Information).

4.3 | Discussion

Study 1 showed that framing COVID-19 vaccines as scarce decreases perceived priority and, consequently, willingness to

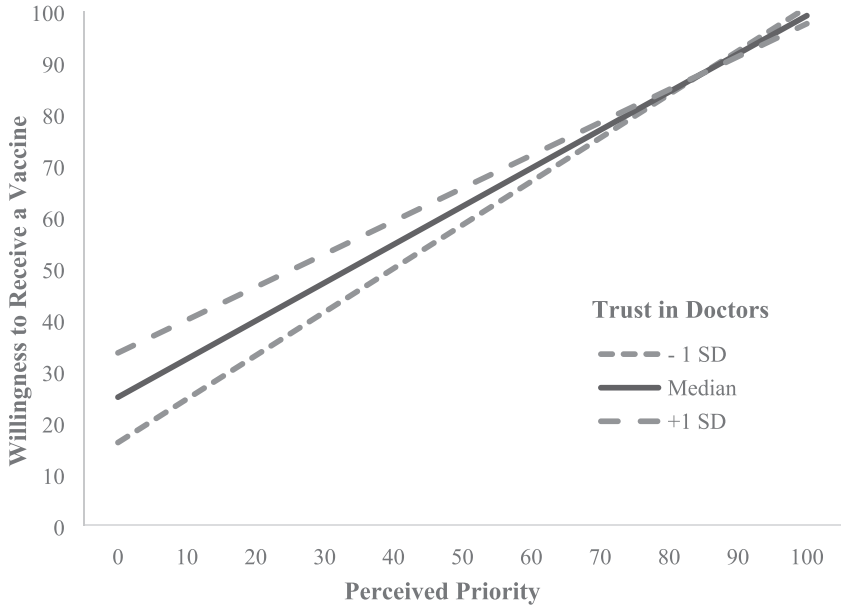


FIGURE 2 Willingness to receive a vaccine at different levels of perceived priority to the self by trust in doctors (Study 1)

receive a vaccine, especially for those who trust healthcare providers less. For participants with high trust in doctors, the increased trust may have "inoculated" them from the harmful effect of low perceived priority on willingness to receive a vaccine, making them more prone to follow their doctor's recommendation from the scenario even in the high vaccine scarcity condition. These findings contradict predictions from extant literature on the effects of scarcity on demand for goods.

Nevertheless, Study 1 presents two main weaknesses. First, we relied on a relatively homogeneous student sample with a likely low risk of developing severe COVID-19 complications (Dowd et al., 2020). Second, we had originally hypothesized that vaccine scarcity would increase willingness to receive a vaccine rather than decrease it. Given the importance of COVID-19 vaccination efforts and the widespread sense of scarcity associated with the vaccines, we ran Study 2 to replicate Study 1 results within a broader population, thus addressing these weaknesses.

5 | STUDY 2

We hypothesized that the negative effect of scarcity on perceived priority could be reduced if participants had increased objective risks of experiencing severe COVID-19. Moreover, we sought to replicate our results in a situation where hesitancy was not directed towards hypothetical vaccines but towards vaccines already given emergency use authorization by the relevant governmental authorities and available to the general public.

5.1 | Methods

We advertised 300 Prolific Academic slots for US participants who previously stated that they had been diagnosed with chronic diseases (e.g., heart or lung diseases, stroke, etc.) and 300 slots for those who did not declare having such diagnosis (590 completed the study, five participants revoked consent, final $N = 585$, 52.5% female, $M_{age} = 40.23$, $SD_{age} = 14.20$, see MDA Table S1). We restricted our study to participants who had not received a COVID-19 vaccine and had not contracted COVID-19.

This study employed a 2 (scarcity: high vs. low) × 2 (risk: high vs. low) between-subjects design. Scenarios were adapted from Study 1, adding information about the two vaccines against COVID-19 (Pfizer/BioNTech and Moderna/NIAID) licensed in the United States at the time of the data collection (January 27 to February 10, 2021; see Supporting Information for questionnaire). We measured compassion with others with a single-item 7-point rating scale ("How much compassion do you feel for those most vulnerable to COVID-19?", from 1 = *Not at all* to 7 = *A great deal*).

