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JEL Codes:

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## **Abstract**

Using nationally representative panel data on 7,766 individuals (22,878 observations), we investigate the association between several well-being indicators (depression, anxiety, stress, and loneliness) and the general tendency to follow official recommendations regarding self-protection against COVID-19, in France, Germany, Italy, Spain, and Sweden over the course of four data collection waves. Employing a flexible specification that allows the correlation to be non-monotonic, we find a U-shaped relationship, in which transitions to low and high levels of psychological well-being are associated with higher overall compliance, while transitions to medium levels of psychological well-being are associated with less compliance. Moreover, anxiety, stress, and loneliness levels at baseline also have a U-shaped effect on following the recommendations later (i.e., recommendations are followed best by those with lowest and highest levels of anxiety, stress, and loneliness at baseline, while following the recommendations is lowest for those with moderate levels of these variables). These U shapes are in contrast to previous studies which report monotonic relationships between various measures of mental health and compliance, or ambiguous results. Additionally, we observe a U-shaped correlation between the well-being indicators and a number of specific behaviours (including washing hands and mask wearing). Importantly, most of these specific behaviours play a role in the general tendency to follow recommendations. Finally, we uncover the role of gender composition effects in some of our results. While variations in depression and stress are negatively correlated with variations in overall compliance for males, the association is positive for females. The relation in the full sample (composed of males and females) will reflect first the negative slope for males and then the positive slope for females, explaining the U shape.

**Keywords:** Psychological well-being; adherence; compliance; COVID-19; longitudinal research design; Europe.

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# 1 Introduction

Having a better understanding of who is non-compliant with COVID-19 protective behaviours, and why, is important. This can help governments and other bodies better design and implement policies that promote greater engagement among those less likely to comply. We contribute to this enhanced understanding by providing evidence regarding the link between psychological well-being and following recommendations, with a novel longitudinal dataset covering five European countries (France, Germany, Italy, Spain, and Sweden).

## 1.A Literature review

Psychological well-being can affect compliance with health-related recommendations through various psychological mechanisms. A consequence of this complexity is that the sign and shape of the relationship between well-being and compliance is difficult to predict *a priori* by a mere application of current models of preventive behaviours.

For instance, in the COM-B modelling approach to prevention, individuals' compliance with a prevention behaviour will depend on their degree of motivation, their capabilities to understand and perform the behaviour, and the opportunities to implement them (Michie, Van Stralen, and West 2011). These three dimensions can be presented in terms of benefit-cost trade-offs, echoing the economic approach to prevention (Ehrlich and Becker 1972). Compliance involves costly efforts that individuals are willing to bear only if they feel sufficiently motivated by the benefits in terms of risk reduction, if they believe that they are capable of implementing the recommendations with efficacy, and if their environment provides them with the opportunities to do so. The benefits of following the recommendations depend on the subjective perceptions of COVID risks and expected immediate and future losses associated with severe symptoms, hospitalisation, or death. The costs of effort include a quantitative and qualitative loss of social life, and the attention required to perform the recommendations in many everyday activities. These costs and benefits depend on opportunity factors outside of an individual's control, such as the virtual and real social networks in which individuals are embedded or pre-determined commitments in job or family activities.

Emotions and cognitions can impact in various ways the three components of the COM-B model: motivation, capabilities, and how individuals perceive opportunities. Consequently, as psychological well-being reflects the interplay of emotions and cognitions, its overall impact on adherence to recommendations is not clear *a priori* (Fochmann et al. 2019). For instance, depression is typically characterized by an inability to form projects for the future, but also by a tendency to engage in the ruminative elaboration of negative information. Hence, depression will likely be associated with lower expected benefits from self-protection. But depressed individuals will also have a tendency to overestimate the probability of worst-case scenarios in contexts where ambiguity and lack of information prevail (Kircanski, Joormann, and Gotlib 2012). Similarly, heightened anxiety states triggered by some threats can lead individuals to adopt uncertainty-reducing actions, either by voluntarily taking the risk or by increasing self-protection efforts (Anderson et al. 2019). The effect of depressed and/or anxious psychological states on the motivation to comply with recommendations is, therefore, uncertain.

Empirical studies undertaken in the context of the current COVID pandemic often find a negative association between measures of psychological well-being and compliance with specific measures. In other words, depression and anxiety symptoms seem to be negatively related to compliance with specific measures (Zhao et al. 2020; Stickley et al. 2020). However, this finding is not systematic. Mirroring the lack of clear theoretical predictions about the effects of psychological well-being on prevention efforts, some empirical studies have provided heterogeneous results, varying with the choice of countries, samples, empirical methods, and variables measuring psychological well-being and compliance with recommended self-protection behaviours (Okruszek et al. 2020; Carlucci, D'Ambrosio, and Balsamo 2020; Gustavsson and Beckman 2020; Bailey, Whelen, and Strunk 2021; Ebrahimi, Hoffart, and Johnson 2020; Etilé and Geoffard 2022).

This methodological variability can produce opposite-sign estimates of the association between psychological well-being and compliance, as illustrated by the following two studies from Hong Kong. Zhao et al. (2020) find, in a Hongkongese sample, a negative relationship between depressive symptoms, anxiety, and psychological distress on the one hand, and compliance with social distancing measures on the other. Lee et al. (2021) report, for another Hongkongese

sample, a positive relationship between mental distress measured by depression, state anxiety, trait anxiety, and other psychological abnormalities, and compliance with specific precautionary measures (including wearing a face mask, frequent hand washing, household disinfection, and social distancing). Interestingly, these opposing results are obtained in the same country but from different samples and with different measures of both psychological well-being and compliance behaviours.

The existing literature also shows a within-study variability with respect to the different measures of psychological health. For example, Solomou and Constantinidou (2020) find a negative association between depression scores and compliance, although a positive link between anxiety and compliance with precautionary measures. In Liu et al. (2020), fewer respondents with depression take preventive measures compared with those without depression; in contrast, whether individuals are classified as being anxious or not is found to be unrelated to compliance.

## **1.B Our contribution**

Previous empirical studies thus provide ambiguous evidence about the relationship between psychological health and compliance (as also pointed out by Wright, Steptoe, and Fancourt (2021)). One key issue is whether this lack of clarity reflects true heterogeneity in the relationship, or whether it stems from limitations of the data and shortcomings of the econometric strategies employed, sometimes by necessity. Regarding the data, most of the published studies employ cross-sectional data with small samples from a single country (e.g., Lee et al. 2021), with, as the authors often note, the usual shortcomings: potential for reverse causality, a lack of control for fixed unobserved characteristics, and a lack of statistical power. In addition, these surveys often rely on online convenience samples, with people self-selecting into the survey already knowing what the questionnaire is about (e.g., Gustavsson and Beckman (2020) and Liu et al. (2020), among others). The sample may thus not be representative of the populations of interest. In addition, published articles generally focus on a limited set of preventative behaviours, while the relationship between psychological health and compliance with recommendations may vary from one specific recommended behaviour to another.

Furthermore, previous papers use econometric specifications that restrict the relationship between psychological well-being and behaviour to be monotonic. This is especially the case when the self-reported scores measuring depression, anxiety, or stress are dichotomised. Dichotomisation does not allow for non-linear relationships and may, as highlighted above, produce spuriously opposite results reflecting sample composition effects: a sample containing many people with severe psychological health concerns finds a positive relationship between typical mental health measures and compliance (i.e., greater psychological health issues, more compliance) (Lee et al. 2021), whereas another study from the same country finds the opposite result (Zhao et al. 2020). Using a more refined measure of psychological health, i.e., not just classifying people as having depression symptoms or not, but instead allowing people to have different levels of depression (such as mild, moderate, and severe depression), is likely to help identify more precisely the shape of the association between psychological health and compliance.

