Overcoming vaccine hesitancy: Evidence from Italy during the COVID-19 pandemic

Overcoming Vaccine Hesitancy:

Evidence from Italy during the COVID-19 Pandemic

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Abstract

Objectives: Here we investigate whether releasing COVID-19 vaccines at open-day events boosted Italy's vaccination campaign in 2021. This strategy exploits insights from psychology.

Study design: We built an original dataset covering 200 days of vaccination data in Italy, including "open day" events. Open-day events (in short: open days) are instances where COVID-19 vaccines were released only for a specific day at a specified location (usually, a large pavilion or a public building). Importantly, releasing vaccines through open days instead of the usual appointment channel leaves the supply of vaccines unaltered. Our dependent variables are the number of total and first doses administered in proportion to the eligible population. Our key independent variable is the presence of open-day events in a given region on a specific day.

Methods: We analyzed the data using regression with fixed effects for time and region. The analysis was robust to alternative model specifications.

Results: We find that when an open day event was organized, in proportion to the eligible population, there was an average 0.39-0.44 percentage point increase in total doses administered and a 0.30-0.33 percentage point increase in first doses administered. These figures correspond to an average increase of 10,455-11,796 in total doses administered and 8,043-8,847 in the first doses administered.

Conclusions: Releasing vaccines by organizing open-day events was associated with an increase in COVID-19 vaccinations in most Italian regions. These results call for further study of the effectiveness of open days to increase vaccinations and protect against other infectious diseases or future pandemics.

Keywords: Vaccine hesitancy; COVID-19; vaccinations; open-day events; behavioral public health; Italy

Lay abstract: Here we investigate whether releasing COVID-19 vaccines at open-day events boosted Italy's vaccination campaign in 2021. We built an original dataset covering 200 days of vaccination data in Italy, including "open day" events. Open-day events (in short: open days) are instances where COVID-19 vaccines were released only for a specific day at a specified location (usually, a large pavilion or a public building). Importantly, releasing vaccines through open days instead of the usual appointment channel leaves the supply of vaccines unaltered. We find that administering COVID-19 vaccines at open-day events where vaccines are distributed at prominent locations in limited quantities and for a limited time was associated with a statistically significant increase in total and first doses administered. Releasing vaccines by organizing open-day events was associated with an increase in COVID-19 vaccinations in most Italian regions.

Introduction

Vaccines against COVID-19 have been a key pillar of the public health strategy to mitigate the COVID-19 pandemic [1–3], and yet many citizens around the world have been reluctant to get vaccinated [4,5]. In response to the complex landscape of vaccine hesitancy, researchers and public authorities around the world have attempted a broad range of communication initiatives and behavioral strategies to encourage citizens to receive the shot [6,7]. In this paper, we focus on Italy -the first epicenter of the COVID-19 outbreak outside of China, where vaccine hesitancy has posed a significant public health challenge even before COVID-19 vaccines became available. For instance, in a survey conducted in 2015-2016, about 16% of Italian parents were hesitant or opposed to vaccinating their children [8]. Two surveys conducted in 2020 in Italy revealed a 31% hesitancy among adults to vaccinate against influenza [9] and a 14% hesitancy to vaccinate against a future COVID-19 vaccine among university students [10]. At the same time, Italy offers an excellent case study because it lacks the political polarization in vaccine hesitancy and health policy [11] that is seen elsewhere, such as in other European countries [12] or the United States [13–16].

In Italy, a key measure to counter COVID-19 vaccine hesitancy was the introduction of 'open-day' distribution initiatives overseen by regional administrations [17]. At an open day event, a limited quantity of COVID-19 vaccines are released *only for that day* and at a particular location (typically, a large fair pavilion that accommodates large crowds). Importantly, open-day events leave the supply of vaccines unaltered, but they concentrate the release of vaccines on a single day at a particular location instead of spreading it out over an indefinite period of time (e.g., through vaccination booking portals). Any leftover vaccines go back to the general vaccine supply, if unexpired.

The timing of the release of vaccines is crucial to why open-day events can be more successful than regular vaccination campaigns where vaccines are ever available through a booking portal. Amongst many different initiatives and strategies that have been rolled out around the world, open-day events in Italy are interesting from a public health perspective because they build on basic features of human psychology, such as the fear of missing out (FOMO) [18] and the psychology of scarcity [19,20]. Since they exploit basic traits of human nature, these strategies potentially lend themselves to tackling a variety of public health issues. Notably, leveraging natural scarcity or creating FOMO motivations were listed among the strategies for promoting COVID-19 vaccinations proposed by Wood and Schulman in the New England Journal of Medicine (NEJM) in 2021 [7]. The proposals in the NEJM rest on solid ground in the psychology of consumer behavior [20,21] but still await empirical validation. To satisfy this need, in this paper, we leverage a novel dataset on COVID-19 vaccinations in Italy to test the efficacy of open-day events as a strategy to increase the uptake of COVID-19 vaccines in the population.

Previous research in the field of marketing found that when consumers have the perception that a product is hardly available, they may attribute a higher value to that product. Thus, companies strategically create perceptions of product scarcity to increase consumers' interest in them. Typical strategies used in marketing include restricting the timing of sales, restricting the quantity released of a given product, or a combination of both strategies [20,21]. Creating a sense of scarcity is so vital to boosting sales that famous psychologist of influence Robert Cialdini dubbed scarcity as one of the six principles of persuasion [22]. Specifically, a meta-analysis of hundreds of effect sizes in studies of product marketing found that creating a sense that a product is scarce through limited release for a limited time works particularly well when consumption of the product is conspicuous and requires high involvement from the consumer [21]. COVID-19 vaccines share these features, to the point that people often posted vaccination selfies on social media and shared their post-vaccine experiences [23,24].

Together, insights from psychology and marketing inform the hypothesis that releasing COVID-19 vaccines in limited quantities and for a limited time (open-day events) should increase the administration of COVID-19 vaccines compared to the status quo where vaccines are released outside of these special events. Of course, this *limited-release hypothesis* takes into account the number of vaccine doses available and the number of patients eligible. To test the limited-release hypothesis, we turn to our original dataset from Italy.