5.2 | Results

A MANOVA revealed that scarcity reduced willingness to receive a vaccine ($F(583) = 4.62$, $p = 0.032$, $\eta_p^2 = 0.008$): participants in the high (vs. low) scarcity condition displayed a lower willingness ($M = 71.72$, $SD = 37.58$ and $M = 78.05$, $SD = 33.55$, respectively). The effect of scarcity on perceived priority did not reach the standard level of statistical significance (High: $M = 67.95$, $SD = 38.92$; Low: $M = 73.31$, $SD = 35.51$, $F(583) = 3.03$, $p = 0.082$, $\eta_p^2 = 0.005$). In addition, scarcity did not impact perceived vaccine protection and risk ($ps > 0.15$).

5.2.1 | Study 1 replication

A moderated mediation model on the effect of scarcity on willingness to receive a vaccine via priority, moderated by trust in doctors and

controlling for skepticism, was supported (index of moderated mediation: coefficient = 0.53, *SE* = 0.22, 95% CI = 0.1203, 1.0266, 10,000 bootstrap samples, see Figure 3 and Table 2). Scarcity (contrast coded: −0.5 = Low, +0.5 = High) significantly reduced perceived priority to receive a vaccine ($\beta = -6.65$, *SE* = 2.63, $t(582) = -2.53$, $p = 0.012$), which in turn increased willingness to receive a vaccine ($\beta = 0.74$, *SE* = 0.02, $t(578) = 36.79$, $p < 0.001$; H1 is supported). Trust in doctors ($\alpha = 0.90$) also increased willingness ($\beta = 8.21$, *SE* = 1.04, $t(578) = 7.90$, $p < 0.001$) and moderated the effect of priority on willingness ($\beta = -0.08$, *SE* = 0.01, $t(578) = -6.28$, $p < 0.001$; H2 is supported).

As in Study 1, the *conditional indirect effect* of scarcity on willingness to receive a vaccine via priority was strongest in those low in trust in doctors ($\beta = -5.68$, *SE* = 2.25, 95% CI = −10.1431, −1.2539) and weakest in those high in trust in doctors ($\beta = -4.29$, *SE* = 1.76, 95% CI = −7.8713, −0.9194; see Figure 4). The interaction between scarcity and trust in doctors was not a significant predictor of willingness ($t < 1$). However, in this sample, the *conditional direct effect* of scarcity on willingness to receive a vaccine was significant for those high in trust in doctors ($\beta = -3.35$, *SE* = 1.69, 95% CI = −6.6778, −0.0313), but not significant for those low in trust in doctors ($\beta = -1.80$, *SE* = 1.80, 95% CI = −5.3473, 1.7398). Therefore, higher levels of trust in doctors corresponded to a reduced detrimental effect of vaccine scarcity on willingness to receive a vaccine. The simple mediation model is also significant (see Supporting Information).

5.2.2 | Objective risk

We hypothesized that risk (contrast coded: −0.5 = Low risk, +0.5 = High risk) would moderate the effect of scarcity on perceived priority: for participants at higher risk to develop severe COVID-19, scarcity would not induce lower perceived priority. However, hypothesis 3 was not supported: neither the moderated mediation with risk as the moderator in the first stage (model 8) nor the moderated moderated mediation (model 29, with trust in doctors as the moderator for the second stage) were significant. As expected, participants from the high-risk group had higher perceived priority to receive the vaccine ($M = 76.08$, $SD = 34.88$) than those in the low-risk group ($M = 65.30$, $SD = 38.86$), $t(583) = 3.53$, $p < 0.001$); the former also had a marginally higher willingness to receive a vaccine ($M = 77.69$, $SD = 34.06$) than the latter ($M = 72.19$, $SD = 37.12$), $t(583) = 1.87$, $p = 0.06$). However, the interaction between scarcity and risk was not a significant predictor of perceived priority or willingness to receive a vaccine (both ts < 1). Therefore, even though the risk was a significant predictor of perceived priority, risk level did not significantly impact the effect of vaccine scarcity on priority.