Given these issues, we aim to clarify the relationship between well-being and health behaviour, to better tailor interventions at the population level: is there an association between well-being and the general tendency to follow official recommendations? If there is, what shape does it have? What explains this shape? Is the same shape found for particular health behaviours (such as wearing a mask)?

In this paper, we employ data from the COME-HERE (COVID-19, MEntal HEalth, REsilience and Self-Regulation) longitudinal survey, which covers five European countries (France, Germany, Italy, Spain, and Sweden) during the pandemic. The data contain information on self-reported depression, anxiety, stress, and loneliness, that we take as indicators of psychological well-being. The data also include information on the general tendency to follow recommendations (overall compliance) as well as on a number of specific health behaviours (like wearing a mask). Using a flexible econometric approach, we first establish that variations in psychological well-being have a U-shaped effect on variations in following the recommendations, regardless of the dimension of well-being that we consider. Transitions to low and high levels of psychological well-being are associated with higher overall compliance, while transitions to medium levels of psychological well-being are associated with lower overall compliance. We



also show that, while baseline levels of anxiety, stress, and loneliness (measured at wave 1) still have a U-shaped effect on following the recommendations later, the baseline level of depression is negatively associated with compliance. We then focus on the role of specific health behaviours in this finding, providing evidence on the relationship between psychological health and specific behaviours. We finally explore country and gender heterogeneity in the link between well-being and the following of recommendations. We conclude with a discussion of the implications of our findings for improvements of health behaviours at the population level.

We contribute to the literature on disparities in preventive behaviours on several fronts. First, our analysis exploits high quality data from the COME-HERE survey. These data cover five countries during the COVID-19 pandemic. Given differences in recommendations between these countries, investigating compliance in different countries seems important. The sample size is substantially larger than in many of the previous studies. Also of note is that individuals do not self-select into the survey. The longitudinal nature of the COME-HERE data enables fixed effects analysis and lag models, thus informing about the relationship between psychological health and adherence controlling for individual heterogeneity and taking into account reverse causation. Second, in contrast with the previous literature, the COME-HERE data contain information on a range of health behaviours. This enables us to test whether the effect of psychological well-being on health behaviours depends on the choice of the behaviour measure. Third, to uncover the relationship between health and behaviour, we consider different degrees of mental health and use a flexible econometric specification that allows the impact of mental health to be non-monotonic. Thus, we account for the fact that behaviours may not monotonically increase or decrease when mental health deteriorates. This approach seems all the more relevant as the previous theoretical and empirical literature provide mixed predictions and findings regarding the effect of psychological well-being on behaviours.

## 2 Data and method

### 2.A Sample

Our data come from the pandemic-dedicated COME-HERE (COVID-19, Mental Health, Resilience and Self-Regulation) longitudinal survey, conceived by the University of Luxembourg (see <https://pandemic.uni.lu/>). Ethical approval was obtained from the Ethics Review Panel of the University of Luxembourg (ERP 20-026 C/A). In this panel survey, a representative sample of individuals from five European countries (France, Germany, Italy, Spain, and Sweden) is repeatedly asked questions about psychological health and behaviours during the pandemic. Data also contain information on demographic factors and socioeconomic status. Our study focuses on waves 1 (April 2020), 2 (June 2020), 3 (August 2020), and 4 (November-December 2020). Our sample of interest contains 7,766 individuals, corresponding to 22,878 observations.

### 2.B Health behaviours

We measure health behaviours using a variable capturing the overall tendency to follow official recommendations, a series of indicators capturing *specific* behaviours (the Coronavirus Behavior Scale (CBS) and adherence *items*), and general measures equal to the sum of several specific behaviours (the CBS and adherence *scores*). All health behaviour measures in our data are self-reported.

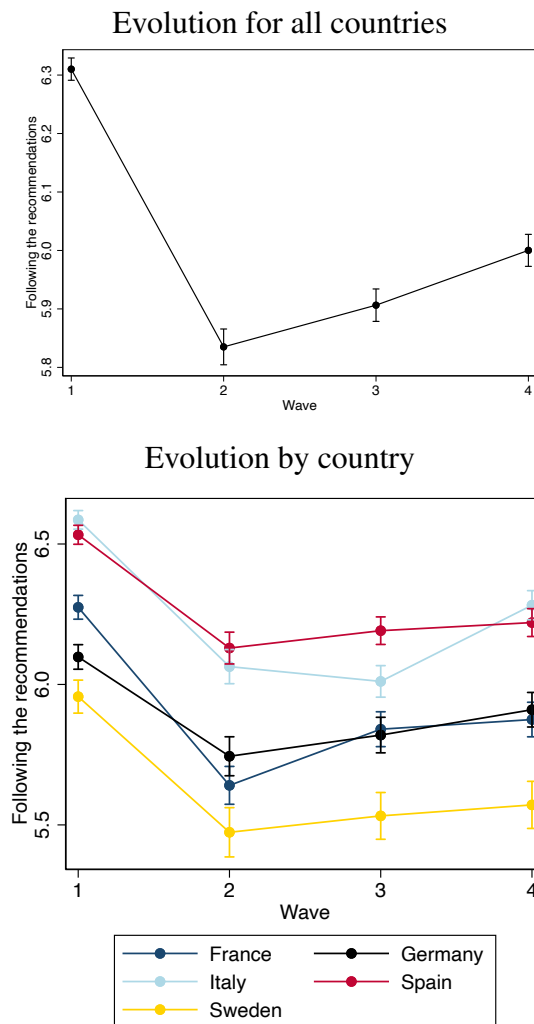
Background information on recommendations in the five countries are provided in Online Appendix A.

#### Following official recommendations

Our main outcome of interest is a general indicator for following official recommendations. In all waves, respondents are asked whether they are “following the recommendations from authorities to prevent the spread of COVID-19,” on a scale running from 1 (“Not at all”) to 7 (“Absolutely”). The mean of the variable equals 6.08 and its standard deviation is 1.19 (for 22,878 observations). Figure 1 highlights that, in the full sample, following the recommendations drops between April (wave 1) and June 2020 (wave 2), and then steadily increases until

the end of 2020 (wave 4). In spite of this increase, following the recommendations in wave 4 remains lower than in wave 1. Moreover, the level of compliance is higher in Italy and Spain, medium in France and Germany, and lower in Sweden.

Figure 1: Evolution of following recommendations over time



## The CBS

In wave 1 (only), we asked the questions of the CBS that contains a list of 14 reasonable and unreasonable specific behaviours. Here, we focus on the nine reasonable behaviours. The question is the following: “How much do you agree or disagree with the following statements? I am planning to/have already...”

- “cleaned and disinfected surfaces in my home more often” (CBS\_1)
- “bought medical masks” (CBS\_2)

- “stayed home when I feel ill” (CBS\_3)
- “started avoiding crowded spaces” (CBS\_4)
- “bought disinfectant” (CBS\_6)
- “limited my travel plans” (CBS\_7)
- “started washing my hands more” (CBS\_8)
- “shaken hands with people less” (CBS\_9)
- “been doing more work or leisure activities from home” (CBS\_14)

Responses are provided on a scale running from 1 (“Strongly disagree”) to 5 (“Strongly agree”). We will study each of these nine specific behaviours separately. We will also use the CBS score (for reasonable behaviours) which is the sum of the nine items.

Because the CBS questions are only asked in the first wave of the COME-HERE data, we cannot estimate models that include individual fixed effects or lagged well-being to study these indicators.

### **Adherence to protective behaviours**

Finally, in waves 3 and 4, respondents are asked whether they adopt a number of specific protective behaviours: “In the past week, how often did you do any of the following?”

