Journal of Risk and Uncertainty
https://doi.org/10.1007/s11166-026-09507-8

ORIGINAL PAPER

Lessons learned from the COVID-19 pandemic: The role of self-control, risk aversion, and fear of infection in shaping compliance with preventive measures

Giuseppe Attanasi[1,2] · Carlo Ciucani[3] · Andrea Morone[4,6] · Piergiuseppe Morone[5,6] · Paola Tiranzoni[7]

Received: 10 June 2024 / Accepted: 3 August 2026

Abstract

This paper refers to interview data collected in six municipalities in the Lecce province of southern Italy, across three waves: 2020, 2021, and 2022. The principal aim of the research was to determine whether compliance with four government-recommended non-pharmaceutical measures to prevent the spread of COVID-19 — indoor and outdoor mask use, and indoor and outdoor physical distancing — differed over the years and, if so, whether these differences were influenced by personal characteristics. Specifically, we focused on the psychological features of self-control, risk aversion, and fear of contracting COVID-19 and their relationships with these four measures. The results suggest that virus mortality, the regulations in force, and experience of the pandemic affected compliance with certain preventive measures across all waves. With regard to psychological features, the three factors of interest were found to predict preferences for, and substitutions across, the measures, with effects that varied across the waves.

Keywords COVID-19 · Containment measures · Self-control · Risk aversion

✉ Andrea Morone
andrea.morone@uniba.it

1 Department of Economics and Law, Sapienza University of Rome, Rome, Italy

2 Institute of Entrepreneurship and Innovation, Corvinus University of Budapest, Budapest, Hungary

3 National Research Council (CNR) - Institute of Cognitive Sciences and Technologies (ISTC), Rome, Italy

4 Department of Economics, Management and Law, University of Bari Aldo Moro, Bari, Italy

5 Department of Law and Economics, Unitelma Sapienza University of Rome, Rome, Italy

6 Corvinus Institute for Advanced Studies, Corvinus University of Budapest, Budapest, Hungary

7 FocusEconomics, Barcelona, Spain

JEL Classification D81 · D91 · I12 · I18

1 Introduction

Pandemics are among the most disruptive contingencies societies can face, and understanding which factors drive compliance with preventive measures is paramount for effective public health policy. The SARS-CoV-2 (COVID-19) pandemic, which had registered at least 676 million cases and 6.8 million deaths worldwide before the World Health Organization lifted the global public-health emergency in May 2023 (Dong et al., 2020), offered a stark reminder of this imperative, exacting a mortality toll whose monetized global cost has been estimated in the trillions of dollars (Viscusi, 2020). At its peak, governments around the world established different measures to counteract viral spread, ranging from lockdowns to suggested behaviors, producing different outcomes (see, e.g., Perra, 2021; Flaxman et al., 2020). Yet compliance with these measures was far from uniform, raising the question of what individual-level factors shaped adherence to non-pharmaceutical interventions — and whether these factors remained stable as the pandemic evolved.

In the present study, we administered a survey in southern Italy (specifically six municipalities in the Lecce province in the region of Apulia) to gather information regarding compliance with these preventive measures. The work focused on two non-pharmaceutical measures, in particular: mask use and physical distancing. For both measures, we further differentiated between outdoor and indoor compliance. Interviews were conducted in three years (i.e., 2020, 2021, 2022), to evaluate changes in compliance over the course of the pandemic. Considering the factors associated with compliance in the literature, we focused on self-control, risk aversion, and fear of contracting the virus. Thus, the research aimed to contribute to the literature on pandemic preventive measures and, in particular, the relationship between compliance and certain psychological features. A secondary goal was to provide valuable information to policymakers to assist them in designing tools to improve compliance in health emergencies.

The choice of these three psychological constructs — self-control, risk aversion, and fear of contracting COVID-19 — rests on their theoretical relevance to compliance with infection-prevention behaviors. The Behavioral Immune System (BIS) framework (Schaller, 2006; Schaller & Park, 2011) posits that humans possess psychological mechanisms designed to detect pathogen cues and motivate prophylactic responses, such as avoidance of potentially infected individuals. Non-pharmaceutical measures like mask-wearing and physical distancing can be understood as instances of such responses, and individual variation in BIS-related reactivity has been associated with differential compliance during the COVID-19 pandemic (Makhanova & Shepherd, 2020). Within this broad framework, Protection Motivation Theory (PMT) (Rogers, 1975) offers a useful lens for organizing individual-level determinants of protective behavior. PMT distinguishes between *threat appraisal* — the perceived severity and likelihood of the health threat — and *coping appraisal* — the perceived ability to perform and sustain the protective behavior. While our constructs do not correspond to the specific PMT components (perceived severity, vulnerability, self-efficacy, response efficacy), they capture related mechanisms at a dispositional level. *Fear of contracting COVID-19* is the most direct measure of threat appraisal, reflecting the affective response to the perceived danger of infection. *Risk aversion* captures dispositional sensitivity to uncertain negative outcomes that should amplify threat appraisal: risk-averse individuals assign greater weight to the potential costs of infection, increasing their willingness to bear the costs of compliance. *Self-control*, finally, is relevant to the coping side of the process: even when threat appraisal is high, sustained compliance with preventive measures requires the effortful regulation of impulses over extended periods (Baumeister et al., 2007; Duckworth, 2011) — resisting the temptation to remove an uncomfortable mask or to approach others despite distancing norms. These three factors are thus theoretically complementary: fear and risk aversion jointly shape the motivation to comply, while self-control determines whether that motivation translates into sustained behavior.

In the literature, there is no consensus on the definition of self-control. However, a common thread in most descriptions is the *idea of effortful regulation of the self by the self* (Duckworth, 2011). Previous research has identified many associations between self-control and positive life outcomes. Notably, Moffitt et al. (2011) followed a cohort of 1,000 individuals over 30 years, finding that higher levels of self-control reliably predicted better physical health and personal finances, and lower criminal offence behaviors and substance abuse. In line with this, other empirical works have found associations between better health outcomes and behaviors and higher self-control (e.g., Miller et al., 2011; Salmon et al., 2014; Will Crescioni et al., 2011). Closely related to our subject and methodology, other studies have found greater self-control to be associated with higher compliance with social distancing in Swiss (Nivette et al., 2021) and American samples (Graham et al., 2020; Xu & Cheng, 2021).

Risk aversion is a widely researched topic in economics and the behavioral sciences, and prior research has focused on its relationship to health behaviors and outcomes (e.g., Anderson and Mellor, 2008; Guiso and Paiella, 2004; Decker and Schmitz, 2016). With regard to compliance with COVID-19 preventive measures, Sheth and Wright (2020) found no relationship between risk preferences and respect for a stay-at-home mandate among college students in the state of California. The aforementioned paper by Xu and Cheng (2021) instead found risk aversion to be associated with higher mask use and social distancing. Similarly, Cerami et al. (2021) found risk-loving individuals to comply less with containment measures, within an Italian sample.

Previous research has also explored the effect of fear of contracting COVID-19 on compliance with preventive measures. Specifically, Olapegba et al. (2022) and Yıldırım et al. (2021) found that fear of contracting COVID-19 predicted higher compliance in Nigerian and Turkish samples, respectively. Graham et al. (2020) controlled for personal and altruistic fear of the virus, finding the former to have a positive effect on social distancing intentions.

Previous survey-based research on COVID-19 preventive measures has also focused on a range of other individual-level determinants,[1] including gender and age

[1] For a comprehensive review, see Van Bavel et al. (2020).

(e.g., Lewis and Duch, 2021; Bruine de Bruin, 2021; Santos et al., 2022), socio-economic status (e.g., Mamelund et al., 2021; Uddin et al., 2021), information exposure (Siebenhaar et al., 2020), belief in conspiracy theories (e.g., Pavela Banai et al., 2022; Marinthe et al., 2020), trust in science (e.g., Plohl and Musil, 2021; Han, 2022; Goldfinch and Taplin, 2022), prosociality (Campos-Mercade et al., 2021), political orientation and risk perceptions (Bruine de Bruin et al., 2020), or psychological entitlement (Li, 2021).

While the studies reviewed above have established associations between individual-level factors and compliance with COVID-19 preventive measures, the existing literature presents three main limitations. First, most studies rely on data collected during a single phase of the pandemic, typically in the early months (i.e., 2020), when both perceived risk and regulatory stringency were at their highest. While some longitudinal studies have tracked compliance trajectories over time (e.g., Wright et al., 2022; Kusama et al., 2023; Vriens et al., 1897), these have generally not examined how the effects of psychological determinants shift across qualitatively different phases of the emergency. Second, most studies employ composite compliance indices that aggregate multiple preventive behaviors into a single score (e.g., Olapegba et al., 2022; Yıldırım et al., 2021), thereby obscuring potential heterogeneity in the determinants of compliance across different measures. Yet there are strong reasons to expect that the psychological drivers of, say, mask-wearing differ from those of physical distancing, given the different costs, visibility, and regulatory status of each measure. Third, to the best of our knowledge, no study has examined the possibility that individuals *substitute* across preventive measures as the pandemic evolves — that is, that compliance with one measure may increase at the expense of another, as a function of personal traits and changing contextual conditions.

The present study addresses these gaps. We collected data across three waves (2020, 2021, 2022) spanning markedly different phases of the pandemic in terms of virus mortality, regulatory context, and vaccination availability. We analyzed four distinct compliance outcomes — indoor and outdoor mask use, and indoor and outdoor physical distancing — separately, rather than collapsing them into a single index. And we focused on three psychological constructs (self-control, risk aversion, and fear of contracting COVID-19) that, as argued above, capture complementary determinants of protective behavior. This design allows us to examine not only whether these traits predict compliance, but also whether their effects vary across measures and over time, and whether substitution patterns emerge as contextual conditions change. As we discuss in Section 5.2, the results suggest that, as virus mortality decreased and restrictions were lifted, individuals with different psychological profiles shifted their compliance toward specific measures at the expense of others.

The remainder of the paper is structured as follows. Section 2 reports how the COVID-19 emergency was managed by the Italian government from the first lockdown (March 2020) until the last wave of data collection (August-September 2022). Section 3 describes the research methodology. Section 4 describes the results for fear of contracting COVID-19 (Section 4.1), mask use (Section 4.2) and physical distancing (Section 4.3), with non-parametric tests highlighting the differences over time (Section 4.4). Section 5 describes the regressors (Section 5.1) and presents the results of the ordinal logistic models, highlighting the effects of self-control, risk aversion, and fear of contracting COVID-19 on compliance with the specific measures (Section 5.2). Finally, Section 6 concludes the paper by summarizing and discussing the implications of the results.

2 COVID-19 pandemic in Italy

In this section, we summarize the main measures taken by the Italian government to manage the pandemic from the initial outbreak until September 2022 (i.e., the time of our last interviews). We report this information to describe the evolving context in which our data were collected.