5.2.3 | Compassion

We anticipated that altruistic motives (here, compassion for those most vulnerable to COVID-19) would also explain the effect of scarcity on willingness to receive a vaccine via priority, controlling for skepticism. The moderated mediation was significant (coefficient = 0.29, *SE* = .0.15, 95% CI = 0.0502, 0.6250, 10,000 bootstrap samples; H4 is supported, see Figure 5 and Table 3 for full results).

The interaction between compassion and vaccine scarcity was significant ($\beta = -2.91$, *SE* = 1.10, $t(578) = -2.66$, $p < 0.01$). For participants with high compassion (top 48.4% of the distribution), scarcity reduced their willingness to receive a vaccine. For participants with low

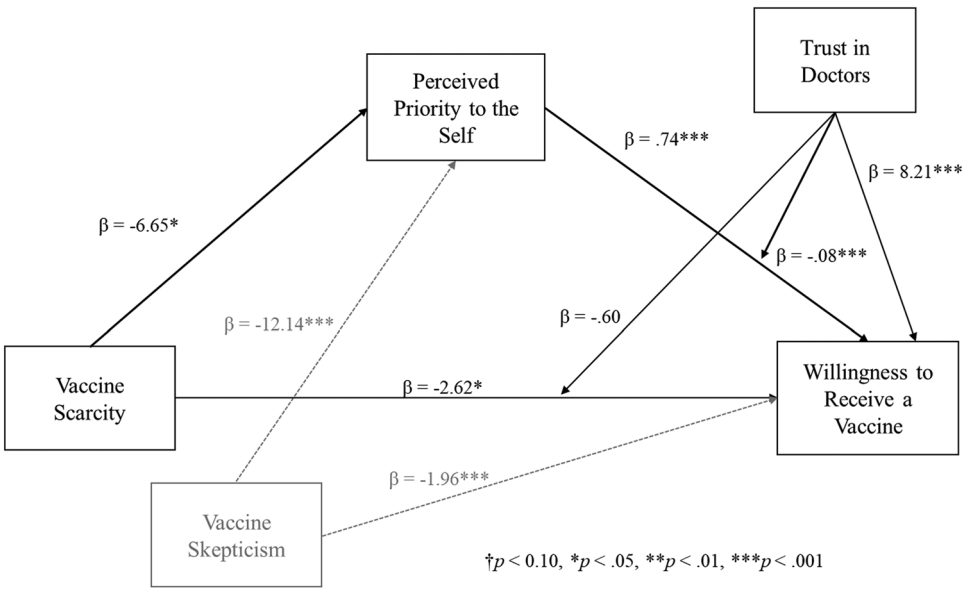


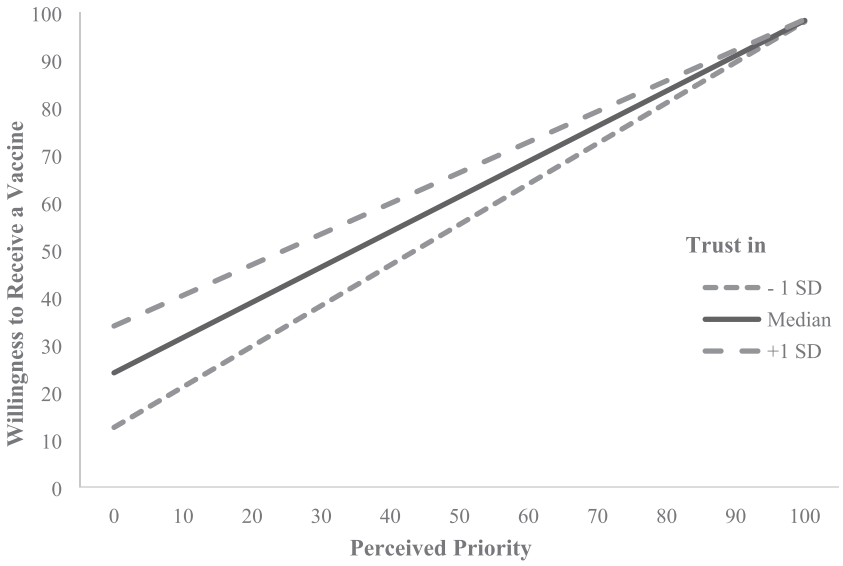
FIGURE 3 Effect of vaccine scarcity on willingness to receive a vaccine, mediated by perceived priority to the self and moderated by trust in doctors (Study 2)