- Kept a distance of 2 metres to other people (ADH\_1)
- Wore a mask, when the distance of 2 metres could not be kept (ADH\_2)
- Avoided shaking hands with or kissing other people (ADH\_3)
- Avoided close contact with sick people (ADH\_4)
- Washed or disinfected my hands regularly (ADH\_5)
- Coughed and sneezed into the crease of my elbow or a tissue (ADH\_6)
- Were particularly careful around vulnerable persons (ADH\_7)
- Called rather than visited a doctor in case of signs of infection (ADH\_8)
- Avoided touching my face (ADH\_9)
- Stayed at home, when I felt sick (ADH\_10)
- Avoided going out for not immediately necessary activities (ADH\_11)

- Avoided unnecessary social contacts (ADH\_12)
- Kept a list of people I had close contact with (ADH\_13)
- Wore a mask in public transport, shops, and similar public places (ADH\_14)
- Wore my disposable mask only once and for max. 8 hours (ADH\_15)
- Washed my reusable mask after every day of use at 60°C (ADH\_16)

Answers are coded on a scale running from 0 (“Never”) to 5 (“All the time”). Respondents can also answer “Not applicable” for each question. As all these items are part of the global recommendations, we treat the “Not applicable” answers as zeros.

We focus on each of these specific behaviours separately. We also employ three general scores that summarize the information. See details on the construction of the scores using exploratory factor analysis in Appendix A (Tables A.2 and A.3, Figure A.2, and related comments).

## **2.C Psychological well-being**

Psychological well-being is a multi-faceted construct that can hardly be captured by a single scale (Vögele, [In press](#)). Therefore, we decided to separately examine the relationships between health behaviour and several measures of specific facets of well-being: depression, anxiety, stress, and loneliness.

The four dimensions of well-being are measured through self-reported psychometric measures that are commonly used in the literature (Stickley et al. [2020](#); Zhao et al. [2020](#)). Importantly, self-assessments of psychological well-being and health have been shown to predict mortality and longevity (for an overview, see Vögele ([In press](#))).

### **Depression**

Depression, otherwise known as major depressive disorder or clinical depression, is a common and serious mood disorder. Cardinal characteristics include persistent feelings of sadness and hopelessness, and a loss of interest in activities once enjoyed. In addition to the emotional problems caused by depression, individuals can also present with physical symptoms such as

chronic pain or digestive issues. To be diagnosed with depression, symptoms must be present for at least two weeks (American Psychiatric Association 2013).

In contrast with a clinical diagnosis of depression, in the current study we measure self-assessed severity of depression using the brief Patient Health Questionnaire 9 (PHQ-9). This is a commonly used questionnaire to screen for depression. This consists in a nine-items module asking for the frequency of depressive symptoms individuals felt in the past two weeks. Items score on a four-point Likert scale where 0 indicates “Not at all” and 3 indicates “Nearly every day.” The continuous measure of severity of depressive symptoms is calculated by adding up the responses of the nine items, ranging from 0 to 27. We use cutoff scores of 5, 10, 15, and 20 to capture no, mild, moderate, moderately severe, and severe depression, respectively (Kroenke, Spitzer, and Williams 2001).

### **Anxiety**

Anxiety is a problem when it becomes overwhelming or unmanageable and it comes up unexpectedly. Anxiety disorders are mental illnesses that have a big impact on individuals’ lives. They include disorders that share features of excessive fear and related behavioural disturbances (American Psychiatric Association 2013).

As is the case of depression, the current study does not employ a clinical psychological assessment, but relies on a self-reported measure assessing anxiety symptoms. Specifically, we use the Generalized Anxiety Disorder (GAD-7) score as a measure of the severity of anxiety. The GAD-7 questionnaire consists of seven items assessing the frequency of anxiety-related problems an individual faced over the last two weeks. Items score on a four-point Likert scale where 0 indicates “Not at all” and 3 indicates “Nearly every day.” The continuous measure of severity of anxiety symptoms, constructed by adding up the responses of the seven items, is a summary score ranging from 0 to 21, where a higher score represents a higher level of anxiety. Following Spitzer et al. (2006), we use the cutoff scores of 5, 10, 15 to capture no, mild, moderate, and severe anxiety, respectively.

### **Stress**

Perceived stress incorporates feelings about the un-controllability and unpredictability of one's life, how often one has to deal with irritating hassles, how much change is occurring in one's life, and confidence in one's ability to deal with problems or difficulties (Phillips 2013).

The Perceived Stress Scale (PSS) is an instrument to assess how different situations can affect one's feeling and one's perceived stress. The instrument is based on a questionnaire consisting of 10 items where people indicate how often they felt or thought a certain way over the past month. Items are scored on a 5-point Likert scale where 0 indicates "Never" and 4 indicates "Very often." The PSS score is a summary measure of all of the 10 items ranging from 0 to 40 with a higher score indicating higher perceived stress. From this continuous measure, cutoff scores of 13 and 26 can be used to capture low, moderate, and high perceived stress respectively (Cohen, Kamarck, and Mermelstein 1994; Amponsah and Owolabi 2011).

### **Loneliness**

Loneliness is a negative emotion produced by "the discrepancy between the quantity, or quality, of social relationships that individuals have, versus what they want" (Kung, Pudney, and Shields 2021, p. 2).

We measure loneliness using the UCLA-Loneliness Scale (ULS-8), which is a widely used questionnaire to capture the level of perceived loneliness. The measure consists of eight items assessing the frequency of feeling of loneliness over the past two weeks. Items score on a four-point Likert scale where 1 indicates "Never" and 4 "Often." The ULS-8 score is the summary measure of the eight items, whereby a higher score represents higher level of loneliness. Cutoff scores of 13, 20, and 25 are used to represent low, normal to moderate, moderate to high, and high levels of loneliness, respectively (Hays and DiMatteo 1987).

Descriptive statistics for well-being variables are shown in Appendix A.

## **2.D Controls**

We also use individual-level information (gender, age, marital status, the composition of the household, education, working from home, income, income change, confidence in the govern-

ment and in health services, and knowledge of the disease) and aggregate-level controls (stringency index and number of deaths). Details about these variables are provided in Appendix A.

## **2.E Method**

To describe the relationship between psychological well-being and following the recommendations, we regress the latter on a set of dummies for each state of psychological well-being, using the best psychological state (e.g., “no depression”) as our reference category. By including dummies rather than a continuous score, we allow for non-linear relationships between the well-being scores and following the recommendations. We estimate separate models for each of the four well-being variables because these variables are highly correlated (Table A.4 in Appendix A).

The model controls for demographic characteristics, socioeconomic status, confidence in the government and health services, knowledge, stringency, and the number of deaths. We also include country-wave fixed effects, to capture any unobserved characteristic that is fixed at the country-wave level and that may have an effect on individual health behaviour (for instance, any official public health recommendations and any health, healthcare, or economic policy that is country-period specific). Importantly, because we control for variations in the population-level COVID-19 contamination risk and in governmental health recommendations, the estimated associations do not reflect a full mediating effect between COVID-19-related macro shocks and compliance. The associations between psychological health and behaviour are identified from variations in psychological health that are independent from the macro shocks.

We first estimate OLS regression models of following the recommendations in wave  $t$  as a function of psychological well-being measured in the same wave (“pooled OLS”). Second, we estimate an OLS model with individual fixed effects (“OLS-FE”) to control for individual characteristics that are fixed over time, such as risk and time preferences. This model identifies the impact of individual transitions in psychological well-being on following the recommendations. Finally, we estimate OLS regression models of following the recommendations measured



in waves 2, 3, and 4 as a function of well-being in wave 1 (“lag model”). This is informative of the extent to which average individual behaviour is predicted by the initial state of psychological well-being. Any significant associations can then be explained either by a long-lasting effect of psychological well-being state or by some unobserved trait that would simultaneously explain initial well-being and behaviour. Given that psychological well-being is measured well before behaviour, reverse causation is unlikely in this model. In all models, standard errors are clustered at the date (day of interview) and country level.

