RCHESTRA

Connecting European Cohorts to Increase Common and Effective Response to SARS- CoV-2 Pandemic

DELIVERABLE

WP8 D8.4

Impact of pandemic on socio-economic parameters

Barcelona Institute of Global Health (ISGlobal)

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Executive Summary

Content*:*
In deliverable 8.4 we focus on two key aspects related to the COVID-19 pandemic: the socio-economic implications on the population and the adherence to mandated measures during the lockdown and post-confinement periods.

From a socio-economic perspective, our analysis examines the well-being and financial adversities experienced by a general population cohort in Spain during the COVID-19 pandemic, considering factors such as age, gender, education, and income. Our findings indicate that income disparities played a significant role in generating increased adversities during the pandemic period. Individuals with the highest income and education levels reported greater perceived social support compared to those with lower income and education levels. From a financial perspective, the pandemic had a disproportionately severe impact on individuals with lower levels income, and in a lesser magnitude, those with lower educational levels. These results underscore the importance of addressing the financial needs and providing social support to individuals who face heightened social vulnerability.

From a behavioural perspective, we investigate the factors influencing individuals' adherence to mandated guidelines and regulations implemented by governments to mitigate the transmission of the virus, including socio-demographic characteristics, risk perception, knowledge about the virus, and clinical factors. We use a data from a general population cohort and a clinical fragile population cohort (WP4). Our results suggest that factors such as female sex and perceived risk of severe disease or death are consistently associated with increased compliance with COVID-19 mandates, across compliance definitions and cohorts. Additionally, results show that the perceived risk of infection and knowledge about the transmission of the virus played a significant role in increasing the adoption of overall protective measures.

Dissemination level: *This document is public.*

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Abbreviations

BMI – body mass index

CI – confidence interval

COVID-19 - COronaVIrus Disease 19

FSSQ - Functional Social Support Questionnaire

GLM - generalized linear model

HC_A – High Compliance definition A

HC_B - High Compliance definition B

INSERM - Institut National de la Santé et de la Recherche Médicale

LIH – Luxembourg Institute of Health

OR – odds ratio

PCA – Principal component Analysis

REDCap - Research Electronic Data Capture

SAS - Andalusian Health Service

SD – standard deviation

SE – Socio-economic

SOT - solid organ transplant

UBA - Universidad de Buenos Aires

UNIBO - University of Bologna

UNIVR– University of Verona

WHO – World Health Organization

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Core Content

General Introduction

We analyse (i) the socio-economic implication of the COVID-19 pandemic on the population and (ii) the adherence to the mandates to control the epidemic, specifically during the lockdown and post-confinement periods.

From the socio-economic point of view, it is important to distinguish the primary effects of the pandemic (infection/disease) from those of the lockdown(s). The impact on socio-economic indicators also occurs through the (necessary) measures taken to reduce the transmission of SARS-CoV-2, which disproportionately impacted some groups more than others due to a lack of safety nets, precarious jobs, no previous savings, etc. Therefore, the adverse effects of the pandemic and the response to the pandemic may not be evenly distributed between social strata. We explore well-being- and financial-related adversities encountered in a general population cohort in Spain during the COVID-19 pandemic (2020-2021) across age, gender, education and income.

Furthermore, our research aims to investigate the various factors that influence individuals' adherence to the mandated guidelines and regulations implemented by governments to mitigate the transmission of SARS-CoV-2. In the initial stages of the pandemic, when effective pharmaceutical interventions were not yet available and vaccines were not yet developed, the primary emphasis was placed on modifying citizens' behaviour to interrupt the transmission chain. As we progressed into 2021, with the distribution and administration of vaccines across different population segments at different points in time, adherence to safety measures remained crucial in minimizing transmission rates. Our study seeks to explore the interplay of these factors, including socio-demographic characteristics, risk perceptions, knowledge about the virus and clinical factors, to gain a comprehensive understanding of the determinants influencing individuals' compliance with COVID-19 guidelines.

By examining these factors, we can provide insights to inform public health strategies and interventions that promote sustained adherence and compliance with guidelines, inform modelling of disease spread, and help manage future infectious disease outbreaks or pandemic situations.

We analyse risk factors of COVID-19 preventative behaviour in two different cohorts, a general and a fragile patient cohort.

Data

This section of the report provides an overview of the two cohorts utilized in our analysis: the COVICAT/CONTENT general population cohort and the fragile population cohort (WP4). We present general information and describe the data collection process of each cohort, setting the foundation for the subsequent analysis.

COVICAT/CONTENT general population cohort

COVICAT/CONTENT is a general population sample of 20,586 persons in 5 ongoing adult general population cohort studies in Spain (initial pre-pandemic cohorts). It includes participants in several autonomic regions of Spain, although the majority of them are from Catalonia. Participants were followed prospectively for 2 years, with two major contacts: May-August 2020 (COVICAT) and May-December 2021 (CONTENT). The study contacts can be found in Figure 1.

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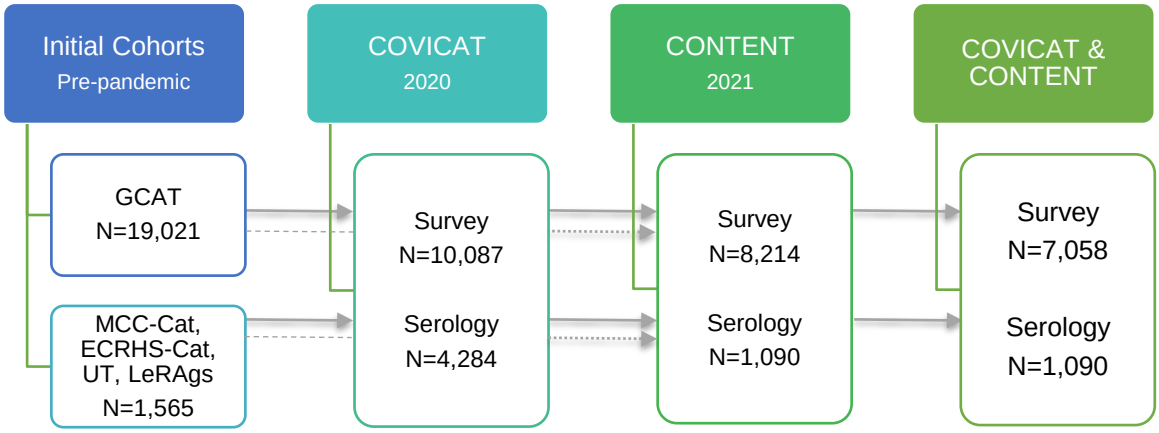

Figure 1. The first column reports the name and number of participants (N) of the initial pre-pandemic cohorts. The second and third columns report survey and serology number of participants for COVICAT (2020) and CONTENT (2021), respectively. Column 4 shows the total sample size of individuals followed up in both COVICAT and CONTENT.

Data collection for this sample is primarily completed on a study portal website and an associated smartphone web-based solution (app) sending messages and questionnaires through participants' smartphones. These methods are attractive to manage potential recruitment issues during the pandemic and to collect information in a flexible way and in real-time, such as during potential new infection surges. The study portal and the smartphone web-based solution provided optimal platforms to easily interact with the participants while adhering to physical distancing measures.
Participants were contacted via email, or, for those without registered email, through phone or text messaging. Participants were directed via a hyperlink to the study portal where they were able to review the consent form. All participants provided informed consent, and we obtained ethical approval for the study from the Parc de Salut Mar Ethics Committee (CEIm-PS MAR, number 2020/9307/I). The data collection process allowed participation via phone-calls, for subjects (many of advanced age) who were unfamiliar with web-based approaches or those that were not comfortable with online participation.

Fragile population cohort (WP4)

The data collection was carried out by WP4. WP4 is focused on fragile patients, represented by 35 cohorts of 10 different fragile populations including patients with HIV infection, solid organ transplant (SOT) recipients, patients with oncological diseases (cancer and haematological patients), and patients with Parkinson's Disease (PD). With the aim to capture information on demographic and socio-economic characteristics, use of health care resources, risk perception and take-up of preventative measures, WP8 designed a socio-economic (SE) questionnaire was and included in WP4 study protocol (questionnaire in the Supplemental material C).

Information was collected at least at two different points in time for each patient. The first collection point took place at the first contact with the patient: either the first contact for an underlying condition visit or vaccine administration. When the first collection point could not correspond to the time of vaccine administration, it was collected during the first post-vaccination follow-up. The second collection point is at the 12-month follow-up (either during a vaccination follow-up or at the end of the study visit). Information was also collected at month 6 follow-up whenever possible.