TABLE 2 Study 2 Conditional Mediation Model – Unstandardized OLS regression coefficients with confidence intervals (standard errors in parentheses) estimating perceived priority to the self and willingness to receive a vaccine. Trust in doctors is mean-centered, vaccine scarcity is contrast coded (−0.5/+0.5)

	Stage 1: Perceived priority to the self		Stage 2: Willingness to receive a vaccine	
	β	C.I.	*β*	C.I.
Scarcity	−6.65 (2.63)*	−11.8077, −1.4954	−2.62 (1.22)*	−5.0228, −0.2221
Perceived priority to the self			0.74 (0.02)***	0.7046, 0.7840
Trust in doctors			8.21 (1.04)***	6.1701, 10.2528
Trust in doctors × Perceived priority			−0.08 (0.01)***	−0.1055, −0.0552
Scarcity × Trust in doctors			−0.60 (0.96)	−2.4831, 1.2901
Vaccine skepticism	−12.14 (.82)***	−13.7446, −10.5351	−1.96 (0.46)***	−2.8523, −1.0611
Intercept	98.28 (2.28)***	93.8115, 102.7565	28.20 (2.21)***	23.8619, 32.5377
	R^2 = 0.28, p < 0.001		R^2 = 0.83, p < 0.001	

Note: N = 585; Standard errors in parentheses; Index of moderated mediation: 0.534 (0.23), C.I.: 0.1174, 1.0399; *p = .05; ***p < .001.

FIGURE 4 Willingness to receive a vaccine at different levels of perceived priority to the self by trust in doctors (Study 2)



compassion scores (bottom 1.4% of the distribution), scarcity increased their willingness (see Figure 6).

5.3 | Discussion

Study 2 confirmed Study 1's findings, namely that highlighting the scarcity of COVID-19 vaccines reduces an individual's willingness to receive a vaccine due to a reduction in the perceived priority of being vaccinated. With two studies showing a similar, albeit counter-intuitive pattern of results, it is unlikely that our observation is due to chance. Even so, Study 2 failed to establish risk as a statistically significant moderator of the effect of scarcity on perceived priority to the self. We expected that those at higher risk of developing severe COVID-19 would consider vaccination a priority even when faced with scarcity of COVID-19 vaccines. This surprising result may be because risk estimates are subjective and malleable, especially risk perceptions regarding vulnerability to an uncertain but negative health outcome (Menon et al., 2002; Murdock & Rajagopal, 2017).

Nevertheless, Study 2 revealed that vaccine scarcity might affect an individual's vaccination acceptance by multiple mechanisms. For highly compassionate individuals with equal levels of perceived priority, scarcity reduces their willingness to receive a vaccine. But scarcity also reduces one's perceived priority to the self, subsequently decreasing willingness; this detrimental effect can be counteracted by high trust in doctors. Thus, increasing one's trust in doctors may be an important lever for improving willingness to receive a vaccine even when individuals feel that COVID-19 vaccination is less of a priority for themselves. In summary, increasing the availability of vaccines or at least decreasing the perception that vaccines are scarce should be the focus of vaccination campaigns, given that scarcity, in this context, reduces willingness to receive a vaccine.