Our study is mainly descriptive and shows correlations between psychological well-being and behaviour, rather than a causal effect of well-being on behaviour. Indeed, well-being may be endogenous because of reverse causation and the omission of third common hidden factors. First, it is entirely possible that behaviour influences psychological health (reverse causation). Note however that reverse causation is highly unlikely in the lag model. Second, although we include a number of right-hand side variables (in particular country-wave fixed effects and individual fixed effects), the correlation between psychological health and behaviour may still be due to the omission of third common hidden factors.

### **3 The U-shaped relationship between psychological well-being and following the recommendations**

In this section, we report our main estimation results showing that the correlation between psychological well-being and overall compliance is U shaped in the full sample. The estimates are shown graphically in Figures 2 (pooled OLS), 3 (OLS-FE), and 4 (lag model). In each figure, we represent the coefficients on the different mental well-being categories, compared to a situation of a very high well-being level, as well as their 95% confidence intervals. Whatever the models, we always find that the correlation between mental health and following the recommendations is U shaped, with one exception (the correlation with depression in the lag model).

More precisely, in the pooled OLS model for depression, the left-hand side of the curve is flat, meaning that individuals with mild depression follow the recommendations as much as

individuals with no depression. The slope then becomes negative, indicating that those with moderate depression follow the recommendations less (by 0.20, i.e., 0.17 standard deviation of following the recommendations) than those with no depression, and that those with severe depression follow the recommendations even less (by 0.24, i.e., 0.20 standard deviation). Finally, when the slope turns positive, we observe that individuals with severe depression follow the recommendations as much as those with no depression. A similar U shape is found for anxiety, stress, and loneliness.

In the OLS-FE model, we find a U shape for the four psychological well-being indicators. In other words, transitions to low and high levels of well-being are associated with higher scores of following the recommendations, while transitions to medium levels of psychological well-being are correlated with lower scores. The magnitude of the coefficients is generally smaller than in the pooled OLS approach. The coefficient on mild depression is statistically similar to that of no depression; moderate depression is associated with a lower score of following recommendations by 0.07; moderately severe depression has the same effect as no depression; and severe depression is associated with a higher score of following the recommendations by 0.08.

Yet, these OLS-FE results may be driven by a mixing of population groups that would be characterised both by different patterns of transitions between well-being states and by different correlations between psychological health and compliance. In Appendix B, we report additional OLS-FE results for samples restricted either to individuals who are in very good psychological health at wave 1, or to individuals who are in mild to severe psychological states at wave 1, or to individuals whose state does not improve over time. We thus focus on sub-samples with more homogeneous patterns of transitions. The results are displayed Figures B.1, B.2, and B.3 in Appendix B. We almost always still find U shapes for the four well-being indicators in these sub-samples, albeit to a lesser extent for stress and depression than for anxiety and loneliness. Hence, the U shape is not driven by some heterogeneity in the psychological well-being/compliance relationship between groups of individuals characterized by different patterns of variations in well-being.

Finally, the lag model, in which reverse causation is highly unlikely, shows U shapes for anxiety, stress, and loneliness, but a negative correlation with depression (Figure 4). Consequently, anxiety, stress, and loneliness levels at baseline have a U-shaped effect on following the recommendations later, while the depression level at baseline has a detrimental impact on following the recommendations later.

Figure 2: The U-shaped relationship between psychological well-being and following the recommendations (pooled OLS)

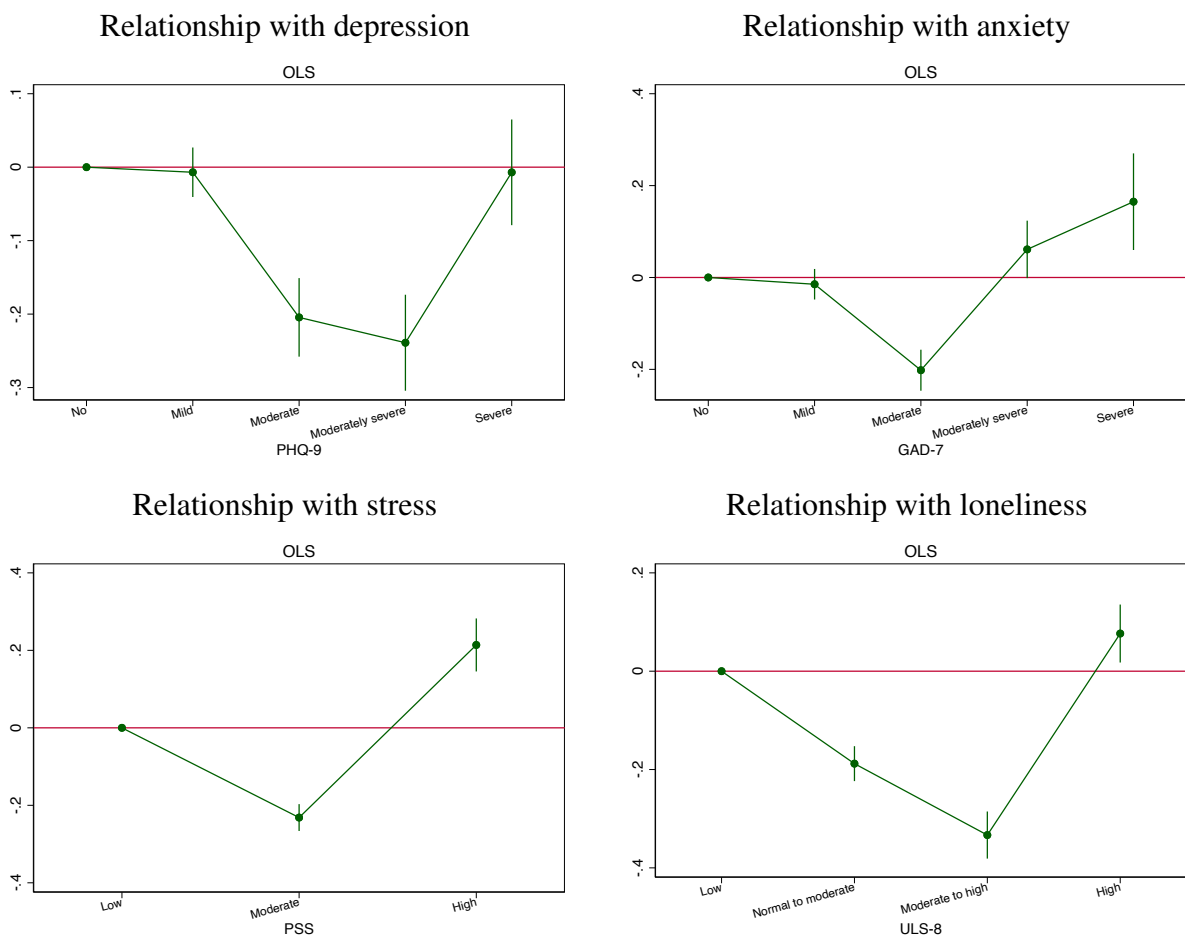


Figure 3: The U-shaped relationship between psychological well-being and following the recommendations (OLS-FE)