The first cases of COVID-19 in Italy were registered on January 30, 2020,[2] in Rome. Unrelated to this, a state of emergency was declared on the following day. Clusters of infections were later detected in Lombardy and Veneto,[3] and, by the beginning of March, the virus had spread to all Italian regions.[4] On March 9, by decree[5] of the then Prime Minister Giuseppe Conte, the country became the first in Europe to be locked down, marking the start of the so-called *phase 1*: travel was restricted outside of critical work and family emergencies, and residents were required to keep a distance of at least one meter from one another when in public locations (face masks were not yet available to the public). The Prime Minister later announced (on March 11) that all commercial and retail businesses — except for those providing essential services — would remain closed[6].

As infection rates slowed, the Prime Ministerial decree of April 26, 2020[7] announced the beginning of the so-called *phase 2* on May 4. This decree permitted in-person visits with friends and relatives, as long as face masks were worn and a distance of at least one meter was maintained. Public parks and beaches reopened, and bars and restaurants resumed takeaway service (only deliveries were allowed in phase 1). Beginning June 3, travel was once again permitted across regions[8], and on June 12, indoor sports events and competitions resumed.[9] Containment measures were further reduced in *phase 3*, when cinemas, theaters, and concert halls were allowed to reopen at reduced capacity. It is in this context that our **first wave of data collection** occurred (i.e., August 24 to 29). On the final day of this data collection window, there had been 5,333 COVID-19 cases and 556 reported deaths from COVID-19 in Apulia (relative to 268,218 cases and 35,477 deaths in Italy). Moreover, the infection and death curves had been relatively flat over the prior 4 months, both for Apulia and the country (see Dong et al., 2020).

[2] Source: corriere.it (in Italian), consulted April 15, 2023.

[3] Source: reuters.com, consulted April 15, 2023.

[4] Source: avvenire.it (in Italian), consulted April 15, 2023.

[5] Full text (in Italian).

[6] Source: repubblica.it (in Italian), consulted April 15, 2023.

[7] Full text (in Italian).

[8] Source: ilsole24.com (in Italian), consulted April 15, 2023.

[9] Full text (in Italian).

Alongside a new surge of infections, restrictions were once again imposed by decree[10] on October 7, 2020. Mask use was made mandatory, both indoors (as in phases 1 and 3) and outdoors, in public places. The decree further recommended[11] that social gatherings, both indoor and outdoor, be limited to six persons. Later that month, pools, gyms, bars, and restaurants closed (with bars and restaurants closing only after 6 pm).[12] On November 3,[13] a curfew was imposed between 10 pm and 5 am. Regions with more new infections were subjected to more difficult restrictions, ranging from travel restrictions across municipalities (except for strict necessity and professional reasons; i.e., in the so-called *orange zone*) to full travel restrictions within municipalities (i.e., in the so-called *red zone*), until the curve of infections flattened. From December 4, restaurants could once again serve customers at a table, though limitations remained on the number of people and the distance between them. Containment measures strengthened over the Christmas holidays, with *red* and *orange zones* extended to the entire country[14] (i.e., festivity days were subject to a *red zone* and those in between to an *orange zone*). The ban on cross-regional travel (with limited exceptions) was also maintained from October 2020 to February 2021 and reconfirmed by the new government led by Prime Minister Mario Draghi, alongside a further tightening of restrictions.[15]

A calendar announcing the gradual release of the containment measures was established by decree on April 22, 2021,[16] guided by the encouraging results of the vaccination campaign[17] in decreasing virus mortality (see Dong et al., 2020). By August 5, most restrictions had eased. Notably, starting June 28, use of a mask was no longer mandatory outdoors, as long as physical distance was maintained; however, indoor mask use remained compulsory. Despite this general easing of restrictions, regions could still be subjected to *orange* or *red zone* designations if local cases rose. Apulia was in an *orange zone* from November 6 to December 5, 2020; from January 17 to February 10, 2021; and from April 26 to May 9, 2021. It was in a *red zone* from March 15 to April 25, 2021. As the COVID-19 vaccine became available to everyone in Italy, a new decree[18] established that, starting August 6, a *green pass* certifying vaccination, recovery, or a negative COVID-19 test (within the previous 48 to 72 hours, depending on the type of test) would be needed to access restaurants and bars, events, sports facilities, and most private and indoor entertainment venues. It is in this context that our **second wave of data collection** occurred (from August 25 to September 1). On the last day of this collection period, there had been 264,061 COVID-19 cases and 6,714 reported deaths from COVID-19 in Apulia (relative to

[10] Full text (in Italian).

[11] Through another Prime Ministerial decree, full text (in Italian).

[12] By Prime Ministerial decree, Full text (in Italian).

[13] Decree full text (in Italian).

[14] Decree-law relative to the whole paragraph: full text (in Italian).

[15] By decree-law, full text (in Italian).

[16] Full text (in Italian).

[17] Issued on December 2, 2020 with the Italian strategic plan for vaccination against COVID-19; updated January 2, 2021 (see this link).

[18] Full text (in Italian).

4,546,487 cases and 129,290 deaths in Italy). Again, infection and death curves had remained fairly flat, but only over the prior 3 months, both for Apulia and the country (see Dong et al., 2020). By September 21, 2021, a green pass was also required for all categories of workers.[19]

As infections rose again, another decree-law[20] imposed the closure of night clubs and the use of masks outdoors from December 24, 2021 until February 11, 2022. On April 1, 2022, the state of emergency was finally revoked, after more than 2 years. With this, masks were no longer mandatory indoors, with few exceptions. Also, a *green pass* was no longer required. When we collected **data in the third and final wave** (from August 25 to September 2, 2022), only a few restrictions were still in place, such as mask use on public transportation and when working in healthcare or catering. Contrary to the first two waves, in the third wave, self-isolation in the event of contact with an infected person was not compulsory; rather, it was sufficient for the affected individual to wear a mask in the presence of others for a period of 10 days. However, self-isolation remained compulsory in the event of contagion. As of September 2, 2022 (i.e., the final day of data collection), there had been 1,455,456 COVID-19 cases and 9,009 reported deaths from COVID-19 in Apulia (relative to 21,925,073 cases and 175,754 deaths in Italy). While the infection curve was on the rise, the number of deaths had remained quite flat (although less flat than in the previous waves) over the prior 6 months, both for Apulia and the country (see Dong et al., 2020).

3 Methodology

From 2020 to 2022, we administered surveys in six municipalities[21] in the province of Lecce, in the Apulia region of Italy. These municipalities are highly homogeneous from a social, cultural, and economic perspective. Moreover, data collection was conducted during the same week each year, between late August and early September (see Tables A1 and A2 for more details). All interviews were conducted face-to-face by students, who randomly and independently selected respondents at different locations in the study region, with the specific instruction to prioritize residents over tourists. By the end of the third wave, 1,255 individual observations had been collected, namely 399 in 2020, 456 in 2021, and 400 in 2022. With regard to the variables used in the empirical analysis, data were available for 1,090 surveys: 320 in 2020, 376 in 2021, and 394 in 2022.

We chose to collect data over three years, with the aim of comparing reported compliance with preventive measures and assessing whether the impact of psychological factors — self-control, risk aversion, and fear of contracting COVID-19 — varied over time. Observations were therefore collected in substantially different epidemiological and regulatory contexts, as discussed in Section 2. In 2020, mortality was at its highest; in 2021, vaccines were available and mortality was lower; and in 2022,

[19] Full text (in Italian) of the decree-law issuing such a measure.

[20] Full text (in Italian).

[21] Specifically Lecce, Corigliano, Soleto, Sternatia, Martano, and Galatina.

the state of emergency had been revoked. These differences allow us to observe how individuals self-selected into compliance with different preventive measures as the pandemic evolved.

In all three waves, the survey included: (i) 13 items measuring self-control (Tangney et al., 2018; ii) 5 items measuring risk attitude (Hudson et al., 2005);[22] (iii) 1 item measuring fear of contracting COVID-19 (see Section 4.1); (iv) 4 items measuring mask use (see Section 4.2); (v) 5 items measuring physical distancing (see Section 4.3); and (vi) questions investigating gender, age,[23] number of family members,[24] highest educational attainment,[25] and occupation.[26] The only across-wave change concerned vaccination: in line with vaccine availability, the 2021 and 2022 versions of the survey also included the questions *"Did you get vaccinated?"* and, for respondents who had not, *"For what reason have you not yet been vaccinated?"*; the 2022 version further investigated *"How many vaccine shots did you receive?"*.

3.1 Empirical strategy

The analysis proceeded in two steps. In the first step (Section 4), we employed non-parametric tests to examine differences in compliance with preventive measures across the three waves. Specifically, for each variable, we conducted a Kruskal-Wallis test to assess whether distributions differed across years, followed by pairwise post-hoc comparisons using Dunn's test with Holm-Bonferroni correction to control the family-wise error rate. We also compared the relative levels of compliance across the four preventive measures within each year using Wilcoxon matched-pairs signed-rank tests.

In the second step (Section 5), we estimated ordered-logit regressions with indoor mask use, outdoor mask use, indoor physical distancing, and outdoor physical distancing as dependent variables, separately for each year. This estimator is appropriate because all dependent variables are ordinal and measured on a Likert scale ranging from 1 to 5; it does not require treating the response categories as a quantitative metric. The models were estimated with robust standard errors to account for potential heteroskedasticity; the proportional-odds assumption underlying the ordered-logit models is examined in Section 5.2.

The main regressors of interest were the Brief Self-Control Scale (BSCS), measuring self-control through 13 items rated on a 1–5 Likert scale (Tangney et al., 2018); risk aversion, measured through 5 items rated on the same scale (Hudson et al., 2005); and fear of contracting COVID-19, measured with a single item rated on the same scale. In the baseline specifications, these variables are reported in their original scale for parsimony and comparability with previous studies. However, we do not treat the

[22] Appendix B reports the questionnaire items used to construct the self-control and risk-attitude measures.

[23] With alternatives: *<25*; *26–30*; *31–39*; *40–60*; and *>60*.

[24] With alternatives: *1*; *2*; *3*; *4*; and *5 or more*.

[25] With alternatives: *elementary school*; *middle school*; *high school*; *university*; and *postgraduate*.

[26] With alternatives: *student*; *unemployed*; *housewife/husband*; *employee*; *self-employed*; and *retired*.