Methods

Dataset

We constructed the original dataset used in this paper starting from daily COVID-19 vaccination data in Italy ranging from December 27, 2020, to July 14, 2021, available on GitHub at the following link:

https://github.com/italia/covid19-opendata-vaccini. From this dataset, we extracted the vaccine doses delivered to each of the 20 Italian regions; the number of first- and total COVID-19 vaccine doses administered daily; the region where the doses were administered to patients; and information about patient eligibility to get vaccinated. We augmented this dataset with data about open-day vaccination events held between April and July 2021 in each region. We collected information about open-day events from publicly available announcements reported by online local and regional Italian newspapers. In some cases, we were able to collect detailed information about each open-day event, including the city, the exact address (e.g., a hospital), the number of available doses, the brand of the vaccines available, and the age groups at which these initiatives were aimed. However, most of the time, the available data includes only whether a specific number of open-day events were held in a given region on a certain day. Due to the lack of available data, the analysis is not partitioned by vaccine brand and does not include demographic information about vaccine recipients. As a result, our final dataset includes 200 data points (one per day) for each of the 20 Italian regions. Figure 1 shows the number of regions that organized at least one open-day event for every week in our sample. The breakdown of open-day events by region is illustrated in Figure A1.

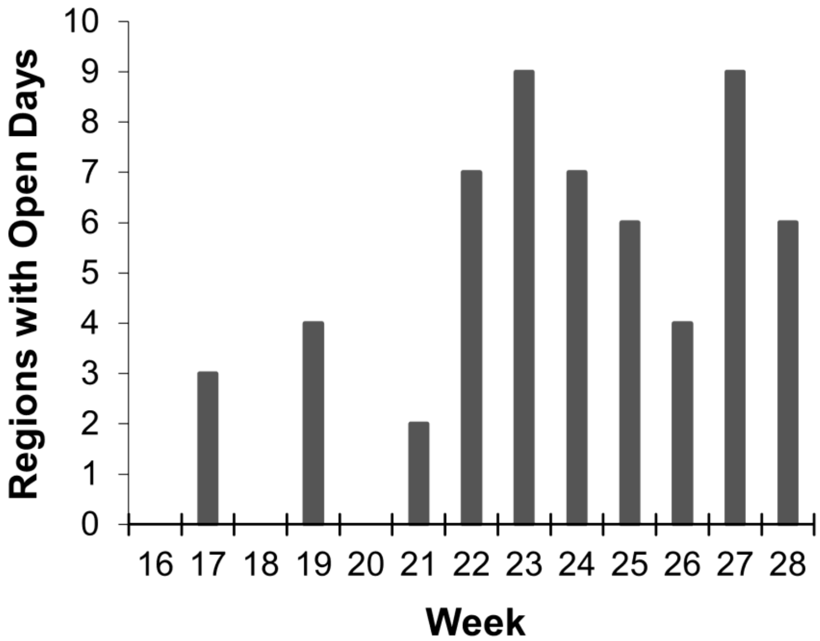

Figure 1. The number of regions organizing at least one open-day event from the third week of April 2021 to the second week of July 2021. The figure shows that the number of regions organizing at least one open-day event peaked in the last weeks of May and June.

Statistical analysis

To investigate the relationship between vaccine administrations and open-day events, we examined the period from December 27, 2020, when vaccines started to become available, until July 14, 2021, when the data collection ended. We constructed a dichotomous variable that is equal to 1 if at least one open-day event was organized that day, or 0 if no open-day event took place. In our analytical strategy, we study the impact of open day events on COVID-19 vaccinations by using as our main dependent variable the total doses administered/eligible population ratio, where the eligible population includes patients aged 12 or older.

Specifically, we estimate the following equation:

$$\frac{doses\ administered}{eligible\ population_{i,t}} = \beta_0 + \beta_1\left(open\ day\ event_{i,t}\right) + \beta_2 Z_i + \varepsilon_{i,t} \quad [1]$$

where the dependent variable is the ratio between the number of administrations and the number of people eligible to receive the vaccine, $open\ day\ event_{i,t}$ is the open-day dummy variable, Z_i represents unobserved time-invariant heterogeneities across regions, $\varepsilon_{i,t}$ is the error term, and $i\ and\ t$ are a region and time index, respectively. We use a panel regression with fixed effects for region and time, since statistically significant Hausman tests consistently showed that the fixed effects models outperformed panel regressions with random effects (a model comparison is available in Table A1). We carried out all our analyses using the Stata 14 statistical software. We report two-tailed tests of significance for all analyses. However, since the limited-release hypothesis is directional, we also report the results of one-tailed tests of significance.

Results

First, we report the descriptive statistics of the study variables. Table 1 shows the main descriptive statistics of the variables present in our dataset. It is worth mentioning a few notable figures. The number of daily doses administered averaged approximately 15,000, with a maximum of 117,252.

The dataset includes a binary open-day variable, which keeps track of whether *any* number of open-day events were organized on a given date, and a count variable, which records the specific *number* of open-day events that were organized on a single day. The count variable ranges from 0 to 21 open-day events recorded. The weekend open-day binary variable tracks whether an open-day event was organized on a weekend (Saturday, Sunday) or during the week (Monday through Friday). Figure A2 reveals that 45% of open days were held over the weekend (38 on Saturdays and 35 on Sundays). Most open-day events (55%) were held during the week, ranging from 24 on Fridays to 12 on Mondays. As a result, most vaccinations at open-day events occurred on weekdays (51%) relative to the weekend (49%), as seen in Figure A3, although most single-day vaccinations at open-day events happened on Saturdays (27%). In some instances, there were caps on patients' eligibility to receive the vaccine. These caps reflected age targets for vaccine administrations. Minimum age eligibility was as low as 12 years old and as high as 80. Maximum age eligibility ranged from 16 to 100 years old. The number of doses delivered was typically positive but could also be occasionally negative when doses were returned. The number of eligible individuals ranged from just over 100,000 to just shy of nine million, which depends on the population size in a given region. Finally, we report descriptive statistics for the ratios between key measures and the eligible population.