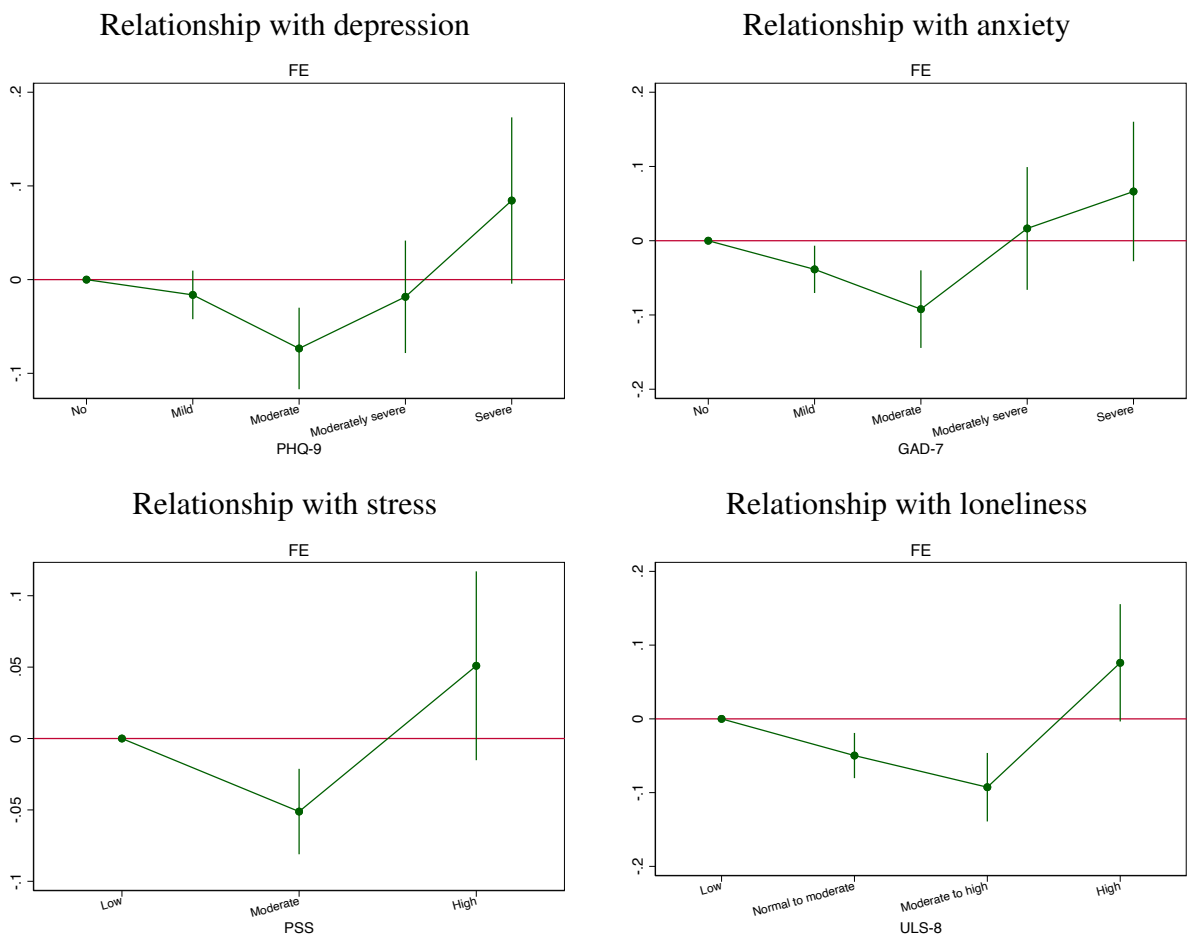
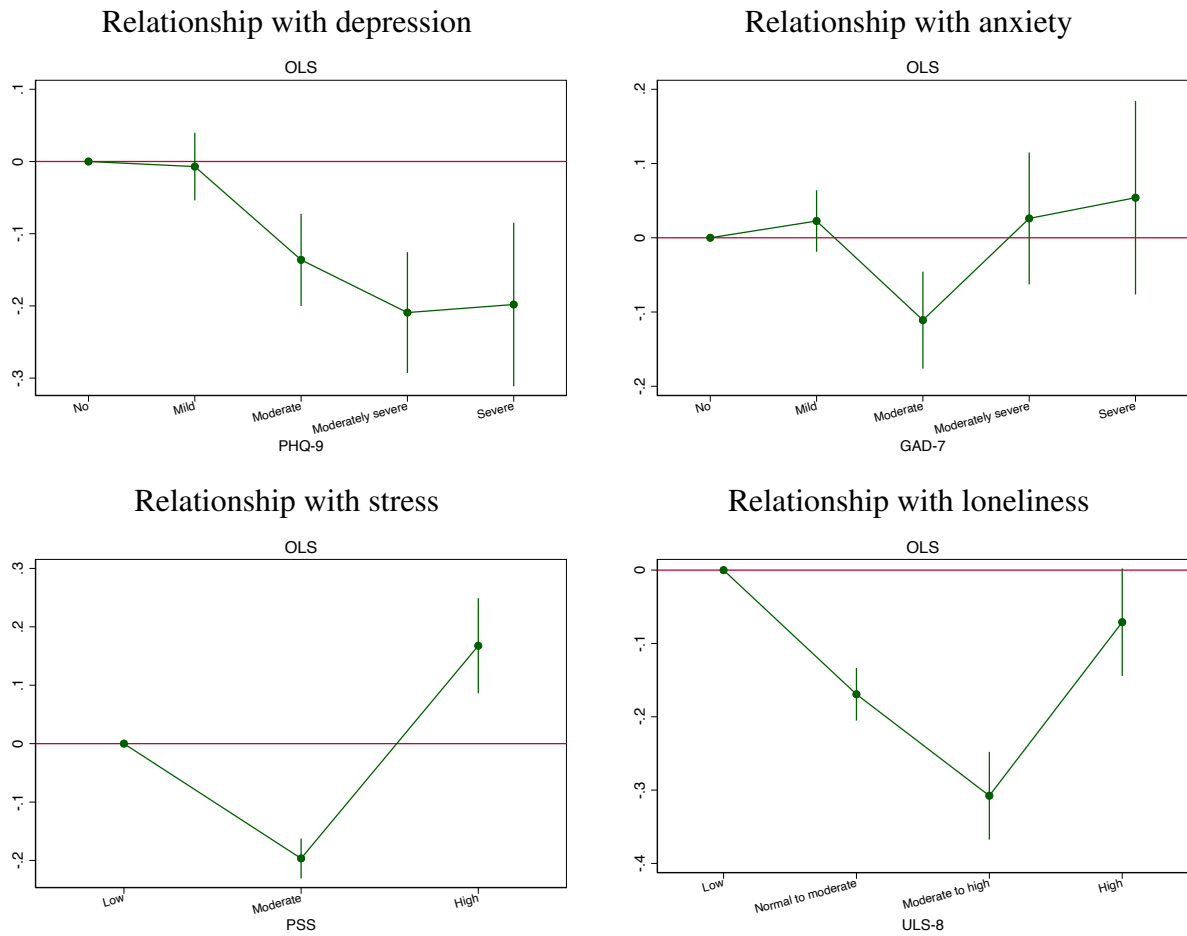


Figure 4: Relationship between psychological well-being, measured in wave 1, and following the recommendations, measured in waves 2 to 4 (lag model)



## 4 Specific health behaviours

In the previous section, we highlighted the existence of a U-shaped association between mental well-being and following the recommendations, in various specifications. We now turn to examine the role of specific health behaviours in this shape. These specific health behaviours are captured by CBS and adherence *items*.