Likert-based regressors as quantitative measures, nor do we rely on the assumption that a one-unit increase has the same substantive meaning across the entire scale. In this regard, and to provide further support for our analysis, we also re-estimated the models using binary indicators for sections of the scale. Specifically, we replaced BSCS, risk aversion, and fear of contracting COVID-19 with above-mean dummy variables taking value one for respondents above the corresponding year-specific mean. We adopted a single split at the year-specific mean rather than a finer partition for three reasons. First, it provides the most parsimonious binary coding of each scale, isolating a single, interpretable contrast (high versus low) for each psychological trait. Second, anchoring the cut-off to the year-specific mean allows the partition to track the shifting distribution of each trait across waves, rather than imposing a fixed external threshold. Third, it preserves adequate cell sizes within each year, which a finer categorisation — particularly for the single-item fear measure — would not guarantee. By construction, this specification does not treat the original response categories as a quantitative metric. These robustness checks are reported in Table 6, and are discussed in Section 5.2.

All models controlled for gender, age, number of family members, years of education, worker status, and vaccination status, the latter only in 2021 and 2022. Since the baseline analysis estimates separate models by year, it allows the association between psychological traits and compliance to vary across pandemic waves. As an additional check, and to investigate explicitly the relevance of interaction effects, we also estimated pooled ordered-logit models including year indicators and their interactions with the psychological regressors. The risk-aversion items were the same in all three waves; however, as explained in Section 5.1, the multi-item risk-aversion scale was internally reliable only from 2021 onward, whereas in 2020 its reliability was too low to be usable and a single best-predicting item had to be employed as a proxy. Because a risk-aversion scale comparable across waves is therefore available only for 2021 and 2022, we report interaction models over two samples: the full 2020–2022 period, which includes BSCS and fear of contracting COVID-19, and the 2021–2022 subsample, in which all three traits, including risk aversion, enter together. These additional analyses are reported in Table 7. They allow us to assess whether the relationship between individual psychological traits and compliance changed significantly across different epidemiological and regulatory phases of the pandemic.

4 Descriptive analysis

We now report the findings for the investigated COVID-19 variables, as reported in the survey, and how these evolved over the study period. All variables were measured in accordance with a Likert scale ranging from 1 to 5. Specifically, Section 4.1 reports respondents' fear of contracting COVID-19, Section 4.2 reports their face mask use and perception of face mask utility, Section 4.3 reports respondents' physical distancing practices, and Section 4.4 presents respondents' compliance with the containment measures over the study period.

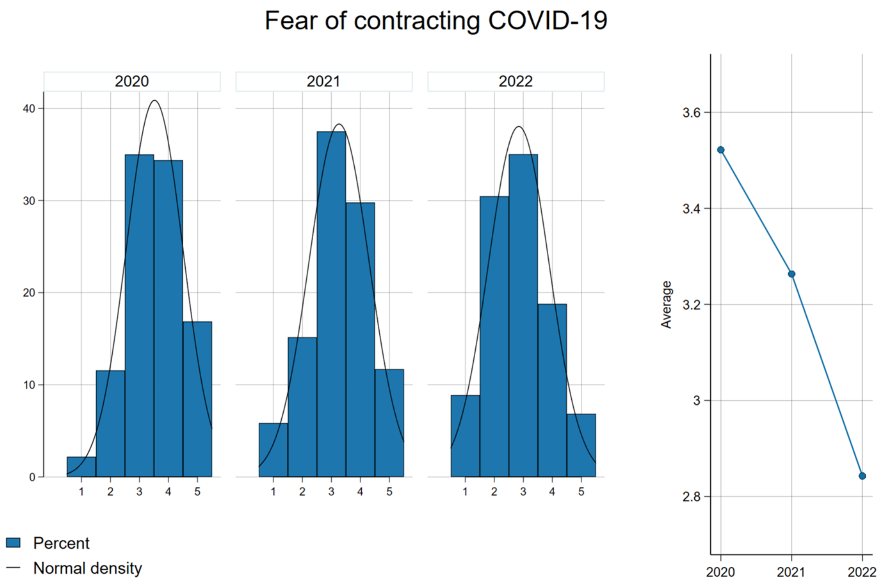

Fig. 1 Fear of contracting COVID-19 distributions (left) and averages (right), by year

4.1 Fear of contracting COVID-19

We first present the distributions and average responses to the question: *"How afraid are you of contracting COVID-19?"* This item was rated on a Likert scale ranging from 1 to 5, and Fig. 1 presents the distributions (left) and averages (right) of respondents' answers for the 3 years. As is evident, this variable steadily decreased over time, with significant differences between years[27] reflecting a sizeable negative correlation (Spearman's rank correlation test: $r = -0.26$, $p < 0.001$). The differences were robust, also when considering the other observed variables in the ordinal logistic models, as the effects were statistically significant (see Table A3).

As expected, *fear of contracting COVID-19* decreased in line with the decreased virus mortality over time[28]. The drop in this fear was most dramatic between 2021 and 2022, perhaps in accordance with the population's general familiarity with the pandemic (especially considering the much higher number of infections in summer 2022 compared to summer 2021). Of course, it is also possible that, with the end of the state of emergency on March 31, 2022 (which released the mandate to self-isolate following close contact with an infected person), individuals became less worried about the prospect of infecting others.

[27] Kruskal-Wallis inequality of populations test, with Dunn's post-hoc test and Holm-Bonferroni corrections: $\chi^2 = 71.640$, $p < 0.001$; $Z = 3.105$, $p = 0.001$ (2020 vs 2021); $Z = 5.700$, $p < 0.001$ (2021 vs 2022); $Z = 8.596$, $p < 0.001$ (2020 vs 2022).

[28] See the Dong et al. (2020) data.

4.2 Mask use

Mask use was mandatory in indoor public places in Italy throughout the entire state of emergency. While outdoor mask use was only voluntary during the 2020 and 2021 data collection periods, it was also mandatory during other times of the state of emergency (see Section 2). Fig. 2 displays the distributions (left) and averages (right) of respondents' answers, by year. The four items described in each quarter of the left figure refer to answers provided on a Likert scale (ranging from 1 to 5), referring to the extent to which respondents agreed with the following statements (starting from the top left corner and moving to the right): *"When I go out, I deem it appropriate to wear a mask indoors"*; *"When I go out, I deem it appropriate to wear a mask outdoors"*; *"I do not believe that a face mask is useful for cutting the odds of contracting the virus"*; and *"I do not believe that a face mask is useful for reducing viral spread"*. Note that, as the graph intertitles suggest, the bottom two items were inverted, so that all scales expressed compliance or agreement with the COVID-19 preventive measures.

Looking at the right-hand graph, a triangular-shaped trend is evident for all items except for outdoor mask use. The latter seems to constantly decrease, indicating that respondents reported less use over the three study waves. This finding was confirmed by the tests reported in Table 1, which found statistically significant differences for all variables across all years. Specifically, negative *Z*s emerged in the 2020 versus 2021 comparisons for *indoor mask use*, *mask for virus* (i.e., *mask for avoiding COVID-19 infection*; see Fig. 2), and *mask for virus spread* (i.e., *mask for avoiding COVID-19 spread*; see Fig. 2), while positive scores emerged for outdoor mask use. For the 2021 versus 2022 comparison, positive *Z*s were found for all four variables. For the

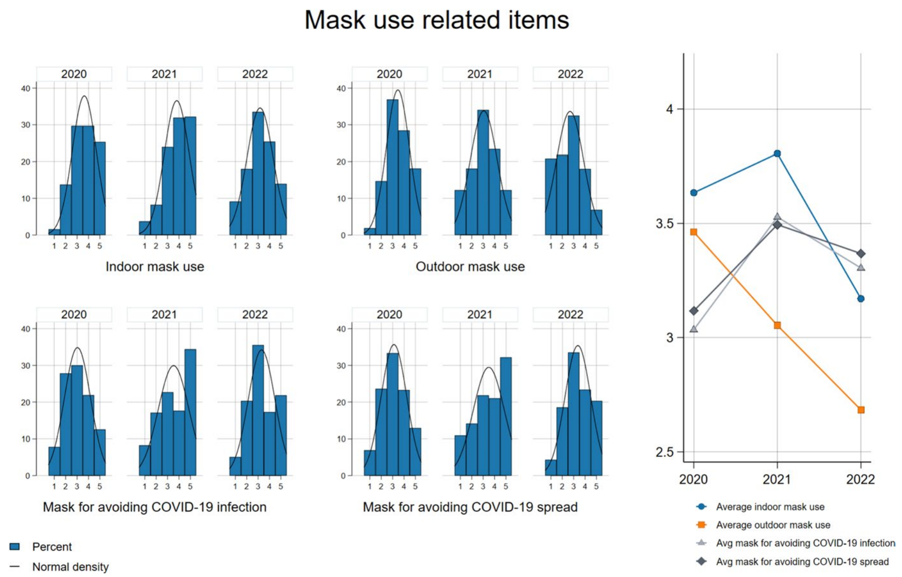

Fig. 2 Mask use items distributions per year (left) and averages across years (right)

Table 1 Differences between years for mask use items. Rows 1 to 3 report the Z and p values of Dunn's post-hoc tests (with Holm-Bonferroni correction) between the 2 years for the variable specified. Row 4 reports the chi-squared and p values of the Kruskal-Wallis inequality of population tests for the 3 years for the specified variable. Z signs are relative to the first year of the comparison (e.g., 2020 in the "2020 vs. 2021" line)

		Indoor MU	Outdoor MU	Mask for virus	Mask for virus spread
2020 vs. 2021	Z	-2.330	4.408	-5.344	-4.460
	p	0.010	< 0.001	< 0.001	< 0.001
2021 vs. 2022	Z	7.787	4.260	2.628	1.861
	p	< 0.001	< 0.001	0.004	0.031
2020 vs. 2022	Z	5.105	8.537	-2.885	-2.728
	p	< 0.001	< 0.001	0.004	0.006
	χ^2	59.295	68.424	26.984	18.913
	p	< 0.001	< 0.001	< 0.001	< 0.001

three items showing triangular trends, we found statistically significant differences between 2020 and 2022. Moreover, except for the 2020 versus 2022 comparison regarding *mask for avoiding COVID-19 infection* and *mask for avoiding COVID-19 spread*, the said differences were robust also when considering the other observed variables in the ordinal logistic models, as the effects were statistically significant (see Table A4).