Next, we look at the results of our analysis that aims at testing the limited-release hypothesis. When at least one open-day event was present, the total doses administered relative to the eligible population increased by 0.44 percentage points (Table 2). In regions with large populations such as Campania and Tuscany, this effect translates into 22,359 and 14,709 additional doses administered, respectively. Meanwhile, in more sparsely populated regions such as Trentino Alto Adige and Marche, this effect corresponds to 4,188 and 6,012 additional doses, respectively. As a robustness check, in a second model, we control for the doses delivered relative to the eligible population (Table 2, model 2). Compared to the previous model, the coefficient for open-day events is slightly smaller, but it always remains positive and statistically significant (0.39 percentage point increase in vaccines administered relative to the eligible population). In an additional robustness check, we add the weekend open day variable to the model and find that the coefficient for weekend is not significant. Meanwhile, the coefficient for open-day events remains positive and significant (Table A4).

Table 1. Descriptive statistics.

Variable	N	M	SD	Min	Max
Doses administered (daily)	3,916	15,012.74	18,892.53	1	117,252
Open day (Yes/No)	4,000	0.040	0.20	0 (No)	1 (Yes)
Open day (Count)	4,000	0.11	0.96	0	21
Minimum age eligibility	144	32.54	18.61	12	80
Maximum age eligibility	144	88.19	22.85	16	100
Doses delivered	2,059	30,917.45	64,327.88	-49,955	779,713
Weekend open day	4,000	0.018	0.13	0 (No)	1 (Yes)
First doses administered	3,916	9,005.31	12,029.30	0	93,189
Eligible individuals	4,000	2,680,845	2,191,825	112,534	8,975,783
Doses delivered/eligible population ratio	2,059	0.011	0.02	-0.01	0.09
First doses administered/eligible population ratio	3,916	0.0032	0.0025	0	0.0139
Total doses administered/eligible population ratio	3,916	0.0055	0.0038	2.56e-07	0.02

Note. N = observations; M = mean; SD = standard deviation; Min = minimum; Max = maximum. A negative number of doses delivered means that some doses were returned before being administered to patients.

To further investigate the effect of open-day events on vaccinations, we estimate these models again, this time using the *number* of open-day events instead of the binary measure of open-day events. As shown in Table 1, the number of open-day events ranges from 0 to 21 across regions, allowing us to estimate the marginal effect of organizing an additional open-day event. These models yield similar results (Table A2). With each additional open-day event, the total doses administered relative to the eligible population increased by 0.05 percentage points. In highly populated regions such as Tuscany and Campania, this translates into 1,671 and 683 additional doses, respectively. In less populous regions such as Calabria and Marche, this effect corresponds to 850 and 683 additional doses, respectively.

Table 2. Regressions of the *total* doses administered/eligible population ratio on the binary open day variable and the doses delivered/eligible population ratio.

	Model 1			**Model 2**		
	Coef	**SE**		**Coef**	**SE**	
Open day (Yes/No)	0.0044	0.0003	***	0.0039	0.0004	***
Doses Delivered/Eligible population ratio	–	–		0.0543	0.0048	***
Constant	0.0053	0.00006	***	0.0056	0.00009	***

Note. Model 1: N = 3,916. Model 2 = N = 2,050. Coef. = Beta coefficient. SE = Standard error. The fixed effects model includes region- and time-fixed effects. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$. The significant Hausman test ($p < .001$) indicates that the fixed effects model outperforms the random effects model.

The marginal effect of open-day events disaggregated by region is displayed in Figure 2. The left panel indicates the marginal effects of organizing at least one open day. The left panel reveals that the largest effects were in Sardinia, Trentino Alto Adige, and Campania. The open-day coefficients were positive and statistically significant in most regions (two-tailed tests). Exceptions include Basilicata, Calabria, Emilia Romagna, Liguria, Apulia, Valle d'Aosta, and Veneto, where the confidence interval overlaps with zero. However, considering that the hypothesized effect of open days is positive, when we use a one-tailed test, the coefficient for Valle d'Aosta ($p = .036$) reaches statistical significance as well. Additionally, with one-tailed tests, the coefficients for Emilia Romagna ($p = .093$) and Liguria ($p = 0.099$) are marginally significant.

The right panel plots the marginal effects of open days using the count variable. Thus, it indicates the marginal effect of organizing an additional open day. The largest effects of an additional open day were in Lazio and Sardinia. Consistent with the binary measure, most coefficients were positive and statistically significant, except in Basilicata, Calabria, Emilia Romagna, Liguria, Apulia, and Veneto (two-tailed tests). When instead we consider the directional hypothesis of a positive effect (one-tailed tests), the coefficient for Liguria (p = .098) is marginally significant.