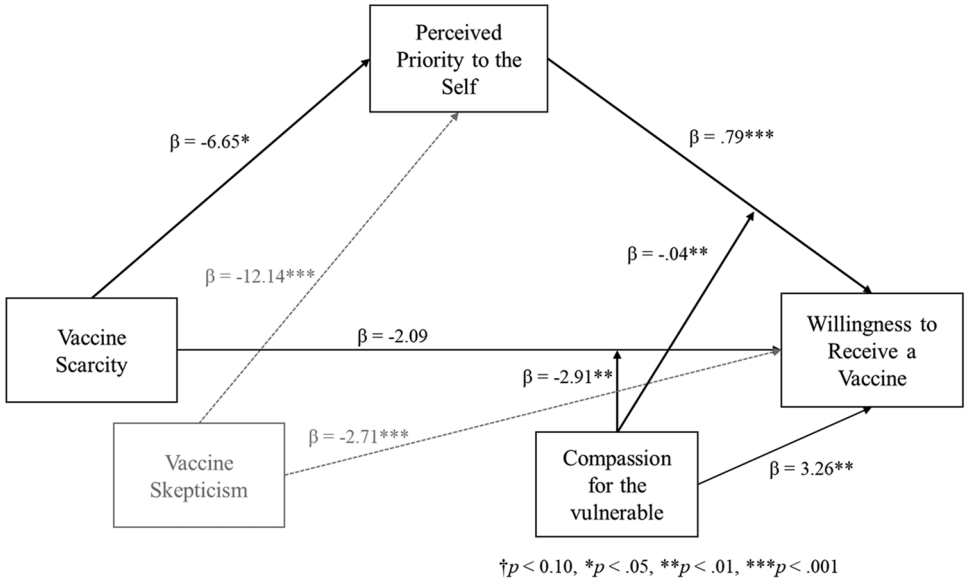


FIGURE 5 Effect of vaccine scarcity on willingness to receive a vaccine, mediated by perceived priority to the self and moderated by compassion for the vulnerable (Study 2)

TABLE 3 Study 2 Conditional Mediation Model – Unstandardized OLS regression coefficients with confidence intervals (standard errors in parentheses) estimating perceived priority to the self and willingness to receive a vaccine. Compassion for the vulnerable is mean-centered, vaccine scarcity is contrast coded (−0.5/+0.5)

	Stage 1: Perceived priority to the self		Stage 2: Willingness to receive a vaccine	
	β	C.I.	*β*	C.I.
Scarcity	−6.65 (2.63)*	−11.8077, −1.4954	−2.09 (1.27)	−4.5823, 0.4050
Perceived priority to the self			0.79 (0.02)***	0.7474, 0.8273
Compassion			3.26 (0.98)***	1.3321, 5.1798
Compassion × Perceived priority			−0.04 (0.01)**	−0.0702, −0.0175
Scarcity × Compassion			−2.91 (1.10)**	−5.0670, −0.7594
Vaccine skepticism	−12.14 (0.82)***	−13.7446, −10.5351	−2.71 (0.46)***	−3.6219, −1.8069
Intercept	98.28 (2.28)***	93.8115, 102.7565	25.87 (2.27)***	21.4045, 30.3365
	R^2 = 0.28, p < 0.001		R^2 = 0.82, p < 0.001	

Note: N = 585; Standard errors in parentheses; Index of moderated mediation: 0.29 (0.15), C.I.: 0.0528, 0.6164; *p < .05; **p < .01; ***p < .001.

6 | GENERAL DISCUSSION

Findings from two experimental studies suggest that scarcity of the COVID-19 vaccines had unexpected effects on demand, reducing people's willingness to receive a vaccine by as much as 10 points on a 100-point scale. This difference in vaccine acceptance could significantly impact our ability to reach population immunity for the current pandemic. If population immunity is out of reach, as many have suggested (Mandavilli, 2021), incremental vaccine acceptance is even more critical as each vaccinated person disrupts the chain of viral transmission. Accordingly, our findings are significant for both academic research and policymakers.

The practical implications of the current research are clear: to promote COVID-19 vaccine acceptance, policymakers and healthcare providers should not highlight the scarcity of vaccine doses. For booster shots, which healthcare regulatory agencies in several countries presently recommend (as of October 2021), perceived scarcity may polarize individual preferences (Zhu & Ratner, 2015). Polarized preferences could result in individuals waiting to be able to implement their preferred vaccination strategy (e.g., specific brand preference, preference for mRNAs, preference for mixing and matching, etc.). Deemphasizing scarcity can also prevent complicating the distribution of boosters and increase vaccine acceptance in general. This recommendation contradicts not only the general