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Table 1 presents the WP4 cohorts that have gathered the questionnaire data.

Centre	Cohort	Sample Size
UNIBO	Transplant (Liver, Kidney, Heart & Lung), Haematology	472
SAS	Transplant (Kidney & Lung), Oncology, HIV, Haematology, Rheumatology, Haemodialysis patients	119
UBA	HIV	82
LIH	Parkinson Disease	150
Padova	Transplant (Liver, Kidney)	107
UNIBO[1]	Oncology, HIV	498
UNIVR[1]	HIV, Cystic Fibrosis	480

Table 1. List of WP4 cohorts that have administered the SE questionnaire. (1) These cohorts were not able to provide data in time for the current report.

Table A, in the Supplemental material B, shows the first collection point descriptive statistics of all information contained in the SE questionnaire for UNIBO (SOT and Haematology), SAS, UBA, LIH and Padova patients, for which the questionnaire was administered.

In addition, a subsample of cohorts was able to provide clinical information: BMI and smoking status, underlying disease and comorbidities for each type of fragile population, and treatment; COVID-19 admission, severity and complications; Sars-CoV-2 vaccination, adverse events related to the COVID-19 vaccine.

Well-being-related and financial adversities encountered in Spain during the COVID-19 pandemic (2020-2021) across age, gender, education and income

Introduction

In addition to the excess in morbidity and mortality, COVID-19 pandemic has been causing, worldwide, remarkable collateral consequences in terms of well-being- and financial-related difficulties. This is also the case in Spain, where the COVID-19 pandemic has been seen as associated with increased post-lockdown depression and anxiety (1). Notably, in many settings adversities have not evenly hit the population: there are inequalities in the existence and magnitude of difficulties across several demographic and socio-economic dimensions (2, 3). The overall objective is to evaluate inequalities in the COVID-19 post-confinement period, using existing epidemiological population cohort studies in Spain with data collected from May to August 2020 (COVICAT) and from May to December 2021 (CONTENT). We investigate the potential heterogeneity across four key dimensions (age, gender, education, and income) in a selected set of outcomes over a span of two years.

Methods

A. Variables

Three sets of outcomes were considered: difficulties during lockdown, social support and financial problems.

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Difficulties during lockdown

We use self-reported information to questions about whether individuals faced any type of difficulty as a consequence of lockdown, including difficulties from not being able to go out; see friends/family; go to the bar, restaurant or other social events; experiencing more conflicts than usual with family members and problems of conciliation with work and family. To investigate the dimensionality and generate a reduced composite of reported difficulties we carried out principal component analysis (PCA). Since the potential underlying factors are likely to be correlated, we computed (oblique) rotated loadings with *oblimin* rotation (Cattell, 1978; Kline, 1979). We extracted the two resulting component scores and used them as outcomes in the main analysis. One component score captured difficulties due to the inability to socialise and the other one captured heightened familial conflict. The scores were rescaled to range from 0-10 for each of the measures. A score of 0 identifies the lowest level of reported difficulties and 10 the highest. This procedure rescales the outcome distribution but it does not alter its shape nor affects any statistical tests performed.

Social support via The Duke–UNC Functional Social Support Questionnaire (FSSQ)

The FSSQ is a questionnaire made up of 8 items, which captures two dimensions of social support: confidant support, which represents whether important matters in life are discussed and shared with someone, and affective support, which represents levels of love and care perceived. The FSSQ score ranges from 0 to 32 and it is constructed by adding up the responses to each item in the questionnaire, which range from 0 “Much less than I would like” to 4 “As much as I need”.

Financial problems

We use information on individuals reporting financial problems when facing habitual payments, such as rent or utility bills, to explore how the pandemic shocked different socio-demographic and -economic groups in 2020 and 2021.

The stratification variables considered were age, gender, education and income. Descriptive statistics (number of non-missing observations (N), frequencies and proportions) are provided in table 2.

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	2020			2021		
Variable	**N**	**Frequency**	**Proportion**	**N**	**Frequency**	**Proportion**
Age						
41-50	9996	3033	30.3%	8158	2107	25.8%
51-60	9996	4444	44.5%	8158	3709	45.5%
61-70	9996	2324	23.2%	8158	2157	26.4%
71-80	9996	195	2.0%	8158	185	2.3%
Sex						
Male	9996	4088	40.9%	8158	3391	41.6%
Female	9996	5908	59.1%	8158	4767	58.4%
Education						
Up to Complete primary studies	9493	1065	11.2%	7855	820	10.4%
Vocational training	9493	2082	21.9%	7855	1545	19.7%
Secondary studies	9493	1937	20.4%	7855	1616	20.6%
University	9493	4409	46.4%	7855	3874	49.3%
Income						
<800 EUR	8918	212	2.4%	6780	135	2.0%
From 800 to <1500 EUR	8918	1153	12.9%	6780	769	11.3%
From 1500 to <2500 EUR	8918	3076	34.5%	6780	2209	32.6%
From 2500 to <6000 EUR	8918	4203	47.1%	6780	3392	50.0%
6000 EUR or more	8918	274	3.1%	6780	275	4.1%

Table 2. Summary Statistics of Stratification Variables: Number of non-missing information (N), Frequency and Proportions (%), in 2020 and 2021.

B. Analysis

The Supplement B to this document contains additional descriptive summary statistics comparing the outcome and stratification factors (tables A, B and C) and pairwise comparisons per stratification factor across groups (tables D, E and F). Continuous variables were summarized using medians and the first and third quartile of the distribution, while categorical variables were presented as frequency tables with corresponding percentages. In the case of the dichotomous outcome, which pertains to problems encountered with habitual payments, crude odds ratios (OR) with 95% confidence intervals (95% CI) were reported, along with p-values. For continuous outcomes, comparisons of medians were conducted using non-parametric tests (Mann-Whitney U test) and adjusted p-values reported. Statistical significance was determined at a threshold of $p < 0.05$.

Results

A. Personal difficulties and difficulties derived from the inability to socialise during lockdown; stratified by age, gender, education and income.

Figure 2 shows the distribution of self-reported difficulties from the inability to socialise and the occurrence of conflicts within the family as a consequence of lockdown; by age, gender, education and income.
By exploring the differences across socio-demographic and socio-economic groups we find significant differences within stratification variables and between measures. In general, across

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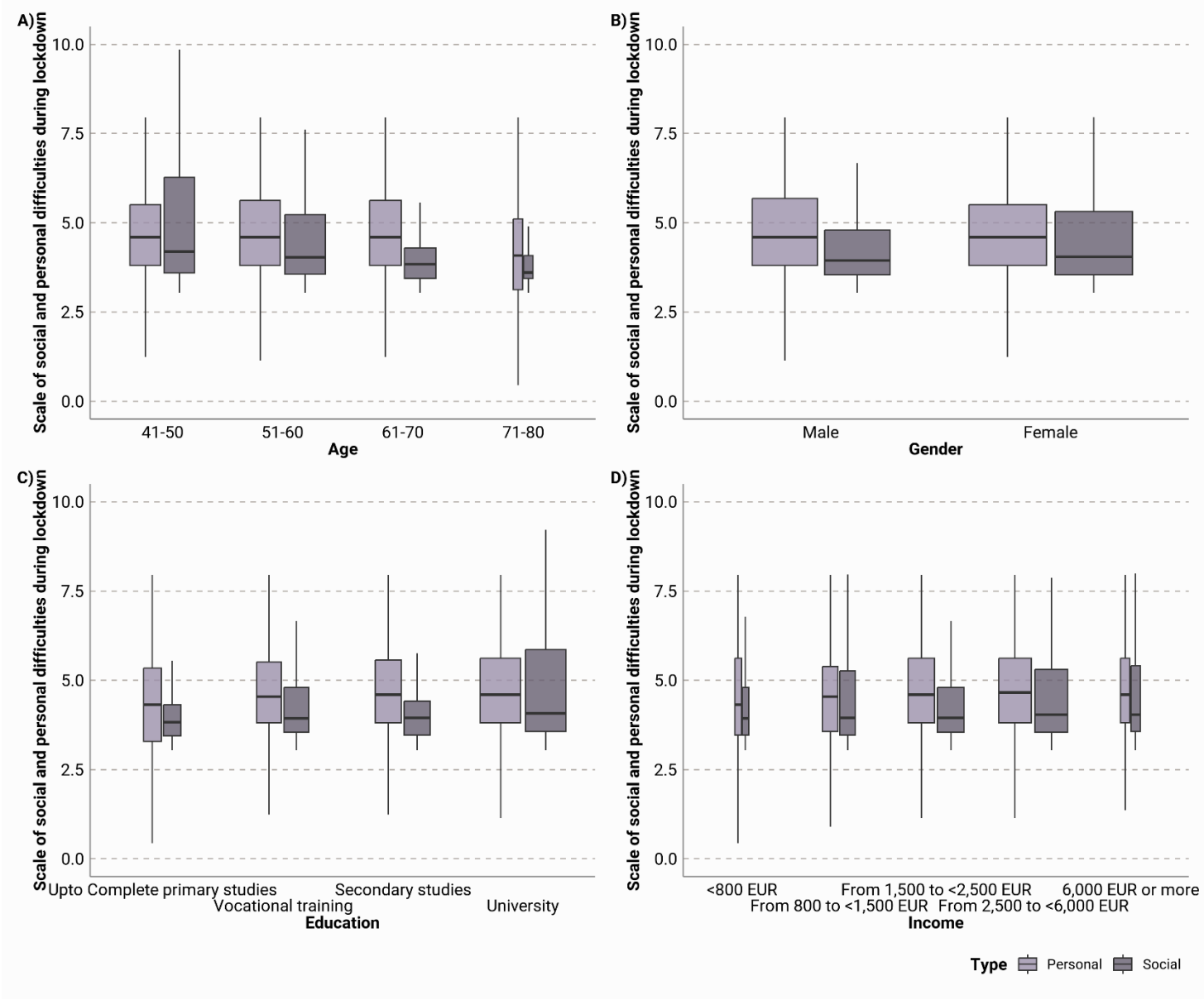