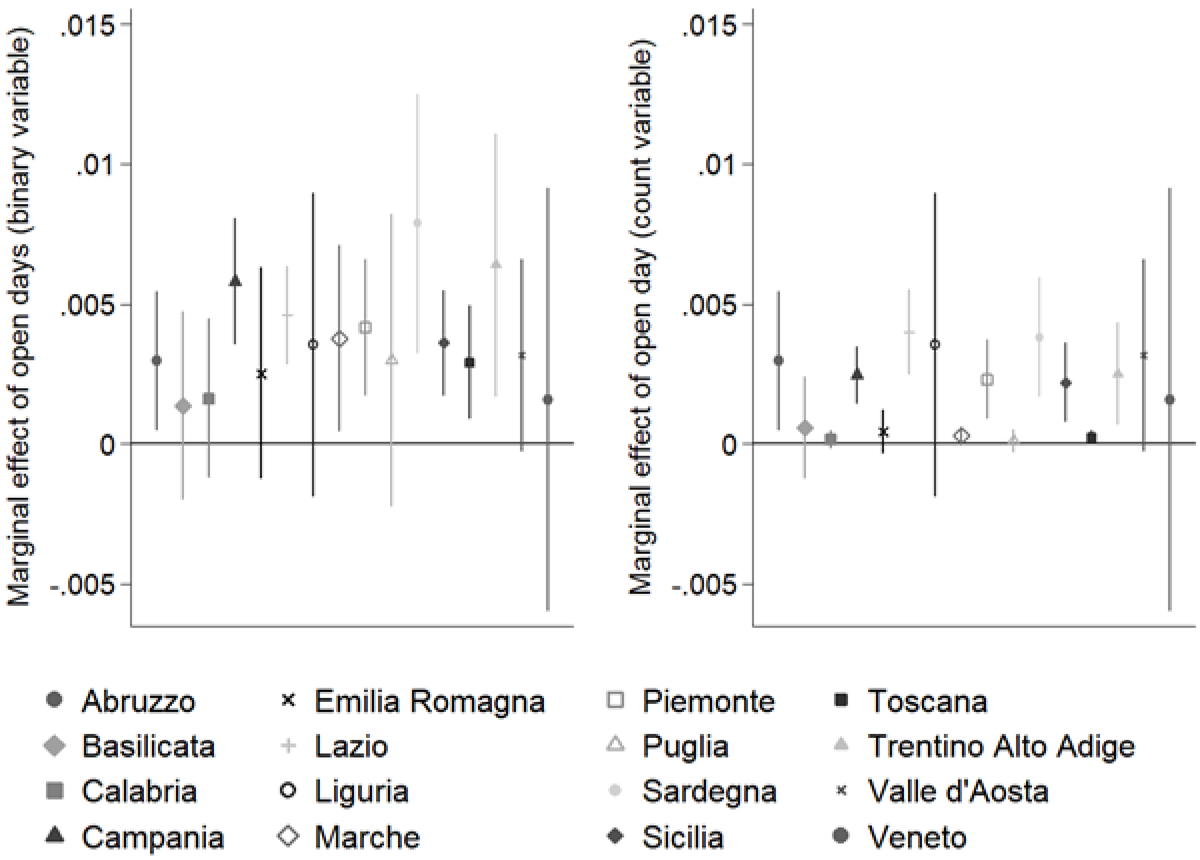

Figure 2. The marginal effect of organizing open day events in a specific region on *total* doses administered. The error bars indicate 95% confidence intervals. The panel on the left shows the marginal effects of open days using the binary measure (Yes/No). The panel on the right displays the marginal effects of open days using the count variable, and thus indicates the effect of organizing an additional open day. Four regions (Friuli Venezia Giulia, Lombardy, Molise, Umbria) are omitted because no open-day events were recorded there in the period considered in this study. Significance tests using both one-and two-tailed tests are reported in Table A7 (left panel) and Table A8 (right panel).

Next, we focus on the people who had never been vaccinated against COVID-19 (Table 3). The results show that, even in this case, the presence of open days is associated with a 0.33 percentage point increase in first dose administrations, which in a large region such as Tuscany corresponds to 11,032 additional first doses administered relative to the eligible population. Adding the control variable to this model, the results remain similar, with a 0.30 percentage point increase in the first doses administered. Taking again the example of Tuscany, this is equivalent to 10,029 extra first doses administered in proportion to the eligible population. A robustness check adding the (statistically insignificant) weekend open day variable shows a similar pattern to the analysis of total doses (Table A5).

We repeat the analysis of first doses administered by examining the effect of each additional open-day event instead of the binary open-day event variable. With each additional open-day event, there was a 0.04 percentage point increase in first dose administrations (Table A3). In a large region such as Tuscany, this effect corresponds to 1,337 additional first doses administered relative to the eligible population. Adding the control variable to this model, the results remain similar, with a 0.03 percentage point increase in the first doses administered. Keeping Tuscany as an example, this effect is equivalent to 1,003 extra first doses administered in proportion to the eligible population.

Table 3. Regressions of the *first* doses administered/eligible population ratio on the binary open day variable and the doses delivered/eligible population ratio.

	Model 1			**Model 2**		
	Coef	**SE**		**Coef**	**SE**	
Open day (Yes/No)	0.0033	0.0002	***	0.0030	0.0002	***
Doses Delivered/Eligible population ratio	_	_		0.0304	0.0032	***
Constant	0.0032	0.00004	***	0.0033	0.00006	***

Note. Model 1: N = 3,916. Model 2 = N = 2,050. Coef. = Beta coefficient. SE = Standard error. The fixed effects model includes region- and time-fixed effects. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$. The significant Hausman test ($p < .001$) indicates that the fixed effects model outperforms the random effects model.

We include a graphical presentation of the marginal effects of open days also for the analysis of the first doses administered in proportion to the eligible population (Figure 3). The left panel shows the effect of open days using the binary measure. Thus, it graphs the effect of organizing at least one open day in each region that organized them. We find that the largest effect was in Sardinia, Campania, and Trentino Alto Adige. Similar to total doses, the coefficient for open days was positive and significant in most regions, this time with fewer exceptions. In Abruzzo, Basilicata, Calabria, and Veneto, there are no statistically significant effects when using two-tailed tests. However, when we use one-tailed tests following the directional hypothesis of a positive effect of open days, the coefficients for Abruzzo (p = .070) and Veneto (p = .090) are marginally significant.