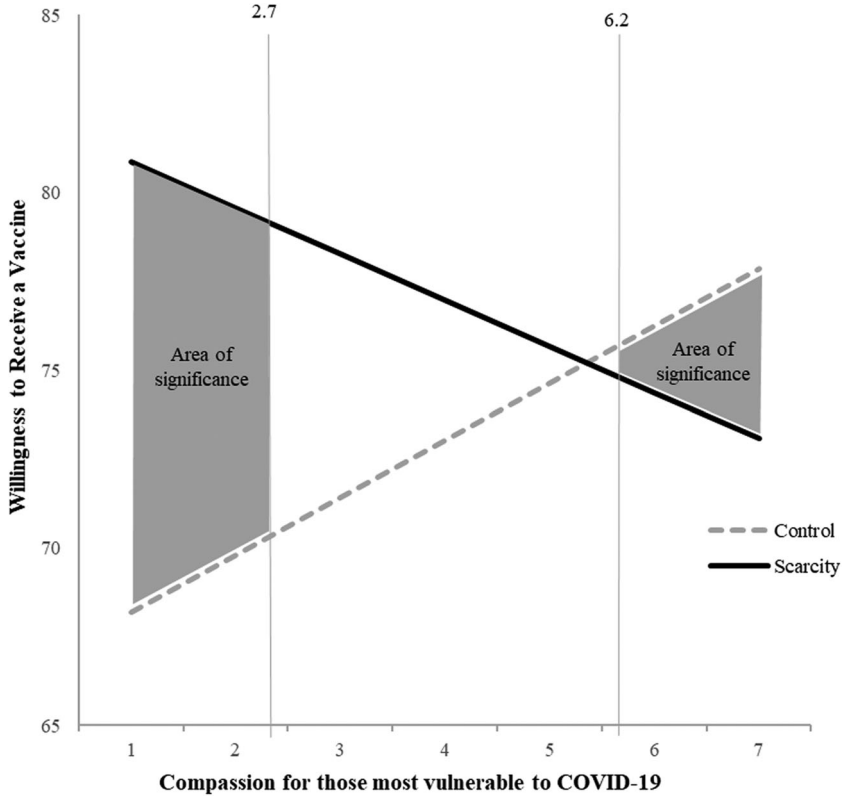


FIGURE 6 Willingness to receive a vaccine at different levels of compassion for the vulnerable by scarcity (Study 2)

findings from the scarcity literature, but also a suggestion from a recent article in a major health journal proposing to leverage natural scarcity to encourage COVID-19 vaccine acceptance (see Table 1 "Strategies for Promoting Covid-19 vaccination," in Wood and Schulman [2021]). Our findings underscore the pitfalls of assuming that scarcity will have the same result on demand regardless of context.

Accordingly, to better understand how scarcity impacts vaccination intentions, we conducted an additional study ($N = 243$, student sample). In this study, we used an incidental (i.e., unrelated to the decision task) manipulation of resource scarcity (Roux et al., 2015) instead of an integral manipulation of COVID-19 vaccine scarcity (i.e., product scarcity). A general resource scarcity frame did not influence perceived priority or willingness to receive a vaccine (both $ts > 1$). This suggests that chronic resource scarcity (e.g., poverty) or transient resource scarcity unrelated to vaccines do not decrease or increase vaccine acceptance and perceived priority. If scarcity reduces willingness to receive a vaccine due to perceptions of lower priority to be vaccinated (our proposed mechanism), then it is intuitive that incidental scarcity does not change willingness to receive a vaccine. Instead, it is the scarcity of vaccines per se that changes individuals' beliefs and intended behaviors.

Indeed, the vast majority of the scarcity literature suggests that product scarcity increases demand, to the point that consumers may even switch brands when they cannot access a product and a direct substitute is available (Biraglia et al., 2021; Das et al., 2021). Building on our results and the relatively meager research on boundary conditions for resource scarcity resulting in generous, not only selfish behavior (e.g., Roux et al., 2015), we propose that in vaccination and related contexts, the effects of product scarcity on demand will be contingent on prosocial considerations. In the vaccination domain, the benefits accrue not only to the individual but also to the general public. In this public health context, access to the scarce product is controlled by medical professionals, governmental agencies, or other entities. Scarcity's deleterious effects (i.e., depletion or ineffective allocation of finite resources) can be reduced by creating informal or institutionalized access rules or by having agents (i.e., gatekeepers) regulating consumption (Osés-Eraso & Viladrich-Grau, 2007; Ostrom, 1990). Individuals may be prone to conserve scarce resources for others if they are altruistic and encounter a system that they believe to be reasonably fair, which can reduce demand for a good (e.g., COVID-19 vaccines).