Figure 2. Box-plot of self-reported difficulties from the inability to socialise and personal difficulties as a consequence of lockdown; by age, gender, education and income. Boxes widths are proportional to the square-root of the number of observations in the stratification variables.

all groups, people reported more personal difficulties during the lockdown, whether it involved work-family conciliation issues or disputes within the household, than problems from the inability to socialise arising from the "stay at home" mandate. Within stratification variables, we find greater difficulties from the inability to socialise in males. Across age groups, we did not find any significant differences in family issues, except for the age group between 71 and 80 years, which reported fewer personal difficulties. However, we observed a decreasing trend in difficulties related to the inability to socialise, with older age groups having suffered less from the prohibition of social gatherings (table D, supplemental material). There are significant differences across education groups for both measures. Those with the highest levels of education reported more difficulties arising both from the inability to socialise and increased family conflict. Last, there were no major differences across income groups regarding personal and social difficulties during the lockdown. Summary statistics can be found in tables A, in the Supplemental material B.

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B. The Duke–UNC Functional Social Support Questionnaire (FSSQ) score stratified by age, gender, education and income.

Figure 3 provides a summary of the distribution of the Functional Social Support Score (FSSQ) by age, gender, education and income.
We observe that the reported levels of social support decreased in 2021 compared to 2020. When looking at the differences per stratification group, we find no major differences in social support across age or sex, except for increased levels of social support amongst women in 2021 compared to men. Concerning education, we observe that those with a university degree report higher levels of social support than all other educational levels both in 2020 and 2021. However, the most significant disparities in scores are found across income groups. The median difference between the lowest and highest levels of income is 6 score points in 2020 and 7 score points in 2021. The 95% confidence interval (CI) of the mean for those "<800 €" was [23.3, 24.9] in 2020 and [19.8, 21.7] in 2021, while the CI for those earning more than 6,000€ was [29.7, 31.0] in 2020 and [27.3, 28.6] in 2021. The analysis reveals an upward trend in the social support score across all income levels, indicating a positive association between income and social support. Notably, the observed differences between 2020 and 2021 are similar, suggesting relative stability in the relationship between income and social support over the two years. Summary statistics can be found in table B, from Supplemental material B.

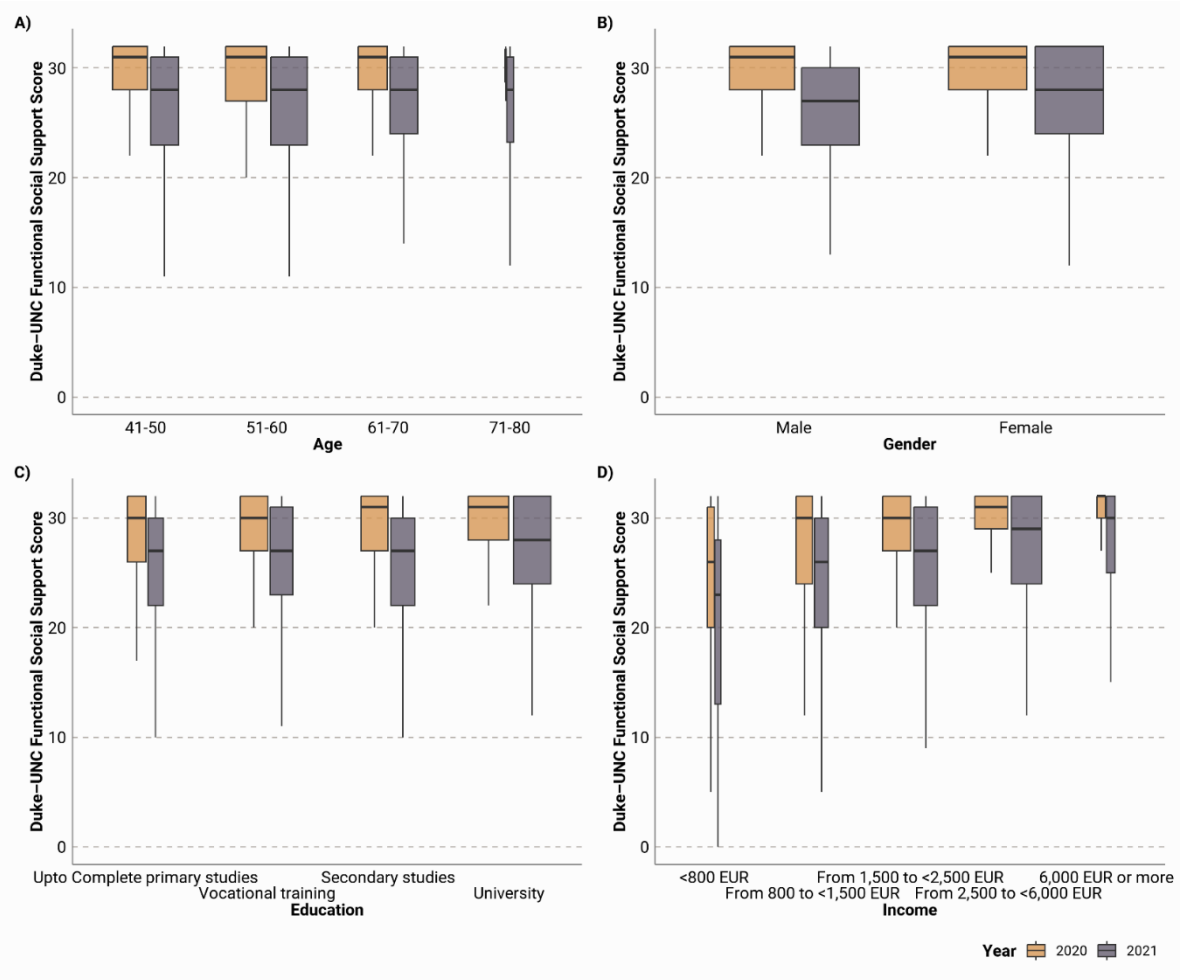

Figure 3. Boxplots of the Duke–UNC Functional Social Support Score by age, gender, education and income. Boxes widths are proportional to the square-root of the number of observations in the stratification variables.

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C. Difficulties in facing habitual payments in 2020 and 2021 by age, gender, education and income.

Generally, a larger proportion of people reported having financial problems in 2020 than in 2021, even though the differences are not equally significant across stratification factors. With respect to age, on average, a higher proportion of people faced problems with payments during 2020. For the age group between 40 and 50 years old, the same level of financial problems persisted in 2021 whereas, for all other age groups, the probability of facing some sort of financial difficulty decreased with age in 2021. Regarding sex, a higher proportion of people had problems with payments in 2020 compared to 2021, with no significant differences between men and women. By educational group, the only significant differences between 2020 and 2021 were within the group of people with the lowest level of studies, with around [12%,16%] of people reporting having faced problems in 2020 compared to [6%,10%] in 2021. In 2020, the proportion of people reporting problems facing habitual payment decreased with the educational level. In 2021, those with the highest level of educational attainment (university) had fewer problems with habitual payments compared to all other groups. This holds true for both the years 2020 and 2021. The most significant disparities were observed among various income groups. We observe that the likelihood of encountering difficulties with regular payments diminishes as income levels increase, albeit at a diminishing rate, with minimal disparities found between the two highest income groups. At the lowest levels of income (<800€), [29%,42%] of people reported economic problems in 2020; with those numbers increasing to [34%,52%] in 2021. It is the only socio-economic group which reported increased problems facing habitual payments in 2021 compared to 2020. The univariate results are plotted in Figure 4 and summarised in table C from the Supplemental material B.