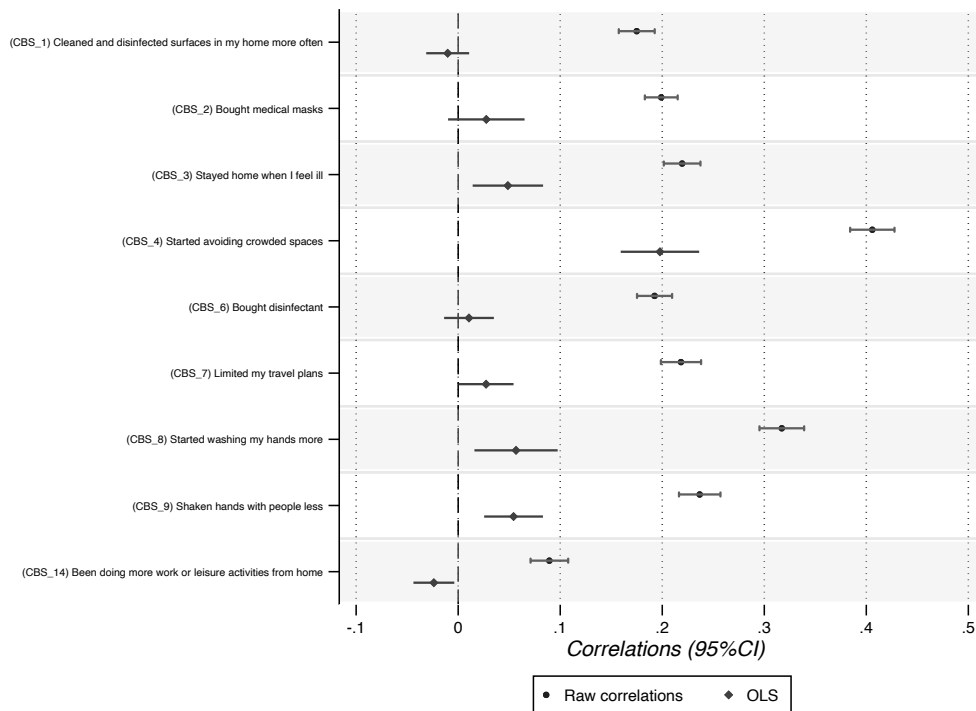
Specific health behaviours may play a role in the U-shaped correlation between well-being and following the recommendations when two conditions are fulfilled: (1) the correlation between well-being and some specific behaviours is U shaped, and (2) among the specific behaviours for which a U shape is found, some behaviours have a significant effect on the general tendency to follow recommendations.

## **4.A Effect of specific health behaviours on following the recommendations**

To drive the U-shaped relationship, specific health behaviours must have a significant effect on following the recommendations. In other words, individuals must evaluate their general tendency to follow recommendations from the implementation of some specific behaviours. To test this, we estimate the impact of specific health behaviours (as measured by the items) on following the recommendations.

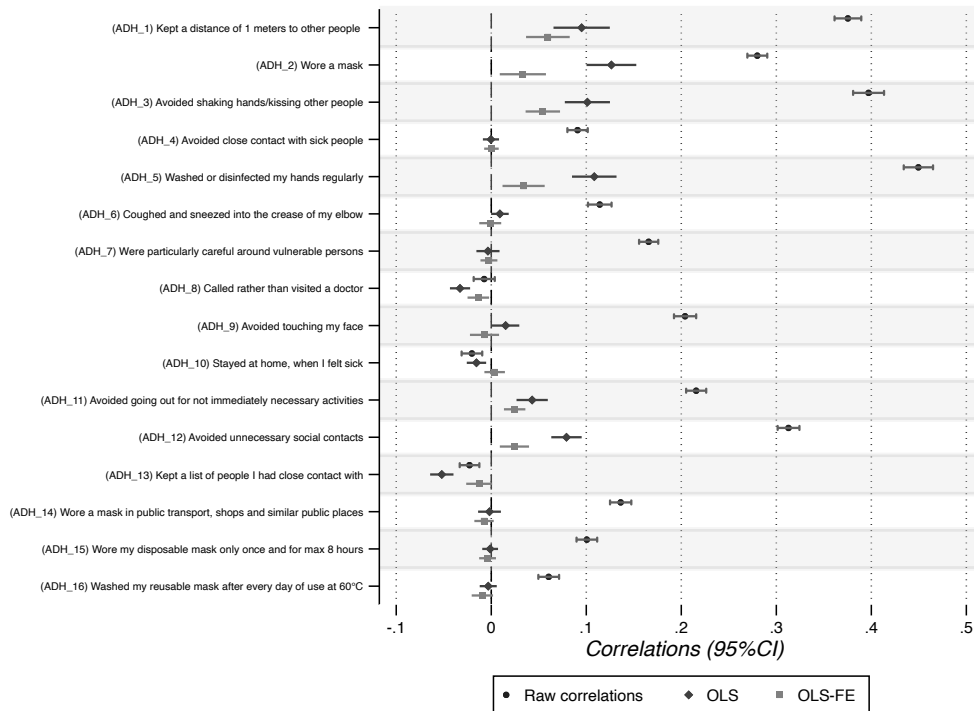
The raw correlation between each CBS item and following the recommendations is presented in Figure 5. All CBS items are positively and significantly associated with following the recommendations, in the absence of control variables. We then regress following the recommendations on the nine CBS items, controls, and country fixed effects. Because CBS items are only measured in wave 1, the model is estimated using simple OLS. The coefficients on the items are shown in the same figure. In the regression, five CBS items have a positive and significant effect (at the 5% level) on the general tendency to follow the recommendations: stayed home when I feel ill (CBS\_3), started avoiding crowded spaces (CBS\_4), limited my travel plans (CBS\_7), started washing my hands more (CBS\_8), and shaken hands with people less (CBS\_9). The effect of CBS\_4 (started avoiding crowded spaces) on following the recommendations is especially large.

Figure 5: Link between CBS items and following the recommendations



The results of the analysis of adherence items are reported in Figure 6. Given that these items are measured in waves 3 and 4, we are able to estimate an OLS-FE model in addition to the OLS model. In both the OLS and the OLS-FE models, six items have a positive and significant effect on following the recommendations: kept a distance of 2 metres to other people (ADH\_1), wore a mask when the distance of 2 metres could not be kept (ADH\_2), avoided shaking hands with or kissing other people (ADH\_3), washed or disinfected my hands regularly (ADH\_5), avoided going out for not immediately necessary activities (ADH\_11), and avoided unnecessary social contact (ADH\_12). In addition, ADH\_9 (avoided touching my face) has a significant effect in the OLS model, but not in the OLS-FE model.

Figure 6: Link between adherence items and following the recommendations



We have thus established that individuals evaluate their general tendency to follow recommendations from the implementation of 11, 12, or 13 specific behaviours (i.e., five CBS items and six to eight adherence items). We demonstrate below that the correlation between well-being and some of these 11–13 specific behaviours is U shaped.

#### 4.B The U-shaped correlation between psychological well-being and a number of specific health behaviours

We examine whether the correlation between well-being and specific health behaviours is U shaped, by re-estimating our main model using each CBS and adherence item as a dependent variable (Table 1).

When CBS items are the explained variables, we can only estimate the OLS model due to data limitations. We find a U-shaped association between well-being and three CBS items: avoiding crowded spaces (CBS\_4), washing hands more (CBS\_8), and shaking hands less (CBS\_9). Importantly, these three behaviours positively influence the general tendency to follow the rec-



ommendations, and CBS\_4 is the CBS item which has the greatest effect on following the recommendations, as shown in Figure 5. Our analysis thus confirms that CBS items play a role in the U-shaped correlation between well-being and following the recommendations.

We reach a similar conclusion for adherence items. In the OLS-FE model, a U shape is found for four adherence items (ADH\_3, ADH\_5, ADH\_7, and ADH\_15) (Table 1). Two items in this list (ADH\_3 and ADH\_5) have a positive and significant influence on following the recommendations (see the OLS-FE model in Figure 6). Finally, in the OLS model with a lag, we observe a U shape for nine adherence items (ADH\_1, ADH\_2, ADH\_3, ADH\_5, ADH\_6, ADH\_7, ADH\_9, ADH\_12, and ADH\_14) (Table 1). Of those, six items (ADH\_1, ADH\_2, ADH\_3, ADH\_5, ADH\_9, and ADH\_12) have a positive and significant impact on following the recommendations (see the OLS model in Figure 6).