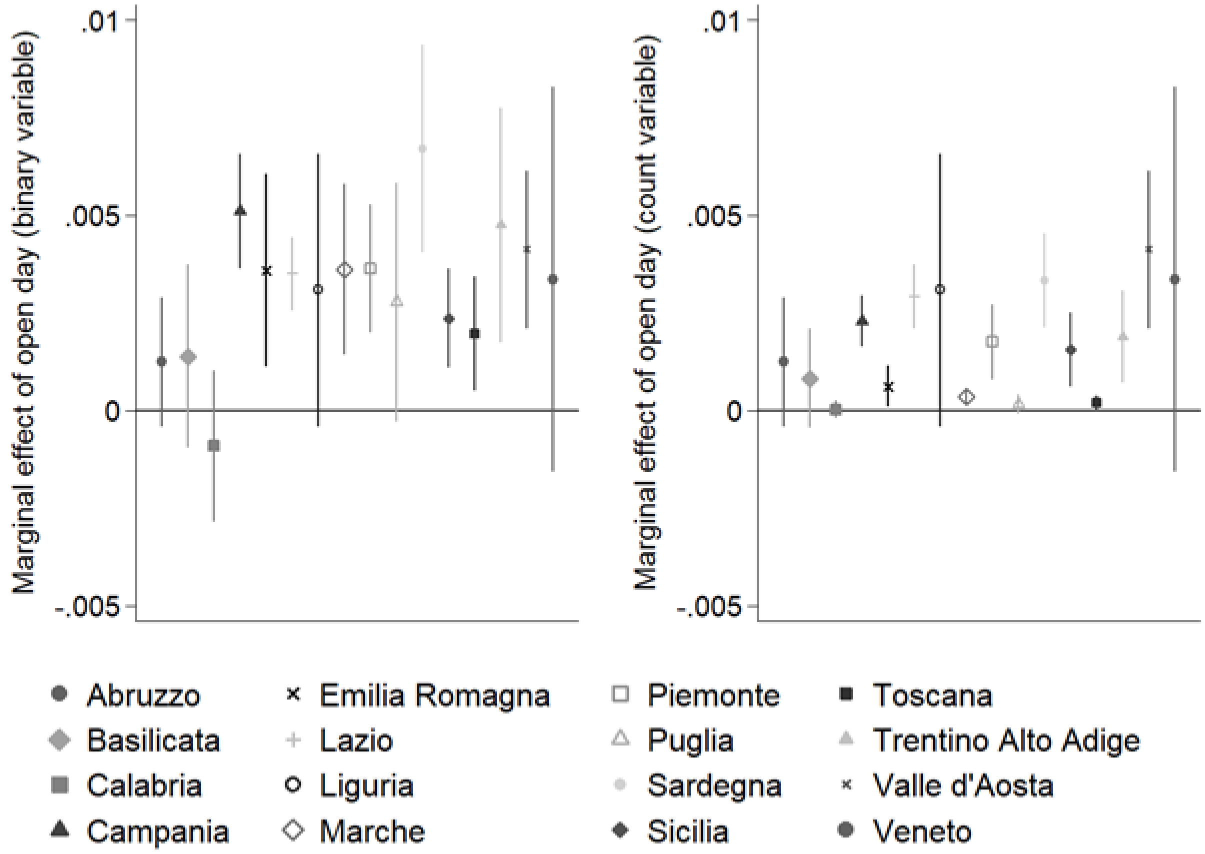

Figure 3. The marginal effect of organizing open day events in a specific region on the *first* doses administered. The error bars indicate 95% confidence intervals. The panel on the left shows the marginal effects of open days using the binary measure (Yes/No). The panel on the right displays the marginal effects of open days using the count variable, and thus indicates the effect of organizing an additional open day. Four regions (Friuli Venezia Giulia, Lombardy, Molise, Umbria) are omitted because no open-day events were recorded there in the period considered in this study. Significance tests using both one-and two-tailed tests are reported in Table A8 (left panel) and Table A9 (right panel).

Looking at the marginal effects of organizing an additional open day (Figure 3, right panel), we find that the largest effects were in Valle d'Aosta and Sardinia. Again, coefficients were positive and significant in most regions, with even fewer exceptions: Abruzzo, Basilicata, Calabria, Apulia, and Veneto (two-tailed tests). However, considering a directional hypothesis and using a one-tailed test, the coefficients for Abruzzo (p = .070) and Veneto (p = .090) are marginally significant.

Discussion

We tested the limited-release hypothesis, which predicts that releasing COVID-19 vaccines in limited quantities on select days ("open days") boosts the number of doses administered although the supply of vaccines remains unchanged. Using an original dataset of open-day events organized in sixteen Italian regions between April and July 2021, we find support for the limited-release hypothesis: open-day events had a positive effect on vaccinations in most regions. Consistent with expectations, open days boosted administrations of both total and first doses. These effects were robust to different econometric specifications, including the use of fixed or random effects, controlling for doses delivered, accounting for the population eligible to receive the vaccine, and administering the vaccines on open days conducted during the weekend versus weekdays. The results support the proposals by Wood and Schulman in the NEJM to exploit basic features of human psychology such as fear-of-missing-out (FOMO) motivations and the psychology of scarcity in order to increase the number of vaccinations against COVID-19 [7].

An alternative interpretation is that open-day events simply make it easier for people to access vaccines. The accessibility interpretation would be misleading, however, because organizing a vaccination distribution at a single pavilion, if anything, *reduces* the convenience of access instead of increasing it, since normally, COVID-19 vaccines are available in pharmacies, doctor's offices, and hospitals at any given time. Instead, the *timing* of open-day events follows the limited-time offer model that is widely exploited in consumer marketing, since the limited-time component draws consumer interest. For example, previous work found that time-independent promotions fail to accelerate purchases, whereas limited-time promotions quickly attract purchases [25]. A further indication that the vaccination boost from open-day events cannot be explained away as the result of increased accessibility comes from the fact that 55% of open-day events were held during the week, resulting in 51% of open-day doses administered at weekday open days. If increased accessibility, instead of a sense of urgency, was the main explanation for the results, we would expect a clear majority of open days and open-day doses administered to be on weekends, when most people are off work, but this is not the case. Still, organizing open-day events on weekends, when most medical offices, hospitals, and some pharmacies may be closed or restrict access to the public, may provide expanded access to vaccine doses in addition to exploiting the sense of urgency created by open-day events.

It is important to underscore that inducing a sense of urgency through limited-time releases of vaccines in limited quantities at open-day events does not raise any ethical concerns about restricting access to the public. Crucially, open-day events leave the supply of vaccine doses unchanged but concentrate the supply of the doses in a particular place and at a particular time, fostering a sense of scarcity and urgency to get a vaccine. Ethical concerns are also dispelled by vaccination outcomes, which indicate that open-day events boosted vaccinations. In turn, more vaccinations reduce healthcare costs and ultimately save lives. Together, these findings encourage further study of how initiatives that create a sense of scarcity and urgency such as open-day events can help achieve vaccination goals and ultimately improve public health outcomes.