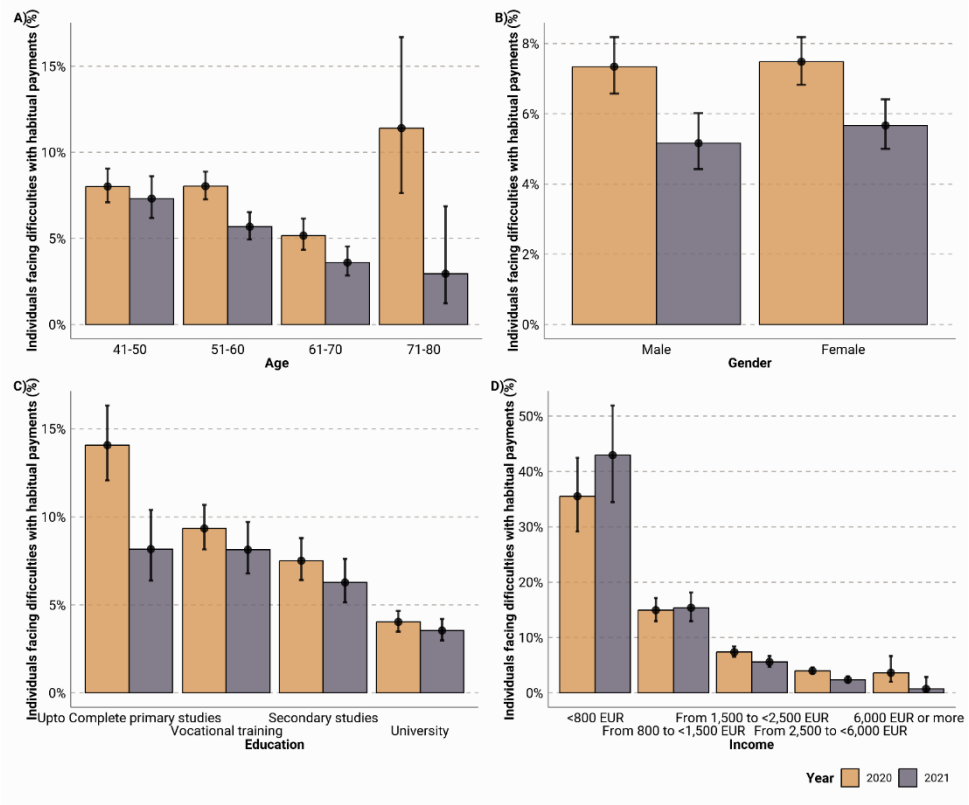

Figure 4. Bar plot of the observed reported difficulties facing habitual payments in 2020 and 2021 by age, gender, education and income. The y-axis shows the proportion of people reporting financial problems when facing habitual payments. The dotted points and error bars depict the estimate and 95% CI, respectively, of the predicted unconditional probability of reporting problems facing individual payments per categorical group, in 2020 and 2021.

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Conclusion

The COVID-19 pandemic has led to several negative consequences on individuals' well-being and their financial situation. This document reports the results of the exploration of data collected in Spain as part of the studies COVICAT (year 2020) and CONTENT (year 2021). Individuals with the highest level of education and income reported more difficulties bearing the State mandates during the lockdown, both when dealing with the prohibition of leaving the house to socialise and the management of conflict within the family. The reason for this may be that the richest and more educated were also more likely to do outdoor social activities before the pandemic and for this reason are the ones more hit by the stay-at-home mandate. Nevertheless, they reported greater levels of perceived social support which likely stems from the presence of a larger social network they can rely on and higher financial means to seek professional support in comparison with less educated and lower-income individuals. Overall, the perceived social support was significantly lower in September-December 2021 compared to April-August 2020. This may reflect the aftermath of the strict lockdown in Spain between March and 2020 May, which led to increased active efforts to look after people in close social circles during a period of relaxation of the initial severe restrictions.

From a financial perspective, the pandemic shocked those with the lowest levels of education and income harder. For those at the lowest level of income, the economic problems increased in 2021, which may be a result of cumulative debt and unemployment spells. The age group between 40 and 50 showed less capacity to recover from the economic difficulties faced in 2020, with persistent levels of economic struggle in 2021, compared with older age groups.

Risk factors of COVID-19 preventative behaviour during 2020 and 2021 in Spain

In the following section, we describe the analysis and results of identifying factors that contribute to enhancing individual compliance with COVID-19 mandates among the general population. We use data collected in 2020 (COVICAT) and 2021 (CONTENT) from a general population cohort from Spain. We perform a cross-sectional analysis for both years and discuss the evolution of risk factors at different points of the pandemic.

This analysis has been done in coordination with WP3, in which a similar analysis has been performed in the KOCO-19 cohort. Currently, results from the KOCO-19-cohort analysis cannot be disclosed, so a discussion of the common and differing findings will be provided in the future.

Methods

This section provides a comprehensive description of the variables included in the analysis, including both the generation of outcomes and the relevant covariates. Additionally, we outline the analytical methods used to investigate the relationship between outcomes and explanatory variables.

A. Variables

Outcomes

We generated two alternative outcomes:

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A. A general index of reported behaviour. The general index includes both the hygiene and social components. To construct the general index, we considered individual dichotomous responses to the adherence to six self-protective measures to prevent infection: hand washing/disinfection, avoiding touching eyes, nose and mouth, and use of mask (hygiene measures); and social distancing of at least 2 meters, self-isolation/staying at home, and avoiding friends/family at home (social distance measures). Table 3 shows sample responses to each preventive measure. The general index is the sum of all reported preventive measures. The distribution of indexes is shown in Figure 5. In addition to the general index, we also plot the hygiene and social indexes, which are the sum of reported hygiene measures and the sum of reported social distancing measures, respectively.

Variable	N	Yes	No	Frequency of Yes
2020				
Social distance	10 087	9420	667	93.4%
Avoid touching eye	10 087	7237	2850	71.7%
Self-isolation	10 087	2742	7345	27.2%
Avoid friends/family at home	10 087	4586	5501	45.5%
Hand-washing	10 087	9977	110	98.9%
Mask-wearing	10 087	9637	450	95.5%
2021				
Social distance	8197	6341	1856	77.4%
Avoid touching eye	8197	3526	4671	43.0%
Self-isolation	8197	608	7589	7.4%
Avoid friends/family at home	8197	2623	5574	32.0%
Hand-washing	8197	7544	653	92.0%
Mask-wearing	8197	7883	314	96.2%

Table 3. Summary Statistics of dichotomous responses to the adherence to infection prevention mandates: Number of non-missing information (N), Frequencies of Yes/No responses and Percentual Frequency of positive responses, in 2020 and 2021.

B. A dichotomous variable of hygiene high compliance. To construct this variable, we applied k-means clustering using categorical answers to the reporting of using masks when going out, hand-washing/disinfection when returning from the street, and using gloves when going out. Figure A, from the Supplemental material, shows responses to each hygiene measure. The possible answers ranged from "0. Never" to "3. Yes, systematically every time". We found 5 clusters of individuals, one of which corresponded to high compliance. The dichotomous outcome variable took a value of 1 for those in the high compliance clusters, and 0 for those in any other cluster. Results of the classification resulting from the k-means cluster analysis are displayed in Table 4.