We may speculate why these differences between years emerged. First, regarding mask use, it is very likely that the government regulations played a prominent role. In fact, for both *indoor* and *outdoor mask use*, the 2022 distributions were concentrated much more so than in 2020 and 2021 (see Fig. 2, left side). Additionally, the average values were lowest in this wave (see Fig. 2, right side). While this decline in mask use had occurred previously, between 2020 and 2021, its further decrease after the end of the state of emergency (i.e., March 31) is likely not a coincidence. Moreover, the end of most other restrictions may have also affected *outdoor mask use*, as not being compelled to wear a mask indoors in public places may have discouraged individuals from carrying a mask at all. Alternatively, the diminished *fear of contracting COVID-19* (see Section 4.1) over the years may have contributed to the decreased *outdoor mask use*, as the decline in these factors showed a very similar trend. It is, however, somewhat surprising that *indoor mask use* increased between 2020 and 2021, while general *fear of contracting COVID-19* decreased and mask regulations remained unchanged. Here again,[29] as *indoor mask use* in public spaces was virtually always mandatory between March 2020 and April 2022, respondents may have become more accustomed to wearing masks during 2020 to 2021. As a potentially concurring determinant, respondents may have recognized the utility of face masks for preventing infection and viral spread in 2021, more so than in 2020 (see Table 1). Interestingly, a reverse causality may also explain this relationship, as some respondents may have believed masks to be useful out of some optimism bias (e.g., Sharot, 2011).[30] In other words, respondents who regularly wore masks indoors may have

[29] As also speculated in Section 4.1 when justifying the decrease in *fear of contracting COVID-19* from 2021 to 2022.

[30] To this end, see Freer and Keefer (2022).

retrospectively attributed greater efficacy to them, partly as a way of rationalizing their own compliant behavior. To support this theory, *mask for avoiding COVID-19 infection* strongly correlated with *indoor mask use only* in 2020 and 2021 (r = 0.40, $p < 0.001$; and r = 0.31, $p < 0.001$, respectively), while no significant correlation was found in 2022.

4.3 Physical distancing

Similar to Figs. 2 and 3 reports the distributions and averages of respondents' answers to the three physical distancing items in 2020, 2021, and 2022 (each rated on a Likert scale ranging from 1 to 5): *"How often do you find yourself less than a meter away from another person indoors?"*; *"How often do you find yourself less than a meter away from another person outdoors?"*; *"I hang out at crowded places."* The bottom right histograms refer to the differences between respondents' answers to: *"Before the 2020 lockdown, how often did you use public transportation?"* and *"How often do you use public transportation?"*. For the sake of comparing averages with the other three items, the latter was re-scaled into a (theoretically) 1 to 5 variable when drawing the averages-comparison graph of Fig. 3. To compare the averages, the other three items were re-scaled into a (theoretical) variable ranging from 1 to 5 (see Fig. 3). Moreover, the items were inverted so that all scales expressed compliance with physical distancing.

Contrary to Section 4.2, which reported significant differences for the items across almost all consecutive years, here, we report significant differences in the variables *avoid gatherings* from 2020 to 2021, *public transportation use* from 2021 to 2022, and *outdoor physical distancing* from 2020 to 2021 and 2021 to 2022 (Table 2). Also,

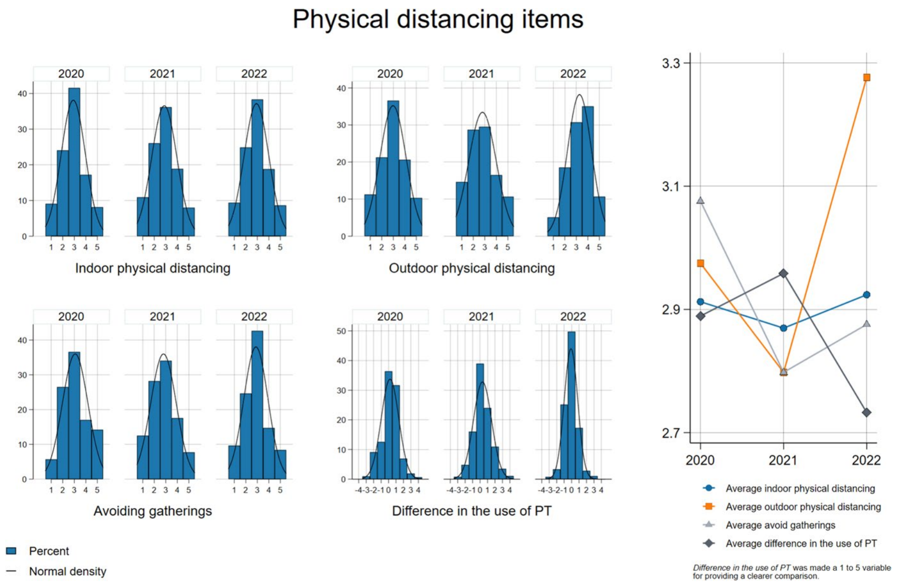

Fig. 3 Physical distancing distributions (left) and averages (right), by year

Table 2 Differences between years for physical distancing items. Rows 1 to 3 report the Z and p values of Dunn's post-hoc tests (with Holm-Bonferroni correction) between the 2 years for the variable specified. Row 4 reports the chi-squared and p values of the Kruskal-Wallis inequality of population tests for the 3 years for the specified variable. Z signs are relative to the first year of the comparison (e.g., 2020 in the "2020 vs. 2021" line)

		Indoor PD	Outdoor PD	Avoid gatherings	Difference in PT
2020 vs. 2021	Z	0.533	2.139	3.043	-0.632
	p	0.594	0.016	0.004	0.264
2021 vs. 2022	Z	-0.684	-6.065	-1.039	5.107
	p	0.741	< 0.001	0.149	< 0.001
2020 vs. 2022	Z	-0.117	-3.648	2.082	4.253
	p	0.453	< 0.001	0.037	< 0.001
	χ^2	0.479	35.309	8.750	27.654
	p	0.787	< 0.001	0.013	< 0.001

apart from the 2020 versus 2022 comparison regarding *outdoor physical distancing*, the said differences were robust when considering other observed variables in the ordinal logistic models, as the effects were statistically significant (see Table A5).

With regard to the observed differences across the first 2 years, we might conjecture that decreased *fear of contracting COVID-19* played an important role, as individuals may have felt increasingly comfortable having other people close to them. Moreover, with respect to the change in *outdoor physical distancing* from 2020 to 2021, it may be relevant that the risk of infection outdoors was much smaller than the risk of infection indoors, and the summer heat made contagion less likely. Awareness of these facts may have contributed to the difference observed here. As for the comparison between 2021 and 2022, the reason behind the rise in outdoor distancing is not obvious. However, with the end of the state of emergency and most restrictions, it may be that individuals substituted physical distancing for mask use (Section 4.2) outdoors, given the relative ease with which one may maintain distance in this setting, relative to indoors. Furthermore, distancing is typically experienced as far more comfortable than wearing a mask, and as the latter was no longer mandatory, this substitution seems plausible. Conversely, no difference emerged for *indoor physical distancing* between any years. It may be that, regardless of virus mortality, individuals maintained a consistent (minimal) distance from others indoors, because such compliance was materially harder, especially considering indoor spaces of limited size.

4.4 Comparison of preventive measures

In this section, we compare the four preventive measures presented in the previous sections: *indoor mask use*, *outdoor mask use*, *indoor physical distancing*, and *outdoor physical distancing*. We further analyze these measures in Section 5.2, in our presentation of the regression models. The present comparison aimed at defining a hierarchy of reported compliance. Table 3 reports the Z and p values relative to the Wilcoxon matched-pairs signed-rank tests, comparing item distributions across the three waves. In all years, *indoor mask* use received the most compliance. However, considering *outdoor mask use*, the results were more nuanced. In fact, while

Table 3 Z and p values of the Wilcoxon matched-pairs signed-rank tests across waves and the four selected precautionary measures: *indoor mask use (MU), outdoor mask use, indoor physical distancing (PD)*, and *outdoor physical distancing*. Z signs must be interpreted vertically (i.e., with reference to the respective column variable)

			Indoor MU	Outdoor MU	Indoor PD
Outdoor MU	2020	Z	7.973		
		p	< 0.001		
	2021	Z	10.547		
		p	< 0.001		
	2022	Z	6.322		
		p	< 0.001		
Indoor PD	2020	Z	13.226	5.996	
		p	< 0.001	< 0.001	
	2021	Z	9.885	-0.303	
		p	< 0.001	0.762	
	2022	Z	7.883	2.094	
		p	< 0.001	0.036	
Outdoor PD	2020	Z	13.131	5.645	0.774
		p	< 0.001	< 0.001	0.439
	2021	Z	6.918	-2.833	-2.715
		p	< 0.001	0.005	0.007
	2022	Z	3.977	-2.001	-4.889
		p	< 0.001	0.045	< 0.001

respondents reported greater *outdoor mask use* than *physical distancing* (indoors and outdoors) in 2020, they preferred *outdoor physical distancing* in 2021 and 2022, and *indoor physical distancing* in 2022 (no statistically significant difference was detected for 2021). Finally, between physical distancing items, respondents preferred *outdoor physical distancing* in the last two waves, possibly due to the greater difficulty involved in *indoor physical distancing*.

Various explanations may be proposed for the finding that *indoor mask use* had the greatest reported compliance. First, as the odds of infection were highest in closed environments, individuals may have sought further protection in that context, especially if they were concerned about insufficient physical distancing (for which indoor compliance was significantly lower than outdoor compliance in two out of the three waves). Moreover, among the recommended containment measures, mask use was the first non-pharmaceutical entry listed on the Italian Health Ministry website.[31] Second, at the time of data collection in 2020 and 2021, *indoor mask use* was mandatory (see Section 2); thus, individuals may have complied out of a fear of sanctions from the authorities (i.e., wearing/not wearing a mask is more visible than maintaining physical distance). A further hypothesis, whereby compliance may have emerged through alignment with a social norm, should not be discarded.[32] Following Axelrod (1986); Cialdini et al. (1990); Bicchieri (2006), social norms are sustained by *empirical expectations* (beliefs about what others do) and *normative expectations* (beliefs about what others think one ought to do). Both empirical and normative expectations have been associated with compliance with social distancing during COVID-19 (Martínez et al., 2021). The high visibility of indoor mask use may have reinforced

[31] As of April 23, 2023; source: salute.gov.it (in Italian). The first overall entry is vaccination.

[32] In this regard, see also Savadori and Lauriola (2021).

strong empirical expectations, encouraging further compliance; conversely, the lower visibility of physical distancing may have made the corresponding expectations weaker and uncertain. A similar social-norm interpretation may be proposed for the decreased (resp., increased) compliance with mask-wearing (resp., physical distancing) from 2020 to 2022 (see Figs. 2 and 3). This pattern is also consistent with evidence showing that social norms surrounding preventive behaviors are sensitive to changes in risk and regulatory context (Vriens et al., 1897).

As already noted, the relative priority given to *outdoor mask use* seemed to change over the years. With regard to the comparison with *outdoor physical distancing*, we may hypothesize that the decrease in virus mortality played a role. In fact, with mortality at its highest in 2020, individuals resorted to *outdoor mask use* more than *physical distancing*; while as mortality decreased, distancing was apparently deemed sufficient. We may also propose the discomfort of wearing a mask as a factor in its decreased compliance, with individuals avoiding wearing a mask unless strictly necessary. *Indoor physical distancing* had the least reported compliance, except in 2020, when its compliance was equivalent to that of outdoor physical distancing. In this regard, we may propose that maintaining physical distance indoors was materially harder than doing so outdoors or simply wearing a mask.