Notably, previous studies had considered more the effect of resource scarcity on altruistic behaviors by showing how these were moderated by both the benefits of the behavior and the costs to the self (Goldsmith et al., 2020; Roux et al., 2015). In contrast, our study considered the effect of vaccine scarcity (i.e., product scarcity) on willingness to receive a vaccine (which has benefits for self and others). We showed that participants scoring high in compassion for others were more likely to have reduced interest in the COVID-19 vaccine. In contrast, those scoring low in compassion had a higher willingness to receive the vaccine.

In addition, scarcity may also reduce one's sense of priority for receiving a vaccine due to the role gatekeepers play in the access to COVID-19 vaccinations and preventative healthcare. This diminished

perceived responsibility can reduce vaccination intentions and perceived priority, as individuals may internalize that their priority—especially in the scarcity condition—is being determined by an external agent and therefore out of their control. Hence, public health campaigns should deemphasize the scarcity of healthcare services, especially those with public benefits, such as vaccinations or smoking cessation programs (Novotny & Zhao, 1999). Similar dynamics are expected in other domains like voting, where gatekeepers control access and the individual benefits for participation are minimal, but the public benefit from high voter turnaround is considerable (Bendor et al., 2003). Previous research has found a negative correlation between voter turnout and the availability of polling machines (Highton, 2006). Paradoxically, voting rights organizations' push for systematic change by emphasizing the lack of adequate polling places in certain neighborhoods may inadvertently depress voting turnout in the short term.

Finally, Study 2 revealed that risk, as expected, increases perceived priority to be vaccinated. That is, participants with a higher risk of health complications indicated that getting the COVID-19 vaccine was a higher priority than those participants with a lower risk of complications. Interestingly, even for this group of high-risk individuals, the scarcity of COVID-19 vaccinations still decreased the perceived priority and willingness to be vaccinated. This could be because not even high-risk individuals surmise that they should have more priority when vaccines are scarce. Ultimately, these surprising results could also be because risk assessments are subjective in healthcare contexts, depending on such factors as distance to pandemic epicenters (Li et al., 2021), and is even potentially malleable depending on message cues (Menon et al., 2002; Murdock & Rajagopal, 2017). Our research highlights that extra care is warranted when considering risk in a healthcare context.

6.1 | Limitations

Our studies used hypothetical scenarios and were conducted when mass vaccination programs were either in the planning phase or hardly initiated. Therefore, the public had limited information about the efficacy and safety of the COVID-19 vaccines. Moreover, as vaccination rates are increasing across the world, the scarcity of COVID-19 vaccines might gain a dramatically different meaning compared to the one utilized in the current research. For example, various governments (e.g., U.S.) have reduced COVID-19 vaccines scarcity locally, guaranteeing the availability of vaccines in their own country by adopting laws such as Defense Production Act, but by doing so, they—inadvertently or not—increased scarcity globally (Astor & Savage, 2021). As a substantial number of consumers from impoverished countries face extreme levels of resource scarcity (Hill & Martin, 2012), they may remain excluded from the supply of vaccines in the near future and continue to experience product (i.e., vaccine) scarcity.

In both studies, vaccine scarcity was justified in two ways. Firstly, we told participants that manufacturers were working around the clock so that everyone could be vaccinated as soon as possible, although there were still not enough vaccines for everyone (Study 1 and Study 2). Secondly, we justified scarcity by mentioning that priority was currently given to "at risk" (Study 1) or "high risk" (Study 2) groups. It is possible that the second justification, although ecologically valid, as it was consistent with how the distribution of the COVID-19 vaccines proceeded at the time of the data collection, had impacted participants' perceived priority and willingness to receive the vaccine. As such, it may have made participants think that they were not (or less) at risk or made them not want to be associated with high-risk groups. Given that in Study 2 health risk increased perceived priority to be vaccinated, this alternative explanation is unlikely because participants (1) were told that there were likely not enough vials for everyone—a clear signal of vaccine scarcity, and (2) were asked to imagine they received a notification from their doctor that their clinic can offer them a vaccine—hence bypassing the judgment about their own risk or lack thereof.