Table 1: Specific health behaviours for which a U shape is found

Model	Sample	Cases in which a U shape is observed	
		Explained variable Specific health behaviour	Explanatory variable Psychological well-being
OLS	Full sample, wave 1 <sup>1</sup>	Avoiding crowded spaces (CBS_4) Washing hands more (CBS_8) Shaking hands less (CBS_9)	Stress, loneliness Stress, loneliness Depression, stress, loneliness
OLS-FE	Full sample, waves 3 and 4 <sup>2</sup>	Avoiding shaking hands with or kissing other people (ADH_3) Washing or disinfecting hands regularly (ADH_5) Being particularly careful around vulnerable persons (ADH_7) Wearing disposable mask only once and for max. 8 hours (ADH_15)	Depression, stress, loneliness Stress Stress Depression
Lag	Full sample, waves 3 and 4 <sup>2</sup>	Kept a distance of 2 metres to other people (ADH_1) Wore a mask, when the distance of 2 metres could not be kept (ADH_2) Avoiding shaking hands with or kissing other people (ADH_3) Washing or disinfecting hands regularly (ADH_5) Coughed and sneezed into the crease of my elbow or a tissue (ADH_6) Were particularly careful around vulnerable persons (ADH_7) Avoided touching my face (ADH_9) Avoided unnecessary social contacts (ADH_12) Wore a mask in public transport, shops, and similar public places (ADH_14)	Depression, stress, loneliness Depression, anxiety, stress, loneliness Anxiety, stress, loneliness Depression, anxiety, stress, loneliness Loneliness Loneliness Depression, loneliness Loneliness Depression, stress, loneliness

**Notes:** <sup>1</sup> Data on CBS items are available in wave 1 only.

<sup>2</sup> Data on adherence items are available in waves 3 and 4.

#### **4.C The relationship between well-being and the CBS and adherence scores**

Unlike for following the recommendations and for specific behaviours, we do not often observe a U-shaped correlation for the CBS and adherence *scores*. In fact, we often (but not always) find that poorer psychological health goes hand in hand with better health behaviours as measured by these scores. Given that the correlation between following the recommendations and the scores is low, the difference in shapes between following the recommendations (U shape) and the scores is not surprising. Details are provided in Appendix C.

### **5 Understanding the U shape**

The U-shaped association between psychological well-being and following the recommendations may be produced by the aggregation of heterogeneous effects across distinct populations characterized by distinct distributions of psychological well-being. We here specifically study this heterogeneity by country and by gender.

#### **5.A Analysis by country**

We estimate our OLS-FE and lag models by country separately. The results, summarized in Table 2, show that the U shape is very commonly observed. In particular, in the OLS-FE model, a U shape is found for each of the four well-being indicators for France and for three well-being measures for Italy, while in the lag model, a U shape is found for three well-being variables for Germany, Italy, Spain, and Sweden. These results highlight that the U shape found in the sample containing all countries is not produced by mixing countries with negative relationships and countries with positive relationships.

Table 2: Relationship between psychological well-being and following the recommendations, by country (OLS-FE and lag models)

Country	Model	Observations	Depression	Anxiety	Stress	Loneliness
France	OLS-FE	4920	U shape	U shape	U shape	U shape
	Lag	3346	Other	Other	U shape	U shape
Germany	OLS-FE	4928	Insignificant U shape	Insignificant	U shape	U shape
	Lag	3348	U shape	Insignificant U shape	U shape	U shape
Italy	OLS-FE	5042	U shape	U shape	Stability and increase	U shape
	Lag	3465	U shape	Insignificant	U shape	U shape
Spain	OLS-FE	4965	Insignificant	Insignificant	Insignificant	Insignificant U shape
	Lag	3361	Other	U shape	U shape	U shape
Sweden	OLS-FE	3182	Insignificant	U shape	Insignificant	Insignificant
	Lag	2046	U shape	Other	U shape	U shape

## 5.B Results by gender

Previous research shows that even though men are more likely to die of COVID-19, they are less compliant than women (Nivette et al. 2021). In our data, females report following the recommendations more than males: the average response is 6.17 for females, versus 6.00 for males (this difference is statistically significant at the 1% level), and the probability of being in the highest category of overall compliance is 7.77 point higher for females than for males (Figure D.1 in the Appendix).

We examine the correlation between psychological well-being and following recommendations by gender. To do this, in the case of depression, we first create 10 population groups: (1) males with no depression, (2) males with mild depression, ... (5) males with severe depression, (6) females with no depression, ... and (10) females with severe depression. We then regress following the recommendations on a series of dummies for whether the individual belongs to each of the population groups. We estimate the OLS-FE and the lag models, and males with no depression and females with no depression serve as reference categories. The usual control variables are included. Similar models are estimated for anxiety, stress, and loneliness.

Figures 7 (OLS-FE) and 8 (lag model) show the coefficients on mental well-being categories for females and males. Results are consistent with a U shape for both genders for anxiety (OLS-FE), stress (lag model), and loneliness (OLS-FE and lag models).

In the OLS-FE model for depression and stress, the U shape we found in the full sample con-

taining females and males (Figure 3) is driven by a gender composition effect, with males contributing to the negative relationships found for low-levels of depression and stress and females contributing to the positive relationships found for the highest levels of these well-being measures (Figure 7). A question is then whether these differences in the correlation between well-being and compliance transitions are driven by gender-specific psychological mechanisms.

In the lag model for depression, the negative slope found in the full sample containing men and women (top-left subfigure in Figure 4) is due to a negative slope for both females and males (top-left subfigure in Figure 8). The absence of gender differences in the lag model demonstrates that initial levels of depression (in wave 1) are similarly correlated with overall compliance for men and women.

Figure 7: Relationship between psychological well-being and following the recommendations, by gender (OLS-FE)