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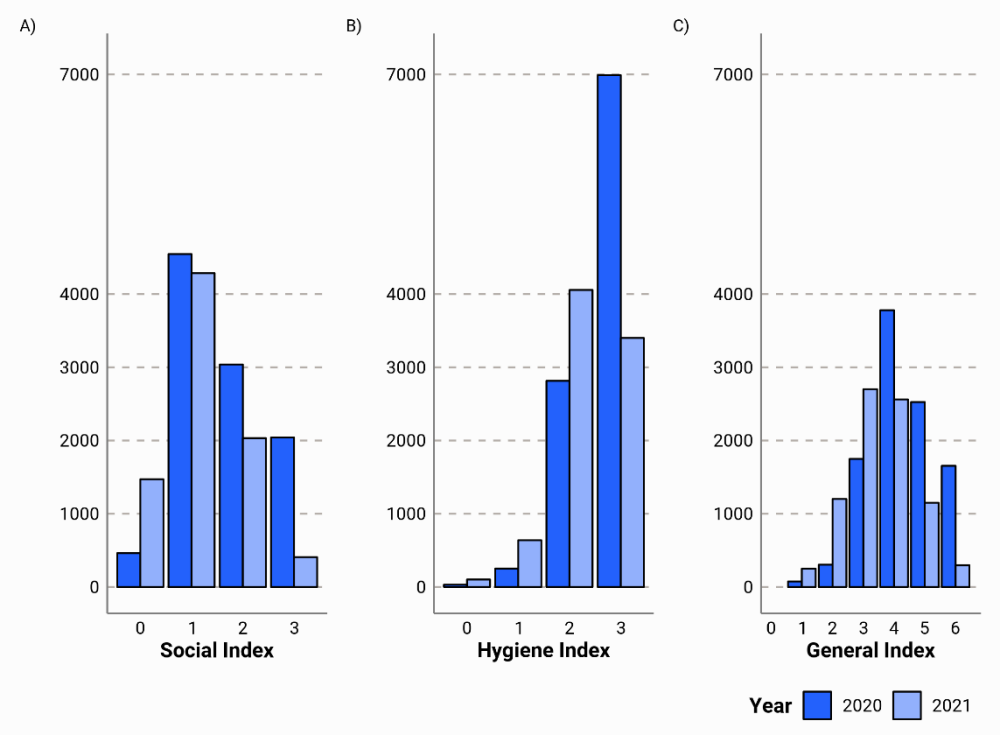

Figure 5. Histogram of the generated indexes of reported behaviour by year. The y-axis depicts the counts and the x-axis the index score.

Cluster	Frequency	Proportion	High Compliance	Frequency	Proportion
2020 (N = 10087)					
Mid-Low-Low	257	2.5%	No	2070	20.5%
Low-Low-High	1134	11.2%			
Mid-Low-High	679	6.7%			
High-Low-High	6749	66.9%	Yes	8017	79.5%
High-High-High	1268	12.6%			
2021 (N = 8196)					
Low-Low	229	2.8%	No	1983	24.2%
High-Low	787	9.6%			
Low-High	399	4.9%			
Mid-Mid	568	6.9%			
High-High	6213	75.8%	Yes	6213	75.8%

Table 4. Summary Statistics of the results of the k-means cluster analysis. Column 1 depicts the characteristics of each resulting cluster. In 2020, the row names describe the frequency of adherence to Mask-wearing - Using gloves - Hand-washing within cluster. In 2021, the use of gloves was removed from the questionnaire, and thus, only Mask-wearing - Hand-washing are included. Columns 2 and 3 show the Frequency and Proportion (%) of individuals in each cluster. Column 4, shows whether each cluster classified as high complier. Columns 5 and 6 report Frequency and Proportion (%) of high compliers.

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Covariates

We investigated the association of individual risk perception and adherence to protective measures by considering the subjective risk of infection assessed on a 10-point Likert scale. In the second wave of data, we also included self-perceived risk of hospitalisation and death. We also included dichotomous variables that captured knowledge about the disease, namely 1. knowledge of transmission through an infected person, 2. through an infected person when coughing, or 3. by touching infected surfaces.

	2020		*2021*	
Variable	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Risk infection	4.2	2.23	3.73	2.08
Risk hospitalisation			2.47	1.93
Risk death			1.56	1.7
Variable	**Frequency**	**Proportion**	**Frequency**	**Proportion**
Knowledge1				
No	2972	34.8%	1591	38.6%
Yes	5556	65.2%	2527	61.4%
Knowledge2				
No	263	3.1%	409	9.9%
Yes	8265	96.9%	3709	90.1%
Knowledge3				
No	1582	18.6%	2284	55.5%
Yes	6946	81.4%	1834	44.5%

Table 5. Summary Statistics of risk perception and knowledge covariates in 2020 and 2021: Mean and Standard Deviation for continuous variables and Frequency and Proportion (%) for categorical and binary variables.

We included demographic and socio-economic factors that might influence compliance with preventive measures, including age, sex, nationality, and education; household characteristics, such as household size, presence of an outdoor space in the house, and whether the couple or children live at home; employment status (employed, not employed, or retired) and income range (below 1500Eur, between 1500 and 2500Eur, and above 2500Eur). In addition, we included individual health factors that may play a role in adherence to measures, such as the presence of chronic illness or having been infected with SARS-CoV-2, either by being a confirmed or suspected case.

Last, we included the 7-day cumulative confirmed cases by PCR/TA per 100 000 individuals as a measure of the actual risk of infection. In the first wave, data was collected during the lifting of the lockdown restrictions, from May 11th to June 18th. Therefore, we include phase dummies as a covariate. The 4 phases of restriction lifting are described in Table 6:

Table 6. Description of changes in mandates during the phases of the lifting of the lockdown restrictions, from May 11th to June 18th.

Table 7. Description of changes in mandates during the phases of the lifting of the lockdown restrictions, from May 11th to June 18th.

Table 8. Description of changes in mandates during the phases of the lifting of the lockdown restrictions, from May 11th to June 18th.

Table 9. Description of changes in mandates during the phases of the lifting of the lockdown restrictions, from May 11th to June 18th.

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	work	*mobility*	*bars/ restaurants*	*gatherings*	*going out*	*schools*	*shops*
Phase 0: Lockdown	telework if possible	only if necessary; compulsory use of mask in public transport	closed	not allowed	only if >14 years	closed	by appointment
Phase 1		allowed mobility within the sanitary region	outdoor only with 50% capacity	up to 10 people	if >14 years: sport or walk from 6-10h and 20-23h; if >70 y: walk form 10-12 and 19-20h; if <14y: 12-19h	closed	
Phase 2		allowed mobility within the sanitary region	indoor at 40% capacity in tables (not at the bar)	up to 15 people	no restriction; priority time for elderly and vulnerable populations: 10-12h and 19 to 20h	closed	malls at 30% capacity
Phase 3			indoor at 50% capacity			closed	
Phase 4: New normality			distance >1.5 between persons			closed	

Table 10. Description of changes in mandates during the phases of the lifting of the lockdown restrictions, from May 11th to June 18th.

Summary statistics can be found in Table 7.

	2020		*2021*	
Variable	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Age	54.55	7.10	56.36	7.52
Incidence	20.51	22.47	303.22	334.07
Variable	**Frequency**	**Proportion**	**Frequency**	**Proportion**
Demographic and clinical characteristics				
Sex				
Male	3481	40.8%	1730	42.0%
Female	5047	59.2%	2388	58.0%
Nationality				
Spanish	8235	96.6%	3920	95.2%
Foreigner	293	3.4%	198	4.8%
Chronic illness				
No	5784	67.8%	2659	64.6%
Yes	2744	32.2%	1459	35.4%
Household characteristics				
Household size				
1	1172	13.7%	2150	52.2%
2	2636	30.9%	838	20.3%
3	2233	26.2%	854	20.7%
4	2009	23.6%	213	5.2%
>5	478	5.6%	63	1.5%
Outdoor space				

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No	845	9.9%	315	7.6%
Yes	7683	90.1%	3,803	92.4%
Couple home				
No	2320	27.2%		
Yes	6208	72.8%		
Children home				
No	3777	44.3%		
Yes	4751	55.7%		
Socio-economic characteristics				
Education: college				
No	4438	52.0%	1924	46.7%
Yes	4090	48.0%	2194	53.3%
Employment				
Employed	5672	66.5%	2840	69.0%
Not Employed	1608	18.9%	452	11.0%
Retired	1248	14.6%	826	20.1%
Income				
<1,500 EUR	1237	14.5%	537	13.0%
From 1,500 to <2,500 EUR	2950	34.6%	1359	33.0%
2,500 EUR or more	4341	50.9%	2222	54.0%
Acute infection and Vaccination				
COVID-19 infection				
No	8107	95.1%	3453	83.9%
Yes	421	4.9%	665	16.1%
Vaccination Dose 1				
No			256	6.2%
Yes			3862	93.8%
Vaccination Dose 2				
No			1247	30.3%
Yes			2871	69.7%
Contextual information: lockdown restriction-lifting phase				
Phase				
1	4332	50.8%		
2	2367	27.8%		
3	203	2.4%		
4	1626	19.1%		

Table 11. Summary Statistics of covariates in 2020 and 2021: Mean and Standard Deviation for continuous variables and Frequency and Proportion (%) for categorical and binary variables.