Limitations and Conclusions

This research comes with limitations that future research could address. Importantly, our dataset covers only Italy and is purely observational because the organization of open-day events was not randomly assigned but was instead decided by each region. A possible concern is that regions that were more capable of organizing open-day events self-selected themselves into offering these initiatives. However, this possibility seems unlikely since among the four regions that did not organize there is Lombardy, which is widely recognized as providing one of the best public healthcare systems in Italy [26]. More generally, the fact that 75% of Italian regions organized at least one open day mitigates worries about selection effects. Also, in addition to comparisons between regions, our panel dataset allows us to make within-region comparisons for weeks with and without open-day events, which further enhances the validity of the dataset to make inferences about the association between open-day events and an increase in COVID-19 vaccinations.

Another possible limitation associated with an observational dataset is that different regions may have organized open-day events differently. For example, some regions may have been more efficient; may have better communicated the rollout of these initiatives with the public; may have given additional small incentives for receiving the vaccinations; or, they may simply have managed these initiatives better overall. These factors may explain why the coefficient sizes differed across regions and why in Calabria - a region which consistently ranks at the bottom in Italy for the quality of healthcare [26], open-day events did not significantly increase vaccinations in proportion to the eligible population. However, in our main analysis, the coefficient for open days was robust to the inclusion of region-fixed effects which capture regional differences. Thus, the robustness of the results to region-fixed effects allays concerns over different implementations of the open day events at the regional level.

Finally, another element that may influence vaccination rates is vaccine mandates. In Italy, COVID-19 vaccines became compulsory for healthcare workers in April 2021 [27]. While the vaccine mandate increased overall vaccinations, it does not alter the effect of open-day events, which is the focus of the present research. Similar considerations apply to the vaccine mandates for school children rolled out in July 2017 against 10 infectious diseases. While there is suggestive evidence that the mandates increased vaccinations also for non-compulsory vaccines [28], any spillover effect would increase the baseline number of vaccinations but does not affect the impact of open-day events on COVID-19 vaccinations.

Overall, these findings suggest actionable insights for how to reach a wider population in future vaccination campaigns against coming pandemics and call for more research on marketing strategies to promote vaccination. Future work could test the effectiveness of limited releases of vaccines in controlled settings, such as laboratory or field experiments, where researchers can reap the benefits of experimental control. To this end, testing the effects on the uptake of vaccines other than the ones against COVID-19 could also prove helpful. Since COVID-19 vaccines have become available only recently, it is plausible that the behavioral effects of limited vaccine releases might be different for vaccines that have been available for decades, such as influenza vaccines. For example, the effects could be larger because of less fear toward the vaccines or smaller because people may consider COVID-19 as a larger health threat than other viruses such as influenza, and thus be less susceptible to FOMO motivations and the psychology of scarcity. We hope that future work will explore these extensions, since vaccinating the largest possible patient population is critical to mitigating or even eradicating many infectious diseases which are a threat to global public health.

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Appendix

Table A1. Model comparison of the regressions of the *total* doses administered/eligible population ratio on the number of open day events and the doses delivered/eligible population ratio.

	Pooled OLS			Fixed Effects			Random Effects		
	Coef.	**SE**		**Coef.**	**SE**		**Coef**	**SE**	
Open day (count)	0.00038	0.0001	**	0.0004	0.0001	***	0.0004	0.0001	***
Doses delivered/eligible population ratio	0.0510	0.0029	***	0.0554	0.0049	***	0.0511	0.0049	***
Constant	0.0058	0.0001	***	0.0057	0.0001	***	0.0058	0.0001	***
Hausman Test		No				0.0000			

Note. N = 2,050. Coef. = Beta coefficient. SE = Standard error. The pooled OLS model includes standard errors clustered at the region level. The fixed effects model includes region-fixed effects. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$. The significant Hausman test indicates that the fixed effects model outperforms the random effects model.

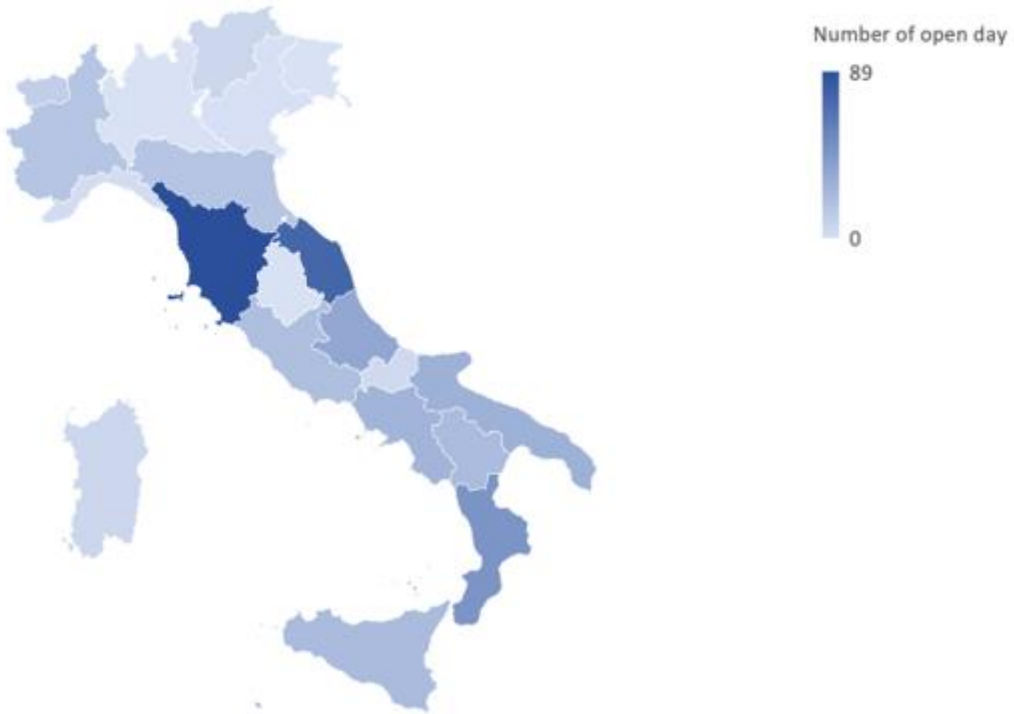

Figure A1. Number of open days in each region (from April 2021 to the second week of July 2021). The figure indicates that Central and Southern Italy organized more open vaccination events compared to the North, with Tuscany holding the highest number of open days (89).