Another plausible explanatory mechanism of scarcity effect on willingness to receive a vaccine could be one's rational versus visceral state of mind when making such a decision. Predicting how one would behave in a future situation involves qualitatively different cognitive and emotional processes than actually being in that situation, partly because people overestimate their future emotions' intensity and duration compared to their felt emotions (Goldsmith & Dhar, 2013; Wilson & Gilbert, 2005). Moreover, when answering our questionnaire, people may have had empathy gaps (Loewenstein, 2005), that is, being in an affectively "cold" state (e.g., not feeling that vaccines are actually scarce) and therefore underappreciating how they would feel and behave when in an affectively "hot" state (e.g., when vaccines are truly scarce). If the scarcity manipulations we used induced participants to think that scarcity was an experimental by-product rather than a reality, their decreased willingness to receive a vaccine might reflect a more rational—or even a socially desirable—response rather than their 'natural' response. However, if the vaccine availability was low, selfishness (e.g., Kristofferson et al., 2017; Roux et al., 2015) or arousal (Zhu & Ratner, 2015) might be strong enough to override these more altruistic intentions. However plausible, we believe that these explanations are unlikely because scarcity was a factual reality at the time of our data collection. Hence, our manipulation, albeit constructed for experimental testing, merely reflected the current situation.

6.2 | Future research

Our proposed model helps better predict the effects of scarcity on demand in different contexts, including public health. Future research could examine further the relationship between perceived priority and behavioral intentions. In our studies, perceived priority was an antecedent of the intended behavior (i.e., willingness to schedule a vaccination), which in turn is an essential antecedent of actual behaviors (in this case, receiving a vaccine). In addition, priority can be

understood both in terms of the importance and urgency of an action (Zhu et al., 2018), so additional studies could explore how these two factors influence vaccination intentions.

Future research should test additional reasons why scarcity reduces the sense of priority and willingness to receive a vaccine. For example, different reasons such as prosociality, motivated reasoning, and feelings of powerlessness and resignation may operate simultaneously, and individual as well as societal factors, such as collectivism (Cho et al., 2021), must be considered holistically. Furthermore, in Study 2, we used a one-item measure for compassion for individuals in high-risk groups for COVID-19. Future research on the effects of scarcity on vaccination intentions could explore different types of compassion, both specific to COVID-19 and more general concern for others (Batson et al., 2007). In addition, new research should further explore the relationship between product scarcity and individual characteristics related to compassion and prosociality. Since the majority of the product scarcity research states that it increases demand for products, it will be interesting to see if compassion moderates this effect in other contexts.

Although efficacy studies of COVID-19 vaccines are proceeding expeditiously, questions regarding their development pace and long-term efficacy remain. As new variants emerge, seasonal boosters may be required. Repeated shots may impact priority and willingness to receive a vaccine, especially among individuals who already experienced hesitancy (both those who eventually accepted the vaccine and those who still have not; Yong, 2021) and among vulnerable populations. Medical providers can also increase their efforts to build trust with vulnerable patients, and consequently increase vaccine acceptance by displaying cultural competency and advocating for eliminating racial and ethnic disparities (Cook et al., 2005; Ngo-Metzger et al., 2006).

Notably, members of vulnerable populations in terms of health outcomes often also suffer from financial deprivation. This chronic resource scarcity means that they may have limited access to necessary products for recovery (Baker, 2009)—in our context, scarce vaccines during a global pandemic. Individuals who grew up poor (i.e., who experienced chronic resource scarcity at young ages) tend to be more patient (Thompson, Hamilton, et al., 2020) and more accepting of substitutes in situations of product scarcity (Thompson, Banerji, et al., 2020). Ironically, their resilience may make them less likely to advocate for access and more likely to be dissuaded by the scarcity of vaccines. Therefore, future research should directly address the impact of vaccine scarcity on the vaccine acceptance of vulnerable populations.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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