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C. Analysis

The statistical models used in this analysis were estimated through a Generalized Linear Model (GLM) framework. For the first set of outcomes (indexes of reported behaviours), we employed a GLM with a Gaussian link. This choice allowed us to capture the linear relationship between the predictors and the response variable, facilitating the interpretation of the estimated coefficients and their significance. For the dichotomous outcome variable, a logistic regression model was used by considering a GLM with log-odds linking function. The coefficient estimated were appropriately transformed into Odds-ratios (OR). Information is assumed to be missing at random. In the results section, tables 8-11 show the results of a multivariate analysis. The tables include coefficient estimates, lower and upper 95% confidence interval (CI) bounds, and p-values. P-values are deemed statistically significant at conventional significance levels (i.e., $p < 0.05$).

Results

A. Descriptive Results

Most of the participants reported a positive behaviour by adhering to most of the measures advised against a possible infection of SARS-CoV-2. The measure that was the least complied with was self-isolation: only about 27% of the sample reported to adhere to that measure in 2020 and 7.4% in 2021. On the contrary, the measure that was the most complied with was hand-washing. In 2020, above 95% of the sample reported wearing a mask when leaving home, which became compulsory on July 7 in Catalonia, Spain (82% of the participants had already participated in the survey before that date). In 2021, mask-wearing remains consistently high at 96.2%. Hand-washing compliance also remained high with 92% of the sample reporting to wash hands systematically when returning home in 2021. The reported frequency of basic hygiene measures confirms that hand-washing was the most systematically used measure in May-August 2020. In 2021, above 80% of the sample reported wearing a mask every time they left the home. This number increased in comparison to 2020, probably due to its mandatory status throughout the whole 2021 year. The results of the k-means clustering of the frequency of adherence to basic hygiene measures yields a 79.5% of high compliers in 2020 and a 75.8% in 2021.

As shown in Table 5, the mean risk perception was 4.21 out of 10, in 2020, and 3.73 in 2021. Knowledge on how the virus transmits was high. In 2020, almost all of the participants (97%) knew that the virus could transmit from an infected person when coughing. Nevertheless, this number was slightly reduced (65%) when speaking about an infected person generally. In 2020, these numbers reduced to 90% and 61%, respectively. The belief that the virus could be transmitted through infected surfaces changed significantly from 2020 (81.4%) to 2021 (44.5%). This change in belief could explain the drop in the proportion of the sample that reported to systematically wash their hands when returning home (84% vs 62% in 2021).

Our sample average age is 55 years with a higher proportion of females (59%) and Spanish nationals (97%). Between 32% and 35% percent of individuals report at least one chronic disease. Most individuals live in household of 2, 3 and 4 members (31%, 26% and 24%, respectively), with approximately 14% living alone. Other household characteristics are the presence of an outdoor space in 90% of households, 73% of individuals living with their partner, and 56% having a child at home. In our sample 48% of the individuals have a college degree, 67% are employed (either formally or informally), 19% are not employed (including unemployment and incapacity for work with and without benefits), and 15% are retired. With regards to monthly income, 51% earn 2500Eur or more, 35% earn between 1500Eur and 2500Eur, and 15% earn less than 1500Eur. During May-August 2020, only 5% of the sample had a SARS-CoV-2 infection (suspected or diagnosed) while the number raised to 16% by

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May-December 2021. In 2021, 94% had been vaccinated with one dose and 70% with two doses. In 2020, 51% of the sample was interviewed during the Phase 1 of the uplifting of lockdown restrictions, 28% during Phase 2, 2% during Phase 3, and 19% during phase 4.

B. Multivariate analysis

Results for the general behaviour index can be found in Tables 8 and 9. Table 8 shows results for the first wave of data (May-August 2020) and Table 9 for the second wave of data (May-December 2021).

During the first COVID-19 wave, the perceived risk of infection and knowledge about the transmission of the virus increased the uptake of protective measures (p=0.045 and p<0.001, respectively). The epidemiological context was also associated with protective measures adherence, with the 7-day cumulative confirmed cases by PCR/TA per 100 000 increasing adherence individuals and the uplifting of lockdown measures (phases) influencing adherence negatively (p=0.011 and p<0.001, respectively). The four phases of the uplifting of lockdown measures involved a loosening in the mandates on social gatherings and mobility, which allowed the population for greater autonomy in their choice of adherence to social distancing protective measures. Certain population characteristics were associated with higher adherence to protective measures. Females (p=0.002), individuals living with their partners (p=0.001), those who were not formally employed (p<0.001), and individuals with chronic illnesses (p<0.001) exhibited greater adherence to measures. On the other hand, Spanish nationals and individuals with children at home displayed lower adherence (p=0.014 and p=0.002, respectively).

In the second wave of data collection, which started at the end of the fourth COVID-19 wave and captured most of the fifth wave, similar factors influenced the uptake of protective measures compared to the previous year. The perceived risk of infection (p=0.015) and knowledge about the transmission knowledge of the virus (p<0.001) remained positively determinant, together with the perceived risk of death (p=0.003). Those with a suspected or confirmed COVID-19 infection had lower adherence than those with no infection (p=0.026) while those with one doses of the vaccine had increased adherence in comparison with those with no vaccine (p=0.036). Female sex individuals (p<0.001), those not formally employed (p=0.012) and with a chronic illness (p=0.001) had a larger adherence to measures, as seen in the previous year.

Variable	Estimate	95% CI		p-value
		Lower	Upper	
Age	0.003	-0.001	0.007	0.165
Female	0.074	0.027	0.121	**0.002**
Spanish	-0.153	-0.276	-0.030	0.014
Education: college	0.026	-0.021	0.073	0.295
Household size	0.003	-0.032	0.038	0.880
Outdoor space	-0.055	-0.129	0.019	0.151
Couple home	0.108	0.043	0.173	**0.001**
Children home	-0.115	-0.188	-0.042	**0.002**
Not employed	0.177	0.116	0.238	**<0.001**
Retired	0.043	-0.039	0.125	0.306
Income: 500 - 2500Eur	-0.049	-0.104	0.006	0.082
Income: >2500Eur	-0.012	-0.053	0.029	0.561

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Chronic illness	0.102	0.053	0.151	**<0.001**
COVID-19 infection	-0.004	-0.106	0.098	0.939
Incidence	0.002	0.000	0.004	**0.011**
Phase 2	-0.208	-0.261	-0.155	**<0.001**
Phase 3	-0.417	-0.564	-0.270	**<0.001**
Phase 4	-0.503	-0.597	-0.409	**<0.001**
Perceived risk of infection	0.010	0.000	0.020	**0.045**
Knowledge1	0.166	0.117	0.215	**<0.001**
Knowledge2	0.313	0.180	0.446	**<0.001**
Knowledge3	0.303	0.242	0.364	**<0.001**
Number of observations	8528			
Pseudo-R	0.064			

Table 12. Multivariate analysis results of the risk factors of social and hygiene mandates compliance in 2020. The outcome variable is the index of general behaviour. We show coefficient estimates, lower and upper 95% CI bounds and p-values. Statistically significant p-values ($p < 0.05$) are highlighted in bold.

Variable	**Estimate**	**95% CI**		**p-value**
		Lower	**Upper**	
Age	-0.002	-0.008	0.004	0.622
Female	0.194	0.127	0.261	**<0.001**
Spanish	-0.045	-0.198	0.108	0.559
Education: college	-0.042	-0.111	0.027	0.238
Household size	0.015	-0.020	0.050	0.393
Outdoor space	-0.005	-0.128	0.118	0.933
Not employed	0.142	0.032	0.252	**0.012**
Retired	0.051	-0.065	0.167	0.385
Income: 1500 - 2500Eur	-0.076	-0.154	0.002	0.058
Income: >2500Eur	0.001	-0.062	0.064	0.972
Chronic illness	0.124	0.053	0.195	**<0.001**
COVID-19 infection	-0.106	-0.200	-0.012	**0.026**
Vaccination: Dose 1	0.160	0.011	0.309	**0.036**
Vaccination: Dose 2	-0.013	-0.093	0.067	0.747
Incidence	0.000	0.000	0.000	0.642
Perceived risk of infection	0.025	0.005	0.045	**0.015**
Perceived risk of hospitalisation	0.014	-0.015	0.043	0.339
Perceived risk of death	0.045	0.016	0.074	**0.003**
Knowledge1	0.118	0.045	0.191	**0.001**
Knowledge2	0.297	0.179	0.415	**<0.001**
Knowledge3	0.318	0.247	0.389	**<0.001**
Number of observations	4118			
Pseudo-R	0.074			

Table 13. Multivariate analysis results of the risk factors of social and hygiene mandates compliance in 2021. The outcome variable is the index of general behaviour. We show coefficient estimates, lower and upper 95% CI bounds and p-values. Statistically significant p-values ($p < 0.05$) are highlighted in bold.