5 Regression analysis

In this section, we present the variables employed as regressors in the regression analyses (Section 5.1), before reporting and discussing the results of the ordinal logistic models with *indoor* and *outdoor mask use*, and *indoor* and *outdoor physical distancing* as dependent variables (Section 5.2).

5.1 Regressors

Table 4 reports statistics relative to the regressors employed in the regression models, separately for each year.

Regarding the item scores for self-control and risk attitude, we had to make some adjustments to accommodate small issues. For self-control, we relied on the *BSCS* introduced in Section 3.1. In line with classical test theory, before accepting the scale and creating a score for the average of the items, we first checked Cronbach's alphas in each year. Although these exceeded the commonly accepted threshold of 0.6 (see, e.g., Ursachi et al. (2015)) in 2021 (0.645), the reliability coefficients for 2020 and 2022 (0.556 and 0.582, respectively)—while coming very close to the threshold—recommended rejection of the scale. In every year, the same item showed the lowest correlation.[33] Thus, we followed the procedure of Kopalle and Lehmann (1997) and removed this item from the scale, generating more consistent alphas of 0.577, 0.692, and 0.598 for 2020, 2021, and 2022, respectively. While two values remained slightly below the acceptability threshold, with this procedure, we improved the scale consistency and, for 2022, we were able to approximate the value to 0.6. Moreover,

[33] That is, *I refuse things that are bad for me*.

Table 4 Means, standard deviations, minima, and maxima (by year) for the regressors employed in the models presented in Table 5. Data for specific years are missing either because the regressor was not employed or observations were lacking

	2020				2021				2022			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Male	0.475	0.500	0	1	0.449	0.498	0	1	0.472	0.500	0	1
Age	39.506	15.669	21.5	70	36.447	15.613	21.5	70	38.25	14.831	21.5	70
Family members	2.862	1.091	1	5	3.059	1.113	1	5	2.886	0.978	1	5
Years of education	13.619	4.268	5	20	13.851	3.303	5	20	13.556	3.562	5	20
Worker	0.603	0.490	0	1	0.497	0.501	0	1	0.543	0.499	0	1
Fear of cont. COVID-19	3.522	0.976	1	5	3.263	1.042	1	5	2.843	1.049	1	5
Vaccinated					0.864	0.343	0	1	0.873	0.333	0	1
BSCS	2.978	0.447	2.167	4.583	3.017	0.534	1.167	4.833	3.119	0.461	1.917	4.75
Risk aversion					3.398	0.776	1	5	3.526	0.757	1.25	5
Risk aversion item 1	3.216	1.039	1	5								
Risk aversion item 3	3.513	1.103	1	5								
Risk aversion item 4	3.694	1.074	1	5								

the bootstrapped 95% confidence intervals for the two alphas fell between 0.494 and 0.659 for 2020, and 0.534 and 0.672 for 2022. Thus, the null hypothesis of alpha equal to 0.6 was not rejected for either of the years, allowing us to conclude that the scale was sufficiently strong.

Alphas for the five-item risk aversion scale from Hudson et al. (2005) were 0.300, 0.662, and 0.595. We again employed the procedure of Kopalle and Lehmann (1997) for the 2021 and 2022 coefficients, as in both years, the same item showed the lowest correlation.[34] This yielded alpha values of 0.659 for 2021 (slightly smaller than the value including all five items) and 0.650 for 2022, both of which exceeded the 0.6 acceptability threshold, indicating the scale to be robust. Since we deemed the 2020 value too low and beyond salvation, for the 2020 regression models, we employed the item with the highest power in predicting[35] the dependent variable under analysis, based on the leaps and bounds approach proposed by Furnival and Wilson (1974) (as also performed by Bellemare et al. (2019)). Consequently, no value was reported for *risk aversion* in the 2020 columns, and, conversely, *risk aversion item* entries were described only in such columns.

The third factor, *fear of contracting COVID-19*, was measured using a single question (rated on a Likert scale ranging from 1 to 5): *"How afraid are you of contracting COVID-19?"* Coding was executed by entering the indicated value.

The other entries in Table 4 were employed as controls (see Table A7 for their effects). *Male* was a dichotomous variable (i.e., 1 = male, 0 = female). *Age* was recoded from the survey entry, which confirmed one of the following alternatives: *18-25*; *26-30*; *31-39*; *40-60*; and *>60*. Specifically, the recoding substituted the entry with the average of the two bounds (e.g., *26-30* became 28). For entries *>60*, we assumed an upper bound of 80. Respondents indicated their number of *family members* from the following alternatives: *1*, *2*, *3*, *4*, and *5 or more*. Subsequently, we coded this variable by directly transposing the entry values (e.g., *5 or more* became 5). For *years of education*, we coded the highest educational level achieved from the alternatives *elementary school*, *middle school*, *high school*, *university*, and *postgraduate*, into the years necessary for achieving the equivalent in the Italian system (e.g., *postgraduate* was coded as 20). *Worker* was a dummy variable, with 1 indicating *employment* or *self-employment* and 0 indicating anything else. We only observed the dichotomous variable *vaccinated* (1 = yes) in 2021[36] and 2022 (we assumed that no respondent had received a vaccination in 2020).

5.2 Regression results

Table 5 displays the ordered-logit coefficients for *BSCS*, *risk aversion*, and *fear of contracting COVID-19*, controlling for *male*, *age*, *family members*, *years of educa-*

[34] That is, *"The only way to make more money is to take fewer risks"*, which slightly deviates from the original *"The only way to make more money is to take more risks"*.

[35] Choosing the Bayesian Information Criterion (BIC) minimizing item.

[36] To avoid losing observations, we coded respondents who reported that they were still awaiting their turn for the vaccine as *vaccinated* (i.e., 1); this applied to 14 respondents in 2021. We did not apply the same coding to 2022, since by then the Italian vaccination campaign had given everyone the opportunity to be vaccinated well before the survey dates.

Table 5 Ordinal logistic regressions using *indoor mask use*, *outdoor mask use*, *indoor physical distancing*, and *outdoor physical distancing* as dependent variables. Ordered-logit coefficients are reported; models control for: *male, age, family members, years of education, worker,* and *vaccinated* (only in 2021 and 2022). Models are estimated separately by year

	Indoor mask use			**Outdoor mask use**		
Panel A	2020	2021	2022	2020	2021	2022
BSCS	1.551***	1.301***	0.341	0.096	-0.474*	-1.135***
	(0.252)	(0.212)	(0.301)	(0.288)	(0.214)	(0.282)
Risk aversion		0.432**	0.257†		0.542***	-0.274†
		(0.136)	(0.134)		(0.143)	(0.141)
Risk Item 1	0.290**					
	(0.104)					
Risk Item 4				-0.167		
				(0.102)		
Fear of contracting COVID-19	0.136	0.459***	0.298**	0.243*	0.182†	0.072
	(0.132)	(0.122)	(0.111)	(0.123)	(0.110)	(0.110)
Observations	320	376	394	320	376	394
BIC	861.0	963.3	1238.0	904.6	1169.4	1232.3
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
	Indoor physical distancing			**Outdoor physical distancing**		
Panel B	2020	2021	2022	2020	2021	2022
BSCS	1.250***	0.784***	-0.109	1.532***	1.140***	0.732**
	(0.258)	(0.215)	(0.265)	(0.286)	(0.231)	(0.249)
Risk aversion		0.080	0.029		-0.111	-0.109
		(0.143)	(0.128)		(0.146)	(0.141)
Risk Item 3				0.219†		
				(0.115)		
Risk Item 4	0.152					
	(0.114)					
Fear of contracting COVID-19	-0.090	-0.195†	-0.304**	0.023	-0.285**	-0.117
	(0.149)	(0.109)	(0.111)	(0.132)	(0.107)	(0.107)
Observations	320	376	394	320	376	394
BIC	942.9	1155.4	1207.2	973.9	1169.6	1075.7
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

† $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

tion, *worker*, and *vaccinated* (with the latter only in 2021 and 2022). Table A7 reports the coefficients for the controls and cutpoints. Of note, the bottom lines report statistics relative to the dependent variable in the specific year, and the minima (*Min.*) reports the value 2 at times, despite the respective items being defined on a Likert scale ranging from 1 to 5. This is because, consistent with common practice, categories with too few observations were collapsed into the closest category. Since only some bottom values[37] were reported by few participants[38], the minima and maxima

[37] Specifically, the lowest response category (value 1) was reported by only 5 respondents for *indoor mask use* in 2020 and by 14 in 2021, by 6 for *outdoor mask use* in 2020, and by 20 for *outdoor physical distancing* in 2022.

[38] The minimum threshold for retaining a response category was set to 25, by rule of thumb.

ranged between 1 or 2 and 5. We focused on four COVID-19 preventive measures: *indoor mask use, outdoor mask use, indoor physical distancing,* and *outdoor physical distancing*.

Before turning to the specific findings, we emphasize that the estimates discussed in this section enter the psychological regressors on their original Likert scale for interpretability and comparability with prior work, but that the substantive conclusions do not depend on this choice: as we detail below and in Table 6, they are confirmed by a binary (above-mean) specification that does not treat the scale as a quantitative metric, and we flag explicitly the few effects that are sensitive to how the scales are treated.