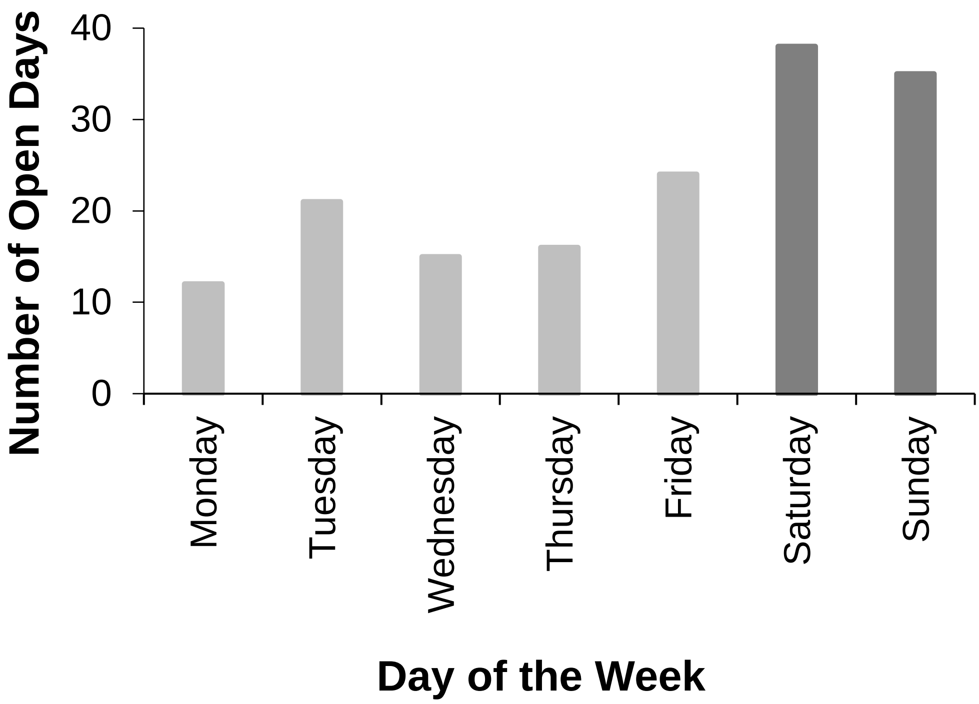

Figure A2. Number of open-day events on each day of the week. Weekends are shaded in dark grey.

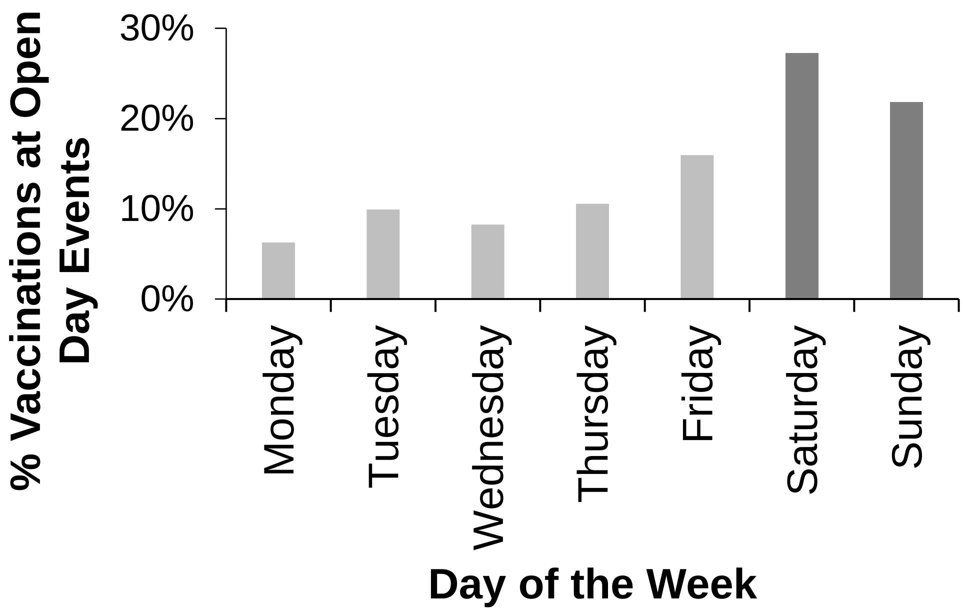

Figure A3. Percentage of vaccinations administered by day of the week during open-day events. Weekends are shaded in dark grey.

Table A2. Regressions of the *total* doses administered/eligible population ratio on the number of open day events and the doses delivered/eligible population ratio.

	Model 1			**Model 2**		
	Coef.	**SE**		**Coef.**	**SE**	
Open day (count)	0.0005	0.0001	***	0.0004	0.0001	***
Doses delivered/Eligible population ratio	_	_		0.0554	0.0049	***
Constant	0.0055	0.0001	***	0.0057	0.0001	***

Note. Model 1: N = 3,916. Model 2 = N = 2,050. Coef. = Beta coefficient. SE = Standard error. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$. Models include region- and time-fixed effects. The significant Hausman test ($p < .001$) indicates that the fixed effects model outperforms the random effects model.

Table A3. Regressions of the *first* doses administered/eligible population ratio on the number of open day events and the doses delivered/eligible population ratio.

	Model 1			**Model 2**		
	Coef.	**SE**		**Coef.**	**SE**	
Open day (count)	0.0004	0.00004	***	0.0003	0.00005	***
Doses delivered/Eligible population ratio	_	_		0.0312	0.0033	***
Constant	0.0032	0.00004	***	0.0034	0.00006	***

Note. Model 1: N = 3,916. Model 2 = N = 2,050. Coef. = Beta coefficient. SE = Standard error. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$. Models include region- and time-fixed effects. The significant Hausman test ($p < .001$) indicates that the fixed effects model outperforms the random effects model.

Table A4. Regressions of *total* doses administered/eligible population ratio on open day events (binary variable) and the doses delivered/eligible population ratio, controlling for open days conducted during weekends.