Results for the dichotomous outcome can be found in Tables 10 (first wave of data, May-Aug 2020) and 11 (second wave of data, May-Dec 2021). The dichotomous variable identifies

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individuals with high compliance of basic hygiene measures, primarily, high compliance with hand-washing and mask-wearing mandates.

During the first wave of the pandemic, several factors were associated with increased likelihood of high compliance with protective measures. These factors included higher age, female sex, living with the couple, non-formal employment, retirement status, chronic illness and COVID-19 infection increased the likelihood of high compliance. Additionally, higher perceived risk of infection and beliefs that the virus transmits through infected surfaces also increased the likelihood of high compliance.

During the second wave of data collection, similar factors continued to be associated with high compliance. These included age, female sex, and non-formal employment. Perceived risk of infection and belief in transmission through infected surfaces remained as influential factors promoting high compliance. In addition, having received only one dose of vaccination also increased the likelihood of high compliance. This suggests that individuals who had started the vaccination process but had not yet completed it still exhibited a heightened sense of responsibility and adherence to protective measures. Last, results show that highly educated (university degree) and high-income individuals were less likely of high compliance with basic hygiene measures.

Variable	OR	95% CI		p-value
		Lower	Upper	
Age	1.018	1.008	1.027	**<0.001**
Female	2.041	1.833	2.272	**<0.001**
Spanish	1.246	0.945	1.642	0.119
Education: college	0.969	0.866	1.084	0.582
Household size	0.944	0.869	1.025	0.171
Outdoor space	0.923	0.771	1.104	0.382
Couple home	1.420	1.222	1.649	**<0.001**
Children home	1.140	0.963	1.348	0.127
Not employed	1.298	1.118	1.507	**<0.001**
Retired	1.458	1.189	1.786	**<0.001**
Income: 1500 - 2500Eur	1.059	0.931	1.204	0.387
Income: >2500Eur	0.936	0.850	1.032	0.183
Chronic illness	1.128	1.005	1.266	**0.041**
COVID-19 infection	1.492	1.138	1.957	**0.004**
Incidence	1.002	0.998	1.007	0.307
Phase 2	0.941	0.830	1.067	0.342
Phase 3	0.686	0.499	0.942	**0.020**
Phase 4	0.805	0.641	1.010	0.062
Perceived risk of infection	1.051	1.026	1.077	**<0.001**
Knowledge1	1.111	0.989	1.247	0.075
Knowledge2	1.326	0.993	1.771	0.056
Knowledge3	1.259	1.095	1.449	**0.001**
Number of observations	8528			
Pseudo-R2	0.02			

Table 14. Multivariate analysis results of the risk factors of basic hygiene high compliance in 2020. The outcome variable is the binary variable hygiene high compliance. We show odds ratios (OR), lower and upper 95% CI bounds and p-values. Statistically significant p-values ($p < 0.05$) are highlighted in bold.

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Variable	OR	95% CI		p-value
		Lower	Upper	
Age	1.026	1.011	1.041	**<0.001**
Female	2.586	2.218	3.016	**<0.001**
Spanish	1.071	0.761	1.507	0.694
Education: college	0.810	0.690	0.950	**0.010**
Household size	1.044	0.964	1.132	0.290
Outdoor space	1.003	0.755	1.332	0.984
Not employed	1.958	1.451	2.642	**<0.001**
Retired	1.276	0.973	1.674	0.078
Income: 1500 - 2500Eur	1.006	0.837	1.209	0.946
Income: >2500Eur	0.847	0.730	0.984	**0.029**
Chronic illness	1.149	0.976	1.352	0.095
COVID-19 infection	1.154	0.928	1.434	0.198
Vaccination: Dose 1	1.413	1.017	1.963	**0.039**
Vaccination: Dose 2	0.937	0.776	1.133	0.503
Incidence	1.000	1.000	1.000	**0.003**
Perceived risk of infection	1.059	1.011	1.110	**0.015**
Perceived risk of hospitalisation	1.024	0.955	1.098	0.506
Perceived risk of death	1.014	0.943	1.089	0.714
Knowledge1	0.941	0.796	1.111	0.472
Knowledge2	1.069	0.823	1.388	0.616
Knowledge3	1.432	1.216	1.687	**<0.001**
Number of observations	4118			
Pseudo-R2	0.05			

Table 15. Multivariate analysis results of the risk factors of basic hygiene high compliance in 2021. The outcome variable is the binary variable hygiene high compliance. We show odds ratios (OR), lower and upper 95% CI bounds and p-values. Statistically significant p-values ($p < 0.05$) are highlighted in bold.

Conclusion

In both analyses, the perceived risk of infection and understanding how the virus spreads were positively associated with compliance in both waves. Certain demographic factors, such as female sex, higher age, and non-formal employment, appeared to be robust factors influencing behaviour across outcomes. Individuals with a suspected or confirmed COVID-19 infection showed consistently lower adherence to protective measures compared to those without an infection. This result could be explained by an increased sense of immunity amongst individuals who already had a SARS-CoV-2 infection.

The analysis of two different behavior outcomes allowed us to find some additional compliance determinants. The analysis of risk factors of high compliance highlighted the inverse relationship between higher education (university degree) and high-income with high compliance to basic hygiene measures. This finding suggests a disparity in adherence based on socioeconomic factors, which was not observed in the first outcome analysis. Additionally, we find that having received only one dose of vaccination was associated with increased likelihood of high compliance. This suggests that individuals who had started the vaccination

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process but had not yet completed it still exhibited a heightened sense of responsibility and adherence to protective measures.

Overall, findings are robust to outcome definitions and outcome generating processes. Factors such as the importance of risk perception, demographic factors, and beliefs about transmission are found to be significantly associated with mandate compliance. However, some differences emerged between outcome analyses, particularly in relation to COVID-19 vaccination status and the influence of socioeconomic factors.

Risk factors of COVID-19 preventative behaviour in Fragile patients

In this section, we examine factors to positively influence individual adherence to COVID-19 mandates in fragile patients. The fragile population cohort is part of WP4 and is presented in the next subsection.

Methods

A. Variables

We generated three alternative outcome variables making use of the self-reported frequency (never, rarely, often, very often) of adherence to the following protective measures:

- Washing your hands with hand-soap or hydro-alcoholic solutions.
- Keeping a distance of at least 2 meters from others.
- Staying at home to avoid social contacts or avoiding gatherings with friends and relatives outside of the household/support bubble.
- Wearing a face mask in public.

The first outcome measure is a sum of reported frequencies: never = 0, rarely = 1, often = 2, and very often = 3; of all four listed measures. Therefore, the index of behaviour ranges from 0 to 12. The next two outcomes are dichotomous variables that take value 1 if the patient is classified as “high complier” and 0 otherwise. For the second outcome (from now on denoted as HC_A), high compliance is defined following the use of k-mean clustering, making use of the categorical responses to the four measures listed above. From the 6 clusters identified, the one denoted as high compliance averaged above the mean frequency for all four measures. For the third outcome (HC_B), patients that reported to adhere to all measures “very often” are categorised as high compliers.

We distinguished three classes of factors that might influence compliance with preventive measures. First, we incorporated individual socioeconomic and demographic characteristics, including age, sex, education, employment status, household size, and marital status. Second, we included information on the individual underlying disease (fragile population cohort) and their vaccination status. Third, to investigate the correlation between risk perception and compliance, we included perceived risk of infection and subjective risk of severe illness or death in case of infection, both assessed on a 10-point Likert scale. Additionally, we included the frequency of searching for COVID-19 information.

B. Data

In the current analysis, we only used information from UNIBO (SOT and Haematology), SAS, UBA, and Padova patients. From a total of 719 patients, we had complete information on 594.

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C. Analysis

For the first outcome (behaviour index), we employed a GLM with a Gaussian link with the outcome variable expressed in logarithmic form. For the dichotomous outcomes, a logistic regression model was used by considering a generalized linear model (GLM) with log-odds linking function. In both cases, information is assumed to be missing at random.