Table 6 Ordinal logistic regressions using *indoor mask use*, *outdoor mask use*, *indoor physical distancing*, and *outdoor physical distancing* as dependent variables. Ordered-logit coefficients are reported for year-specific above-mean dummy variables taking value 1 if the independent variable is above its year-specific mean. Controls include: *male, age, family members, years of education, worker,* and *vaccinated* (only in 2021 and 2022). Models are estimated separately by year

	Indoor mask use			**Outdoor mask use**		
	2020	2021	2022	2020	2021	2022
BSCS (high)	0.926***	1.109***	0.163	-0.070	-0.573**	-0.799***
	(0.217)	(0.211)	(0.209)	(0.213)	(0.199)	(0.197)
Risk aversion (high)		0.756***	0.339		0.806***	-0.354†
		(0.215)	(0.208)		(0.213)	(0.210)
Risk Item 1 (high)	0.399†					
	(0.222)					
Risk Item 4 (high)				-0.562*		
				(0.255)		
Fear of COVID-19 (high)	0.692*	0.925***	0.159	0.998**	0.102	-0.266
	(0.322)	(0.213)	(0.236)	(0.316)	(0.200)	(0.234)
Observations	320	376	394	320	376	394
BIC	879.7	978.9	1252.1	895.5	1174.4	1239.9
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
	Indoor physical distancing			**Outdoor physical distancing**		
	2020	2021	2022	2020	2021	2022
BSCS (high)	1.069***	0.620**	-0.137	1.130***	0.969***	0.256
	(0.229)	(0.206)	(0.204)	(0.217)	(0.206)	(0.197)
Risk aversion (high)		0.156	0.112		0.014	-0.133
		(0.202)	(0.202)		(0.202)	(0.204)
Risk Item 3 (high)				0.790***		
				(0.232)		
Risk Item 4 (high)	0.784**					
	(0.249)					
Fear of COVID-19 (high)	0.058	-0.315	-0.477*	0.497†	-0.345†	-0.164
	(0.312)	(0.207)	(0.232)	(0.298)	(0.198)	(0.248)
Observations	320	376	394	320	376	394
BIC	934.2	1163.9	1212.2	973.7	1187.5	1085.4
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

† $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

With regard to *indoor mask use*, *self-control* and *risk aversion* predicted compliance in both 2020 and 2021, while only *risk aversion* had a positive and marginally significant effect also in 2022. *Fear of contracting COVID-19* also predicted compliance, but only in 2021 and 2022. For *outdoor mask use*, while *self-control* had a negative effect in 2021 and 2022, *risk aversion* predicted compliance in 2021 and, in a marginally significant way, lesser compliance in 2022. *Fear of contracting COVID-19* was associated with greater compliance in 2020 and 2021, although in 2021 the effect was only marginally significant. *Self-control* also predicted *indoor physical distancing* in 2020 and 2021, while *risk aversion* did not determine any significant effect. *Fear of contracting COVID-19* had a negative effect, which was only marginally significant in 2021 and significant in 2022. Finally, *outdoor physical distancing* models highlighted *self-control* as a predictor in all three years. Conversely, *risk aversion* had a marginally significant and positive effect in 2020 through *risk aversion* item 4, which was taken as a proxy for overall *risk aversion* (as was any risk item in the 2020 models). *Fear of contracting COVID-19* again had a negative effect, but only in 2021.

Looking at the results horizontally (i.e., between years and dependent variables), the predictors clearly changed across waves and preventive measures. The regressor with a significant effect for all variables and almost all years was *BSCS*. Individuals with high self-control were predicted to comply more with *indoor mask use* (except in 2022) and less with *outdoor mask use* (except in 2020). Moreover, they were predicted to comply more with *indoor physical distancing* (except in 2022) and *outdoor physical distancing*. The coefficients for *indoor mask use*, *outdoor physical distancing*, and *indoor physical distancing* are intuitive, as greater self-control should help individuals sustain costly or inconvenient preventive behaviors. Furthermore, it seems reasonable that, with virus mortality decreasing and *indoor mask* use no longer mandatory, no effect emerged for 2022. The same would apply to *indoor physical distancing*, to which we might add that, as it may have been more difficult to comply with physical distancing measures indoors, only an outdoor effect was predicted in 2022. However, the negative effect for *outdoor mask* use seems counterintuitive. In this case, we might speculate that some substitution with *outdoor physical distancing* occurred for those with high self-control. In fact, while the coefficient for *outdoor mask use* became negative in 2021 and 2022, a positive effect was predicted for *outdoor physical distancing*. Interestingly, across the waves, the effect sizes (in absolute values) increased for *outdoor mask use* and decreased for *outdoor physical distancing*, suggesting that the interaction between virus mortality and *BSCS* may have played a role (i.e., the more mortality fell, the less individuals with high self-control demonstrated compliance). This latter speculation is further supported by the finding that the same decrease occurred for *indoor mask use* and *indoor physical distancing*.

Risk aversion was a less consistent predictor, as statistically significant effects were estimated only for indoor mask use[39] (although the effect was only marginally significant in 2022) and *outdoor mask use* (only in 2021). Here again, we may offer an immediate interpretation of the observed effects, as it is reasonable to expect those

[39] In 2020, we employ *risk item 1* as a proxy for *risk aversion* (see Section 5.1 for a more detailed explanation).

with high *risk aversion* to demonstrate higher compliance, possibly out of greater concern over the consequences of infection.[40]. The finding that *indoor mask use* persisted across the waves is understandable, as the odds of infection were greatest indoors. Additionally, we might conjecture that the significant *risk aversion* effect for *outdoor mask use* that emerged in 2021 was due to the fact that *outdoor mask use* was mandatory for most of that year (see Section 2). Hence, individuals who were more sensitive to risk may have been less likely to abandon this practice, after complying with it consistently during the months preceding the interview. Of note, the 2022 effects were only marginally significant for both *indoor* and *outdoor mask use*; but while the beta for *indoor mask use* was consistent with the predictions for previous years, the beta for *outdoor mask use* had the opposite sign (counterintuitively). We are inclined to believe that the first result may be more reliable than the second. However, as most of the restrictions were lifted in 2022 and, at the time of the 2022 data collection, the state of emergency had been revoked for 4 months (and virus mortality had been significantly dropping over the prior year), it is reasonable to assume that both effects arose from some noise, and *risk aversion* may not have determined any significant deviation from the norm, in terms of *mask use*. For *physical distancing*, no effect was predicted in any of the years (only a marginally significant effect for *risk item 3* emerged in 2020 for *outdoor physical distancing*). Thus, we may conclude that *risk aversion* only determined higher mask use, possibly because this was perceived as the most reliable preventive measure.

Fear of contracting COVID-19 (see Section 4.1) had a significant effect on all variables, but not in all years. In more detail, it predicted compliance with *indoor mask use* in 2021 and 2022. Notably, *fear of contracting COVID-19* was the only psychological factor in our analysis that had a significant beta in 2022 (i.e., only a marginally significant effect of *risk aversion* was predicted). An immediate interpretation of this is that individuals were more likely to commit to wearing a mask if they were afraid of becoming infected. However, while a mild correlation between these variables emerged in 2020 (Spearman's r = 0.13, $p = 0.023$), the regression model estimates showed no significant effect in this year. In contrast, *fear of contracting COVID-19* was associated with higher *outdoor mask use* for that wave (as well as showing a marginally significant effect in 2021). We may conclude that, as *outdoor mask use* was not mandatory, fear may have made individuals more wary and prone to take measures beyond those recommended by the government. It is perhaps surprising that, for the physical distancing variables, the significant effects were negative. But here again, as speculated when comparing the effects of BSCS on *outdoor mask use* and *outdoor physical distancing*, the negative betas of *indoor physical distancing* in 2021 (marginally significant) and 2022 may indicate substitutions with *indoor mask use* and, in 2021, also *outdoor mask use*. In other words, individuals who were more fearful of contagion may have been more inclined to wear masks, and they may have also believed that masks were sufficient for minimizing infection (similar to risk

[40] *Risk aversion* was also correlated with *fear of contracting COVID-19* in 2021 (Spearman's r = 0.25, $p <$ 0.001), while three risk aversion items correlated with *fear of contracting COVID-19* in 2020 (*risk item 2* r = 0.11, $p = 0.043$; *risk item 3* r = 0.15, $p = 0.009$; and *risk item 4*, r = 0.15, $p = 0.006$).

averse individuals), making them less reliant on physical distancing. However, this substitution only occurred in later years, when virus mortality had fallen drastically.

Because the analysis above reports the psychological regressors on their original scale, we re-estimated all models replacing BSCS, risk aversion, and fear of contracting COVID-19 with year-specific above-mean dummies, so that the response categories are not treated as a quantitative metric (see Section 3.1). The results are reported in Table 6, and confirm the central findings while clarifying which results are more sensitive to the way the scales are treated. *Self-control* remains the most systematic predictor: under the binary specification, the high-BSCS dummy retains its sign and significance in nearly every cell — positive for *indoor mask use* (2020–2021) and *indoor physical distancing*, and negative for *outdoor mask use* (2021–2022) — with the only notable exception being *outdoor physical distancing* in 2022, which is significant under the original scale but not under the dummy. The role of *risk aversion* as a predictor of *mask use* is likewise confirmed where it was strongest (*indoor* and *outdoor mask use* in 2021), whereas the weaker 2022 mask effects do not survive dichotomisation (the *indoor mask use* effect becomes non-significant and the *outdoor mask use* effect remains only marginal), and the absence of any effect on *physical distancing* is unchanged. *Fear of contracting COVID-19* is the most sensitive to the coding: its strong 2021 association with *indoor mask use* and its negative 2022 association with *indoor physical distancing* are preserved, but the significant 2022 effect on *indoor mask use* weakens to non-significance, some marginal effects (*outdoor mask use* in 2021, *outdoor physical distancing* in 2021) lose significance, and a positive effect on *mask use* in 2020 — only mild under the original scale — becomes significant. Overall, the substantive interpretation is unchanged: self-control is the most robust determinant, risk aversion is tied to mask use, and fear of contracting COVID-19 predicts mask use while being associated with lower physical distancing. The results that prove fragile to dichotomisation are concentrated in 2022, the wave with the lowest virus mortality and the fewest restrictions, when the behavioural signal of all psychological traits was weakest.[41]

As an additional check, we investigated whether the association between psychological traits and compliance varied significantly across pandemic waves. To this end, we estimated pooled ordered-logit models including year indicators and their interactions with the psychological regressors. The risk-aversion items were the same in all three waves, but a multi-item risk-aversion scale comparable across waves is available only from 2021 onward, because in 2020 the scale's reliability was too low to be usable and a single item had to be used as a proxy (see Section 5.1); we therefore report two sets of interaction models (Table 7): one estimated over the full

[41] We also verified the proportional-odds (parallel-lines) assumption underlying the ordered-logit models, using Wald tests of the equality of coefficients across response thresholds, computed both separately for each regressor and jointly; the results are reported in Table A6. For the three focal regressors the assumption is not rejected in 34 of the 36 tests; the two exceptions are *BSCS* for *indoor mask use* in 2020 and *risk aversion* for *outdoor mask use* in 2022, the latter coinciding with the counterintuitive, only marginally significant estimate noted above. Where the joint test rejects proportional odds, the focal regressors are otherwise individually non-significant, and the violations are therefore driven by the demographic controls rather than by the variables of interest, so the substantive conclusions are not materially affected by departures from proportional odds.