	Model 1			**Model 2**		
	Coef	**SE**		**Coef**	**SE**	
Open day (Yes/No)	0.0044	0.0004	***	0.0037	0.0004	***
Doses delivered/Eligible population ratio	–	–		0.0545	0.0048	***
Weekend open day (Yes/No)	--	--		0.0005	0.0007	
Constant	0.0053	0.00006	***	0.0056	0.0001	***

Note. Model 1: N = 3,916. Model 2 = N = 2,050. Coef. = Beta coefficient. SE = Standard error. The fixed effects model includes region- and time-fixed effects. * $p < .05$ ** $p < .01$ *** $p < .001$. The significant Hausman test ($p < .001$) indicates that the fixed effects model outperforms the random effects model.

Table A5. Regressions of *first* doses administered/eligible population ratio on open day events (binary variable) and the doses delivered/eligible population ratio, controlling for open days conducted during weekends.

	Model 1			**Model 2**		
	Coef	**SE**		**Coef**	**SE**	
Open day (Yes/No)	0.0033	0.0002	***	0.0028	0.0003	***
Doses delivered/Eligible population ratio	_	_		0.0306	0.0032	***
Weekend open day (Yes/No)	_	_		0.0005	0.0004	
Constant	0.0032	0.00004	***	0.0033	0.00007	***

Note. Model 1: N = 3,916. Model 2 = N = 2,050. Coef. = Beta coefficient. SE = Standard error. The fixed effects model includes region- and time-fixed effects. * $p < .05$ ** $p < .01$ *** $p < .001$. The significant Hausman test ($p < .001$) indicates that the fixed effects model outperforms the random effects model.

Table A6. Significance of marginal effects on *total* doses administered for the open day *binary* variable (controlling for doses delivered) using one- and two-tailed tests.

Region	p-value (one-tailed)		p-value (two-tailed)	
Abruzzo	0.009	*	0.019	*
Basilicata	0.211	n.s.	0.422	n.s.
Calabria	0.129	n.s.	0.258	n.s.
Campania	< .001	*	< .001	*
Emilia Romagna	0.093	†	0.185	n.s.
Lazio	< .001	*	< .001	*
Liguria	0.099	†	0.198	n.s.
Marche	0.014	*	0.027	*
Piemonte	< .001	*	0.001	*
Puglia	0.131	n.s.	0.261	n.s.
Sardegna	0.001	*	0.001	*
Sicilia	< .001	*	< .001	*
Toscana	0.003	*	0.005	*
Trentino Alto Adige	0.004	*	0.008	*
Valle d'Aosta	0.036	*	0.072	†
Veneto	0.341	n.s.	0.683	n.s.

Note. * = Significant at the p < .05 level or better. † = Marginally significant. n.s. = not significant. All significant and marginally significant effects are positive. See Figure 2, left panel.

Table A7. Significance of marginal effects on *total* doses administered for the open day *count* variable (controlling for doses delivered) using one- and two-tailed tests.

Region	p-value (one-tailed)		p-value (two-tailed)	
Abruzzo	0.009	*	0.019	*
Basilicata	0.265	n.s.	0.531	n.s.
Calabria	0.162	n.s.	0.325	n.s.
Campania	< .001	*	< .001	*
Emilia Romagna	0.141	n.s.	0.283	n.s.
Lazio	< .001	*	< .001	*
Liguria	0.098	†	0.196	n.s.
Marche	0.048	*	0.096	†
Piemonte	< .001	*	0.002	*
Puglia	0.334	n.s.	0.668	n.s.
Sardegna	< .001	*	0.001	*
Sicilia	0.001	*	0.003	*
Toscana	0.031	*	0.005	*
Trentino Alto Adige	0.004	*	0.008	*
Valle d'Aosta	0.036	*	0.072	†
Veneto	0.341	n.s.	0.683	n.s.

Note. * = Significant at the $p < .05$ level or better. † = Marginally significant. n.s. = not significant. All significant and marginally significant effects are positive. See Figure 2, right panel.

Table A8. Significance of marginal effects on *first* doses administered for the open day *binary* variable (controlling for doses delivered) using one- and two-tailed tests.

Region	p-value (one-tailed)		p-value (two-tailed)	
Abruzzo	0.070	†	0.140	n.s.
Basilicata	0.121	n.s.	0.242	n.s.
Calabria	0.825	n.s.	1.65	n.s.
Campania	< .001	*	< .001	*
Emilia Romagna	0.002	*	0.005	*
Lazio	< .001	*	< .001	*
Liguria	0.042	*	0.085	†
Marche	0.001	*	0.002	*
Piemonte	< .001	*	< .001	*
Puglia	0.038	*	0.076	†
Sardegna	< .001	*	< .001	*
Sicilia	< .001	*	< .001	*
Toscana	0.004	*	0.009	*
Trentino Alto Adige	0.001	*	0.002	*
Valle d'Aosta	< .001	*	< 0.001	*
Veneto	0.090	†	0.180	n.s.

Note. * = Significant at the p < .05 level or better. † = Marginally significant. n.s. = not significant. All significant and marginally significant effects are positive. See Figure 3, left panel.

Table A9. Significance of marginal effects on *first* doses administered for the open day *count* variable (controlling for doses delivered) using one- and two-tailed tests.

Region	p-value (one-tailed)		p-value (two-tailed)	
Abruzzo	0.070	†	0.140	n.s.
Basilicata	0.103	n.s.	0.205	n.s.
Calabria	0.825	n.s.	1.65	n.s.
Campania	< .001	*	< .001	*
Emilia Romagna	0.011	*	0.022	*
Lazio	< .001	*	< .001	*
Liguria	0.042	*	0.085	†
Marche	0.001	*	0.002	*
Piemonte	< .001	*	< .001	*
Puglia	0.116	n.s.	0.232	n.s.
Sardegna	< .001	*	< .001	*
Sicilia	0.001	*	0.002	*
Toscana	0.014	*	0.028	*
Trentino Alto Adige	0.001	*	0.002	*
Valle d'Aosta	< .001	*	< .001	*
Veneto	0.090	†	0.180	n.s.

Note. * = Significant at the $p < .05$ level or better. † = Marginally significant. n.s. = not significant. All significant and marginally significant effects are positive. See Figure 3, right panel.