Results

Tables 12 and 13 show results for the behaviour index and the dichotomous variables, respectively. In fragile patients, female sex, vaccination status, frequency of COVID-19 news consultation and perceived risk of severe disease or death if patient where to be infected are associated with increased compliance with COVID-19 mandates, across all definitions.

Variable	Estimate	95% CI		p-value
		Lower	Upper	
Age	0.002	0.000	0.004	0.051
Female	0.067	0.034	0.100	**<0.001**
Fragile Cohort (ref: SOT recipient)				
HIV positive	-0.007	-0.056	0.042	0.786
Haematological	-0.056	-0.146	0.034	0.227
Cancer	0.002	-0.047	0.051	0.920
Autoimmune disease	0.017	-0.105	0.139	0.787
Vaccination Doses	0.063	0.034	0.092	**<0.001**
Education (ref: university degree)				
Primary school education	-0.014	-0.057	0.029	0.535
High school education	-0.021	-0.064	0.022	0.349
Partial university	-0.035	-0.100	0.030	0.294
Marital Status (ref: single)				
Married	0.026	-0.023	0.075	0.291
Separated or divorced	0.010	-0.051	0.071	0.744
Widowed	0.022	-0.056	0.100	0.585
Cohabiting	0.050	-0.009	0.109	0.092
Household Size	-0.004	-0.018	0.010	0.573
Employment Status (ref: employed)				
Unemployed	-0.020	-0.083	0.043	0.543
Retired	0.002	-0.041	0.045	0.941
Inability to work	0.021	-0.034	0.076	0.457
COVID-19 news (ref: several times a day)				
Once a day	-0.048	-0.089	-0.007	**0.023**
2-3 times a week	-0.028	-0.077	0.021	0.269
Once a week	-0.054	-0.117	0.009	0.094
Less than once a week	-0.065	-0.110	-0.020	**0.004**
Risk Perception (Infection)	0.000	-0.006	0.006	0.999
Risk Perception (Severe disease/Death)	0.008	0.002	0.014	**0.004**
Number of observations	594			
Pseudo-R2	0.144			

Table 16. Multivariate analysis results of the risk factors of compliance at baseline. The outcome variable is the behaviour. We show coefficient estimates, lower and upper 95% CI bounds and p-values. Statistically significant p-values ($p < 0.05$) are highlighted in bold.

We observe that females score 6.7% [3.4%,10%] higher in the behaviour index and are 1.2 to 2.5 (1.4 to 3.1) times more likely to be classified as high compliers (in parenthesis: 95% CI for HC_B). Each vaccination dose is associated with a 6.3% increase in the index and 1.7 times increase in the odds of high compliance. Those that looked for COVID-19 related information either once a day or less than once a week had lower compliance than those that did it several

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times a day. Last, perceived risk of severe illness or death due to infection was positively associated with compliance. Every two-point increase in the 10-point Likert scale was associated with a 1.6% [0.4%,2.8%] increase in the behaviour index and an increase in the odds of high compliance of approximately 27% [10%,46.7%].

	High Compliance A				High Compliance B			
Variable	**OR**	**95% CI**		**p-value**	**OR**	**95% CI**		**p-value**
		Lower	**Upper**			**Lower**	**Upper**	
Age	1.004	0.984	1.024	0.710	1.021	0.997	1.045	0.086
Female	1.709	1.169	2.498	**0.006**	2.056	1.367	3.094	**<0.001**
Fragile Cohort (ref: SOT recipient)								
HIV positive	0.721	0.401	1.295	0.273	1.457	0.751	2.827	0.266
Haematological	0.788	0.279	2.228	0.654	1.102	0.358	3.392	0.865
Cancer	1.021	0.583	1.790	0.942	0.862	0.474	1.567	0.626
Autoimmune disease	0.666	0.163	2.728	0.572	1.346	0.295	6.152	0.701
Vaccination Doses	1.715	1.182	2.488	**0.005**	1.749	1.161	2.634	**0.007**
Education (ref: university degree)								
Primary school education	0.894	0.543	1.472	0.660	0.982	0.573	1.685	0.948
High school education	0.958	0.580	1.583	0.867	0.838	0.480	1.465	0.536
Partial university	0.556	0.258	1.195	0.133	0.317	0.119	0.845	**0.022**
Marital Status (ref: single)								
Married	1.008	0.574	1.770	0.979	1.688	0.861	3.308	0.127
Separated or divorced	0.869	0.422	1.790	0.704	1.795	0.789	4.088	0.163
Widowed	1.331	0.524	3.385	0.548	2.129	0.795	5.703	0.133
Cohabiting	1.321	0.667	2.618	0.424	1.746	0.784	3.891	0.173
Household Size	0.957	0.822	1.114	0.569	1.067	0.902	1.261	0.449
Employment Status (ref: employed)								
Unemployed	0.307	0.130	0.729	**0.007**	0.374	0.131	1.066	0.066
Retired	1.253	0.767	2.048	0.367	1.075	0.623	1.855	0.795
Inability to work	1.285	0.687	2.406	0.432	1.490	0.766	2.896	0.240
COVID-19 news (ref: several times a day)								
Once a day	0.469	0.292	0.755	**0.002**	0.487	0.293	0.809	**0.005**
2-3 times a week	0.620	0.352	1.092	0.098	0.613	0.333	1.129	0.116
Once a week	0.516	0.248	1.074	0.077	0.427	0.183	0.993	**0.048**
Less than once a week	0.415	0.248	0.694	**<0.001**	0.533	0.305	0.930	**0.027**
Risk Perception (Infection)	1.033	0.962	1.109	0.374	0.982	0.909	1.060	0.637
Risk Perception (Severe disease/Death)	1.058	0.992	1.128	0.084	1.127	1.049	1.211	**0.001**
Number of observations	594				594			
Pseudo-R2	0.08				0.12			

Table 17. Multivariate analysis results of the risk factors of high compliance at baseline. Columns 2-5 show results for the High Compliance definition A (resulting from the k-means clustering analysis) and columns 6-9 show results for the High Compliance definition B (reporting of adhere to all measures “very often”). We show Odds-ratios (OR), lower and upper 95% CI bounds and p-values. Statistically significant p-values ($p < 0.05$) are highlighted in bold.

The results in table 13 also show that some socio-demographic groups differ in their likelihood of high compliance. We find that unemployed patients have lower odds of high compliance compared to those employed.

Conclusion

The results of the analysis conducted on the sample of fragile patients reveal some common and an additional set of factors associated with increased compliance with COVID-19 mandates, compared to those found among the general population sample. In comparison with

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the analysis of the general population sample, we find some consistent risk factors, such as the importance of risk perception and demographic factors in explaining increased adherence to protective measures. Factors such as female sex and perceived risk of severe disease or death if the patient were to be infected were found to be associated with increased compliance with COVID-19 mandates, regardless of the definition of compliance. This suggests that gender may play a role in shaping adherence behavior across different populations and that perceived vulnerability and underlying risk within fragile patient groups played a most relevant role in shaping adherence behavior during the COVID-19 pandemic in this specific population.

Moreover, the analysis on the fragile patient sample introduced additional risk factors specific to that population, such as the vaccination status and the frequency of COVID-19 news consultation. However, these additional factors may be subject to bias and capture some underlying characteristics of the high compliant population of fragile patients. More specifically, vaccination may be an indicator of underlying disease severity, and therefore, be a biased estimate of the direct effect of vaccination on compliance. Similarly, the frequency of COVID-19 news consultation estimate could be partially capturing a personality type or other unmeasured factors. In the fragile population sample, socio-economic characteristics appear to be less relevant than in the general population.

Despite having some sources of bias in our estimation arising mainly from unobserved heterogeneity in our sample, the findings shed light into the compliance of a fragile cohort. Overall, the results from the fragile patient sample complement the earlier findings by expanding our understanding of the factors associated with compliance with COVID-19 mandates.

Recommendations

- The exploration of data from COVICAT and CONTENT suggests the **need to address extra financial help and social support** to individuals with lower levels of education and income. This should be done with short-term policies aimed at resolving urgent matters that follow catastrophes, such as the COVID-19 pandemic, and long-term policies aimed at resolving social vulnerabilities, so that new catastrophic events will not find the community unprepared.

- The perceived risk of infection and knowledge about the transmission of the virus played a significant role in increasing the adoption of overall protective measures. This suggests that **public awareness and understanding of the transmission dynamics influences behaviour**.

- Distinctive factors shape compliance within distinctive vulnerable populations groups, such as the fragile population. This knowledge provides valuable insight into the nuanced considerations and unique circumstances that influence individuals' adherence to guidelines and measures.

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