Table 7 Pooled ordered-logit models with year interactions. Ordered-logit coefficients are reported. Panel A uses 2020 as the reference year and excludes vaccination status because this variable is not available in 2020. Panel B uses 2021 as the reference year and includes vaccination status

	Indoor mask use	Outdoor mask use	Indoor physical distancing	Outdoor physical distancing
Panel A. Full sample (2020–2022)				
BSCS	1.454***	0.005	1.236***	1.638***
	(0.231)	(0.254)	(0.236)	(0.269)
Fear of contracting COVID-19	0.107	0.211†	-0.038	0.049
	(0.119)	(0.108)	(0.129)	(0.129)
Year 2021	-0.110	0.670	1.594	1.971†
	(0.961)	(1.025)	(1.055)	(1.134)
Year 2022	1.162	3.611**	5.060***	4.078***
	(1.129)	(1.166)	(1.105)	(1.014)
BSCS × 2021	-0.293	-0.522	-0.412	-0.362
	(0.296)	(0.324)	(0.312)	(0.357)
BSCS × 2022	-0.902*	-1.377***	-1.424***	-1.047**
	(0.374)	(0.383)	(0.354)	(0.334)
Fear × 2021	0.383*	0.108	-0.132	-0.375*
	(0.160)	(0.149)	(0.164)	(0.173)
Fear × 2022	0.236	-0.156	-0.276	-0.142
	(0.169)	(0.157)	(0.170)	(0.159)
p-value: BSCS × year	0.054	0.001	0.000	0.004
p-value: Fear × year	0.057	0.233	0.263	0.084
Observations	1090	1090	1090	1090
BIC	3070.3	3292.9	3224.4	3207.0
Demographic controls	Yes	Yes	Yes	Yes
Vaccination control	No	No	No	No
Panel B. 2021–2022 subsample				
	Indoor mask use	**Outdoor mask use**	**Indoor physical distancing**	**Outdoor physical distancing**
BSCS	1.270***	-0.438*	0.823***	1.279***
	(0.197)	(0.204)	(0.211)	(0.256)
Risk aversion	0.396**	0.548***	0.103	-0.120
	(0.123)	(0.137)	(0.143)	(0.165)
Fear of contracting COVID-19	0.402***	0.189†	-0.183†	-0.327**
	(0.109)	(0.107)	(0.109)	(0.122)
Year 2022	2.281*	5.152***	3.641**	2.000
	(1.155)	(1.234)	(1.167)	(1.226)
BSCS × 2022	-0.870*	-0.769*	-0.983**	-0.660*
	(0.375)	(0.345)	(0.335)	(0.329)
Risk aversion × 2022	-0.144	-0.853***	-0.091	0.023
	(0.184)	(0.197)	(0.187)	(0.202)
Fear × 2022	-0.077	-0.130	-0.129	0.220
	(0.160)	(0.154)	(0.152)	(0.154)
Observations	770	770	770	770
BIC	2211.6	2368.0	2326.6	2273.1
Demographic controls	Yes	Yes	Yes	Yes
Vaccination control	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

† p<0.10, * p<0.05, ** p<0.01, *** p<0.001

2020–2022 period, which includes BSCS and fear of contracting COVID-19 (Panel A); and one estimated on the 2021–2022 subsample, in which all three traits, including risk aversion, enter together (Panel B).

The interaction analysis refines the interpretation emerging from the year-specific regressions. In the full 2020–2022 sample, the joint tests for the interactions between BSCS and year are statistically significant, or marginally significant, across all four compliance outcomes — a pattern driven by the 2022 wave, whereas the 2021 interactions are not significant. Thus, although self-control is the most consistently significant predictor in every wave (Tables 5 and 6), the magnitude of its association with compliance shifted significantly over the course of the pandemic. By contrast, in the same full-sample model, fear of contracting COVID-19 — while significant in fewer year-by-outcome cells — displays the most constant effect across waves: its joint interactions with year are non-significant for outdoor mask use and indoor physical distancing, and only marginally significant for indoor mask use and outdoor physical distancing. This does not reflect irrelevance: as shown by the year-specific regressions (Table 5) and corroborated by the 2021–2022 subsample, fear of contracting COVID-19 retains significant effects — positively on mask use and negatively on physical distancing — indicating that affective threat appraisal operated as a steady motivational driver throughout the pandemic, whereas the strength of the self-control channel was contingent on the epidemiological and regulatory phase. In the 2021–2022 subsample, the interaction between BSCS and the 2022 indicator is negative and statistically significant for all four outcomes, suggesting that the predictive role of self-control became weaker after the end of the state of emergency. The interaction between risk aversion and the 2022 indicator is statistically significant only for outdoor mask use, while the interactions involving fear of contracting COVID-19 are not statistically significant. Overall, these results confirm that the effect of psychological traits on compliance was not constant over time, but depended on the regulatory and epidemiological phase of the pandemic.

6 Conclusions

The present analysis showed that compliance with measures to prevent the spread of COVID-19 changed between 2020 and 2022 (Sections 4.1, 4.2 and 4.3), with specific measures given different levels of priority (Section 4.4). The analysis also explored how individual factors predicted different rates of compliance with the preventive measures as the pandemic evolved (Section 5.2). The findings showed that factors such as virus mortality, (social) norms, and experience of the pandemic shaped both the priority given to certain measures (in terms of compliance) and differences in rates of compliance with specific measures over the three waves. Moreover, the regression analysis showed that individual factors affected compliance differently over the years, in interaction with the aforementioned variables.

From a utilitarian perspective, compliance with preventive measures can be interpreted as a private cost incurred to reduce exposure to mortality risk. The benefit side of this trade-off is related to the value of mortality-risk reductions, which has been monetized at the policy level in the context of COVID-19 by Viscusi (2020). Our results suggest that individuals were more or less willing to pay this price when the perceived benefits increased or lessened, respectively. For example, because wearing a mask is uncomfortable, respondents appeared to give up this practice outdoors once virus mortality decreased, and to give it up indoors once it was no longer required. Similarly, compliance with outdoor physical distancing was greatest when mortality was highest (i.e., 2020) and when mask use became no longer mandatory in 2022 (suggesting that physical distancing was assumed as a countermeasure).

The present findings suggest that the perceived costs and benefits of compliance depend on personal features, as suggested by the literature (see Section 1). In more detail, the observed association between self-control and greater compliance with physical distancing aligns with Nivette et al. (2021), Xu and Cheng (2021), and Graham et al. (2020)[42]; and the observed association between risk aversion and greater compliance with mask use is consistent with Cerami et al. (2021) and, again, Xu and Cheng (2021)[43]. Moreover, the finding that fear of COVID-19 predicted compliance with mask use supports Olapegba et al. (2022) and Yıldırım et al. (2021)[44]. Most prior research has been based on data from only 2020. In contrast, our findings draw on data collected in 2020, 2021, and 2022. Our observations of later waves in the pandemic suggest that, in line with personal characteristics, individuals engaged in substitution practices (i.e., complying with certain preventive measures over others) as their experience with the pandemic grew and virus mortality fell. For instance, in 2021 and 2022, a direct relationship between self-control and physical distancing outdoors was found, reflecting an inversion of the association between self-control and outdoor mask use. In a similar vein, individuals who feared COVID-19 infection seemed to prioritize mask use at the expense of physical distancing. Framing these results in a utilitarian perspective, individuals may have weighed the perceived costs and benefits of complying with specific measures, and acted accordingly.

These patterns also connect back to the theoretical framework outlined in the Introduction. Interpreted through the lens of Protection Motivation Theory (Rogers, 1975), the two sides of the protective-behavior process behaved differently as the pandemic evolved. *Fear of contracting COVID-19*, the most direct expression of threat appraisal, operated as a stable motivational driver, with its association with compliance — positive for mask use and negative for physical distancing — persisting across all three waves. *Self-control*, which reflects the coping capacity to translate that motivation into sustained behavior, played a more contingent role: its predictive power was strongest when compliance was most costly and mandates were in force, and it faded as the state of emergency receded and the pressure to sustain effortful compliance diminished. This dissociation between a stable threat-appraisal component and a phase-dependent coping component is consistent with the PMT distinction between the motivation to comply and the self-regulatory resources required to

[42] These three articles showed an association with a broader social distancing score derived from multiple items, including physical distancing.

[43] However, both articles employed measures for risk aversion that differed from the measure employed in the present work (i.e., Hudson et al., 2005).

[44] Both works employed a scale of compliance with precautionary measures (including mask use) and a scale of fear of contracting COVID-19

enact it, and with the Behavioral Immune System view of preventive behavior as a calibrated response to perceived pathogen threat (Makhanova & Shepherd, 2020; Schaller & Park, 2011).

The present findings provide valuable insights for policymakers, particularly regarding the design of targeted interventions to promote compliance with preventive measures. Our results suggest that different psychological traits predict compliance with different measures, and that these associations shift as pandemic conditions evolve. This has practical implications. First, the strong and persistent association between self-control and physical distancing suggests that interventions aimed at reducing the self-regulatory burden of compliance — such as environmental nudges that make distancing the default option (e.g., floor markings, rearranged seating) — may be particularly effective, as they reduce the need for sustained effortful regulation (Thaler & Sunstein, 2009). Second, the finding that risk aversion primarily predicted mask use implies that risk communication strategies emphasizing the probabilistic benefits of specific measures may selectively increase compliance among risk-sensitive individuals. Conversely, individuals with low risk aversion may require different motivational levers, such as social norm-based messaging (Van Bavel et al., 2020). Third, the role of fear of contracting COVID-19 as a predictor of mask use — but a negative predictor of physical distancing — highlights a potential substitution effect that policymakers should anticipate: fearful individuals may over-rely on one measure at the expense of others, creating gaps in overall protection. Interventions should therefore promote compliance with bundles of measures rather than single behaviors. Finally, the observed decay of these associations over time, as virus mortality decreased and restrictions were lifted, cautions against static policy designs. Policymakers should acknowledge that the effectiveness of trait-based interventions is likely contingent on the phase of the emergency, and that tools effective in early, high-mortality stages may require recalibration as the population's experience with the threat evolves.

The study has, however, limitations. First, data were only collected in Italy, thereby limiting the generalization to other cultural contexts. Moreover, the data were relative to the Lecce province and collected during a very short time window; this casts further doubt on the external validity of the results. Nonetheless, most of the findings are consistent with the results of previous studies involving samples from very different backgrounds. This invites a more optimistic read on the potential for generalization.

To conclude, our data indicate that compliance with preventive measures depends on individual factors. However, such factors determine different effects through their interactions with pandemic factors, such as behavioral norms and virus mortality. Furthermore, substitutions across measures also occur, possibly driven by psychological factors.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11166-026-09507-8.

Acknowledgements G. Attanasi gratefully acknowledges financial support by the French Agence Nationale de la Recherche (ANR) under Grant ANR-18-E26-0018 (Project GRICRIS), the Italian Ministry of Universities and Research under Grant PRIN 2022 n. 20229LRAHK (funded by the European Union – Next Generation EU, Mission 4 Component 1, CUP B53D23012680006), and the Sapienza University under Ateneo Grants 2023 for project n. RG123188B4CEE028. A. Morone acknowledges and thanks the financial support under the National Recovery and Resilience Plan (NRRP), Mission 4, Component 2, Investment 1.1, Call for tender No. 104 published on 2.2.2022 by the Italian Ministry of University and Research (MUR), funded by the European Union – NextGenerationEU – Project Title "Excessive antibiotic consumption in humans: why, where, and how to curb it?" CUP H53D23002560006 – Grant Assignment Decree No. 967 adopted on 30.06.2023 by the Italian Ministry of University and Research (MUR).

Funding Open access funding provided by Università degli Studi di Bari Aldo Moro within the CRUI-CARE Agreement.

Declarations

Conflicts of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Anderson, L. R., & Mellor, J. M. (2008). Predicting health behaviors with an experimental measure of risk preference. *Journal of Health Economics,27*(5), 1260–1274.

Axelrod, R. (1986). An evolutionary approach to norms. *American Political Science Review,80*(4), 1095–1111.

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science,16*(6), 351–355.

Bellemare, C., Sebald, A., & Suetens, S. (2019). Guilt aversion in economics and psychology. *Journal of Economic Psychology,73*, 52–59.

Bicchieri, C. (2006). *The Grammar of Society: The Nature and Dynamics of Social Norms*. New York, NY: Cambridge University Press.

Bruine de Bruin, W. (2021). Age differences in covid-19 risk perceptions and mental health: Evidence from a national us survey conducted in March 2020. *Journals of Gerontology: Series B,76*(2), e24–e29.

Bruine de Bruin, W., Saw, H.-W., & Goldman, D. P. (2020). Political polarization in US residents' covid-19 risk perceptions, policy preferences, and protective behaviors. *Journal of Risk and Uncertainty,61*(2), 177–194.

Campos-Mercade, P., Meier, A. N., Schneider, F. H., & Wengström, E. (2021). Prosociality predicts health behaviors during the covid-19 pandemic. *Journal of Public Economics,195*, 104367.

Cerami, C., Galandra, C., Santi, G. C., Dodich, A., Cappa, S. F., Vecchi, T., & Crespi, C. (2021). Risk-aversion for negative health outcomes may promote individual compliance to containment measures in covid-19 pandemic. *Frontiers in Psychology,12*, 2116.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology,58*(6), 1015.

Decker, S., & Schmitz, H. (2016). Health shocks and risk aversion. *Journal of Health Economics,50*, 156–170.

Dong, E., Du, H., & Gardner, L. (2020). An interactive web-based dashboard to track covid-19 in real time. *Lancet Infectious Diseases,20*(5), 533–534.

Duckworth, A. L. (2011). The significance of self-control. *Proceedings of the National Academy of Sciences,108*(7), 2639–2640.

Flaxman, S., Mishra, S., Gandy, A., Unwin, H. J. T., Mellan, T. A., Coupland, H., Whittaker, C., Zhu, H., Berah, T., Eaton, J. W., et al. (2020). Estimating the effects of non-pharmaceutical interventions on covid-19 in Europe. *Nature,584*(7820), 257–261.

Freer, E., & Keefer, Q. (2022). Optimism bias and perceptions of behavioral factors for preventing severe covid-19 complications. *Journal of Behavioral Economics for Policy,6*(1), 11–20.

Furnival, G. M., & Wilson, R. W. (1974). Regressions by leaps and bounds. *Technometrics,16*(4), 499–511.

Goldfinch, S., & Taplin, R. (2022). A cross-sectional international study shows confidence in public health scientists predicts use of covid-19 non-pharmaceutical interventions. *BMC Public Health,22*(1), 1–10.

Graham, A., Cullen, F. T., Pickett, J. T., Jonson, C. L., Haner, M., & Sloan, M. M. (2020). Faith in trump, moral foundations, and social distancing defiance during the coronavirus pandemic. *Socius,6*, 2378023120956815.

Guiso, L., & Paiella, M. (2004). The role of risk aversion in predicting individual behaviors. Available at SSRN 608262.

Han, H. (2022). Trust in the scientific research community predicts intent to comply with covid-19 prevention measures: An analysis of a large-scale international survey dataset. *Epidemiology & Infection*, 150.

Hudson, D., Coble, K., & Lusk, J. (2005). Consistency of risk premium measures. *Agricultural Economics,33*(1), 41–49.

Kopalle, P. K., & Lehmann, D. R. (1997). Alpha inflation? the impact of eliminating scale items on cronbach's alpha. *Organizational Behavior and Human Decision Processes,70*(3), 189–197.

Kusama, T., Takeuchi, K., Tamada, Y., Kiuchi, S., Osaka, K., & Tabuchi, T. (2023). Compliance trajectory and patterns of covid-19 preventive measures, Japan, 2020–2022. *Emerging Infectious Diseases,29*(9), 1747.

Lewis, A., & Duch, R. (2021). Gender differences in perceived risk of covid-19. *Social Science Quarterly,102*(5), 2124–2133.

Li, H. (2021). Follow or not follow?: The relationship between psychological entitlement and compliance with preventive measures to the covid-19. *Personality and Individual Differences,174*, 110678.

Makhanova, A., & Shepherd, M. A. (2020). Behavioral immune system linked to responses to the threat of covid-19. *Personality and Individual Differences,167*, 110221.

Mamelund, S.-E., Dimka, J., & Bakkeli, N. Z. (2021). Social disparities in adopting non-pharmaceutical interventions during covid-19 in Norway. *Journal of Developing Societies,37*(3), 302–328.

Marinthe, G., Brown, G., Delouvée, S., & Jolley, D. (2020). Looking out for myself: Exploring the relationship between conspiracy mentality, perceived personal risk, and covid-19 prevention measures. *British Journal of Health Psychology,25*(4), 957–980.

Martínez, D., Parilli, C., Scartascini, C., & Simpser, A. (2021). Let's (not) get together! the role of social norms on social distancing during covid-19. *PLoS One,16*(3), e0247454.

Miller, H. V., Barnes, J., & Beaver, K. M. (2011). Self-control and health outcomes in a nationally representative sample. *American Journal of Health Behavior,35*(1), 15–27.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., Houts, R., Poulton, R., Roberts, B. W., Ross, S., et al. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences,108*(7), 2693–2698.

Nivette, A., Ribeaud, D., Murray, A., Steinhoff, A., Bechtiger, L., Hepp, U., Shanahan, L., & Eisner, M. (2021). Non-compliance with covid-19-related public health measures among young adults in Switzerland: Insights from a longitudinal cohort study. *Social Science & Medicine,268*, 113370.

Olapegba, P. O., Chovwen, C. O., Ayandele, O., & Ramos-Vera, C. (2022). Fear of covid-19 and preventive health behavior: Mediating role of post-traumatic stress symptomology and psychological distress. *International Journal of Mental Health and Addiction,20*(5), 2922–2933.

Pavela Banai, I., Banai, B., & Mikloušić, I. (2022). Beliefs in covid-19 conspiracy theories, compliance with the preventive measures, and trust in government medical officials. *Current Psychology,41*(10), 7448–7458.

Perra, N. (2021). Non-pharmaceutical interventions during the covid-19 pandemic: A review. *Physics Reports,913*, 1–52.

Plohl, N., & Musil, B. (2021). Modeling compliance with covid-19 prevention guidelines: The critical role of trust in science. *Psychology, Health & Medicine,26*(1), 1–12.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change1. *Journal of Psychology,91*(1), 93–114.
Salmon, S. J., Fennis, B. M., de Ridder, D. T., Adriaanse, M. A., & De Vet, E. (2014). Health on impulse: when low self-control promotes healthy food choices. *Health Psychology,33*(2), 103.
Santos, J. V., da Costa, J. G., Costa, E., Almeida, S., Cima, J., & Pita-Barros, P. (2022). Factors associated with non-pharmaceutical interventions compliance during covid-19 pandemic: a portuguese cross-sectional survey. *Journal of Public Health (Oxford, England)*.
Savadori, L., & Lauriola, M. (2021). Risk perception and protective behaviors during the rise of the covid-19 outbreak in Italy. *Frontiers in Psychology,11*, 577331.
Schaller, M. (2006). Parasites, behavioral defenses, and the social psychological mechanisms through which cultures are evoked. *Psychological Inquiry,17*(2), 96–101.
Schaller, M., & Park, J. H. (2011). The behavioral immune system (and why it matters). *Current Directions in Psychological Science,20*(2), 99–103.
Sharot, T. (2011). The optimism bias. *Current Biology,21*(23), R941–R945.
Sheth, K., & Wright, G. C. (2020). The usual suspects: do risk tolerance, altruism, and health predict the response to covid-19? *Review of Economics of the Household,18*(4), 1041–1052.
Siebenhaar, K. U., Köther, A. K., & Alpers, G. W. (2020). Dealing with the covid-19 infodemic: Distress by information, information avoidance, and compliance with preventive measures. *Frontiers in Psychology*, page 2981.
Tangney, J. P., Boone, A. L., & Baumeister, R. F. (2018). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. In *Self-regulation and self-control*, pages 173–212. Routledge.
Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving decisions about health, wealth, and happiness*. Penguin.
Uddin, S., Imam, T., Khushi, M., Khan, A., & Moni, M. A. (2021). How did socio-demographic status and personal attributes influence compliance to covid-19 preventive behaviours during the early outbreak in Japan? lessons for pandemic management. *Personality and Individual Differences,175*, 110692.
Ursachi, G., Horodnic, I. A., & Zait, A. (2015). How reliable are measurement scales? external factors with indirect influence on reliability estimators. *Procedia Economics and Finance,20*, 679–686.
Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., et al. (2020). Using social and behavioural science to support covid-19 pandemic response. *Nature Human Behaviour,4*(5), 460–471.
Viscusi, W. K. (2020). Pricing the global health risks of the covid-19 pandemic. *Journal of Risk and Uncertainty,61*(2), 101–128.
Vriens, E., Andrighetto, G., & Tummolini, L. (2024). Risk, sanctions and norm change: the formation and decay of social distancing norms. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *379*(1897).
Will Crescioni, A., Ehrlinger, J., Alquist, J. L., Conlon, K. E., Baumeister, R. F., Schatschneider, C., & Dutton, G. R. (2011). High trait self-control predicts positive health behaviors and success in weight loss. *Journal of Health Psychology,16*(5), 750–759.
Wright, L., Steptoe, A., & Fancourt, D. (2022). Trajectories of compliance with covid-19 related guidelines: longitudinal analyses of 50,000 UK adults. *Annals of Behavioral Medicine,56*(8), 781–790.
Xu, P., & Cheng, J. (2021). Individual differences in social distancing and mask-wearing in the pandemic of covid-19: The role of need for cognition, self-control and risk attitude. *Personality and Individual Differences,175*, 110706.
Yıldırım, M., Geçer, E., & Akgül, Ö. (2021). The impacts of vulnerability, perceived risk, and fear on preventive behaviours against covid-19. *Psychology, Health & Medicine,26*(1), 35–43.