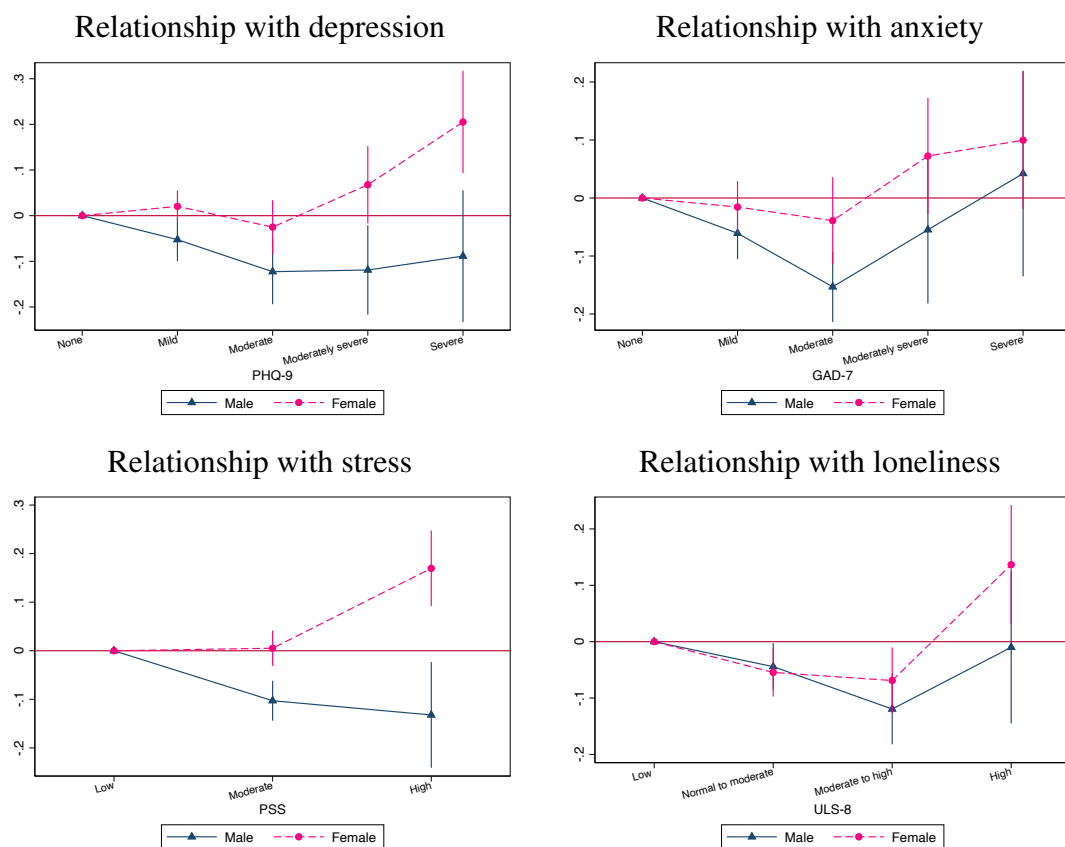
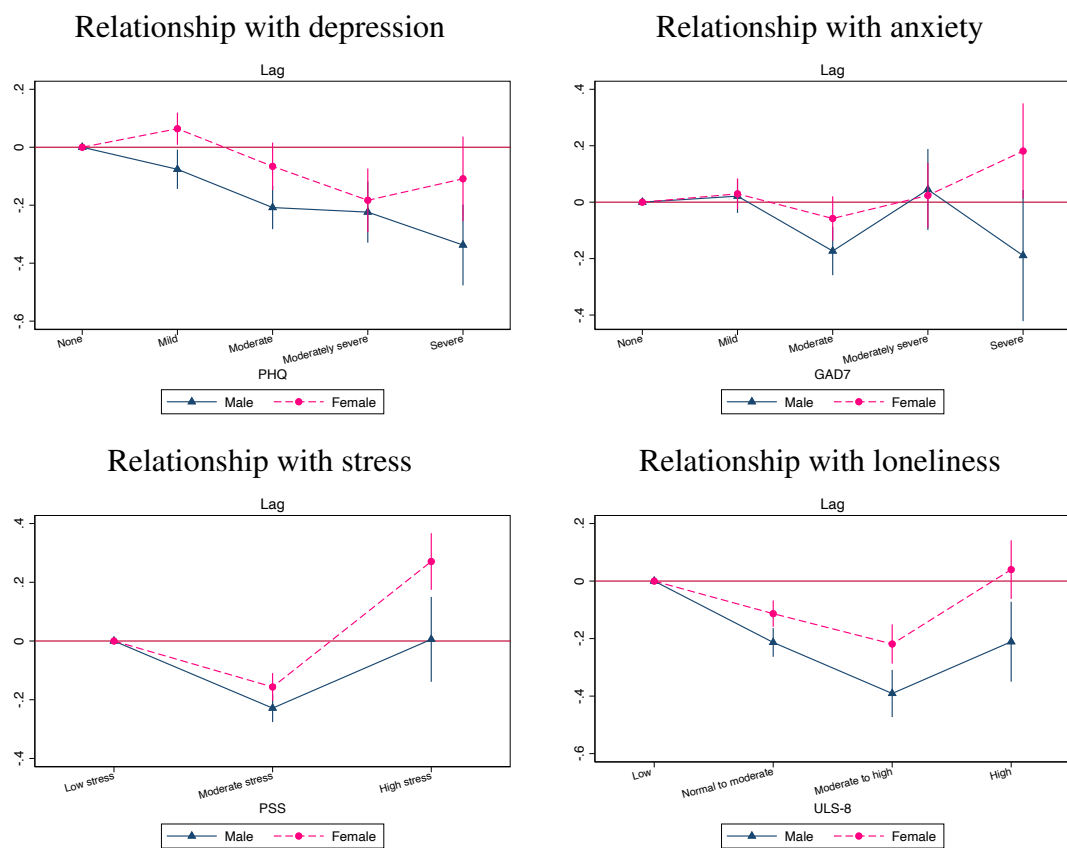


Figure 8: Relationship between psychological well-being and following the recommendations, by gender (Lag model)



## 6 Conclusion

Using novel panel data on 7,766 individuals (22,878 observations) from five European countries during the COVID-19 pandemic, we study the relationship between psychological well-being (as measured by depression, anxiety, stress, and loneliness) and the general tendency to follow official recommendations regarding COVID-19.

We find a U-shaped correlation between well-being and following the recommendations: those with the lowest and highest levels of depression, anxiety, stress, and loneliness follow the recommendations more, while those with moderate levels of these variables follow them less, in the OLS model. This may mean that individuals with moderate psychological health problems have a lower level of perceived benefits or risks of compliance than other people.

For anxiety, stress, and loneliness, we obtain consistent results when we estimate OLS-FE regressions (which account for individual unobserved characteristics that are fixed over time) and lag models (in which we use well-being at baseline and in which reverse causality is highly unlikely). These results suggest that both the transitory component of the well-being measures (captured in the OLS-FE model) and their permanent components (captured in the lag model) are correlated with overall compliance.

In contrast, results for depression depend on the choice of the model: while the OLS-FE regression produces a U-shaped association, baseline depression in the lag model displays a negative and monotonic relationship with compliance. In other words, the higher her depression score at baseline, the less the individual will follow official recommendations later. Higher depression scores may be related to overall resignation and fatalism, hence the belief that following recommendations is futile. Importantly, the results for depression highlight that the effect of a transitory depression state is not necessarily the same as that of a permanent depression state. Consequently, future research should investigate the specific role of transitory emotional states versus permanent states that possibly relate to long-term mental health conditions or stable personality traits.

After establishing that individuals evaluate their general tendency to follow recommendation

from their implementation of a set of specific recommendations (measured by CBS and adherence items), we examine whether compliance with specific recommendations is also U shaped in well-being. For all models taken together, we find a U shape for thirteen specific behaviours (three CBS items, in the OLS model, and 10 adherence items, in either the OLS-FE or the lag model). The U shape for washing hands is very robust since it is found in all of our approaches. Taken together, these results highlight the role of specific behaviours in the U-shape in following the recommendations. Interestingly, while baseline depression has a detrimental impact on following the recommendations, it has a U-shaped effect on some specific behaviours (e.g., wearing a mask and washing or disinfecting hands regularly).

However, for many couples of psychological well-being measures and recommended specific behaviours, no U shape is found. This heterogeneity across behaviours implies that in studies on the link between well-being and behaviours, researchers need to be clear about what type of behaviours they are talking about and be ready for the possibility that the effect of well-being be different for different behaviours.

We also investigate cross-country heterogeneity. The general tendency to follow the recommendations is higher in Italy and Spain, medium in France and Germany, and lower in Sweden. However, regarding the effect of well-being on following recommendations, our analysis does not provide evidence of important heterogeneity between countries, as U-shaped effects are found in all countries.

Results for men and women are often similar. We find U shapes for both females and males in a number of specifications. Moreover, the detrimental effect of depression at baseline on the general tendency to follow recommendations is found for both genders. In contrast, results for men and women are very different in some cases, generating gender composition effects. In particular, in the OLS-FE model, the U shaped correlation between depression or stress and following the recommendations in the full sample is driven by a gender composition effect, with males driving the negative slope for lower levels of depression and stress, and females driving the positive slope for higher levels of these mental health indicators.

Our goal is to explore the correlation between well-being and following recommendations.



The relationship between well-being and compliance is complex. While we estimated different types of econometric models, those are insufficient to prove causality. Future research may explore the causal effect of well-being on compliance.

As the pandemic runs its course, it will continue to put a strain on the psychological health of many people. Although we are careful to not over-interpret our results as causal, they suggest that transitioning to an intermediate level of depression, anxiety, stress, or loneliness may lead to a decrease in compliance with public health recommendations. This is in line with a growing body of evidence that emphasizes the risk that worsening psychological health may lead to an increase in behaviours that amplify the COVID-related risks, both at the individual and collective level, such as the adoption of unhealthy eating habits leading to weight gain and increased risks of severe COVID symptoms (Landaeta-Díaz et al. 2021; Himmelstein, Beaver, and Gilman, [In press](#); Philippe et al. 2021; Chang, Wu, and Chiou 2021). Hence, maintaining and expanding budgets for mental health policy is crucial.

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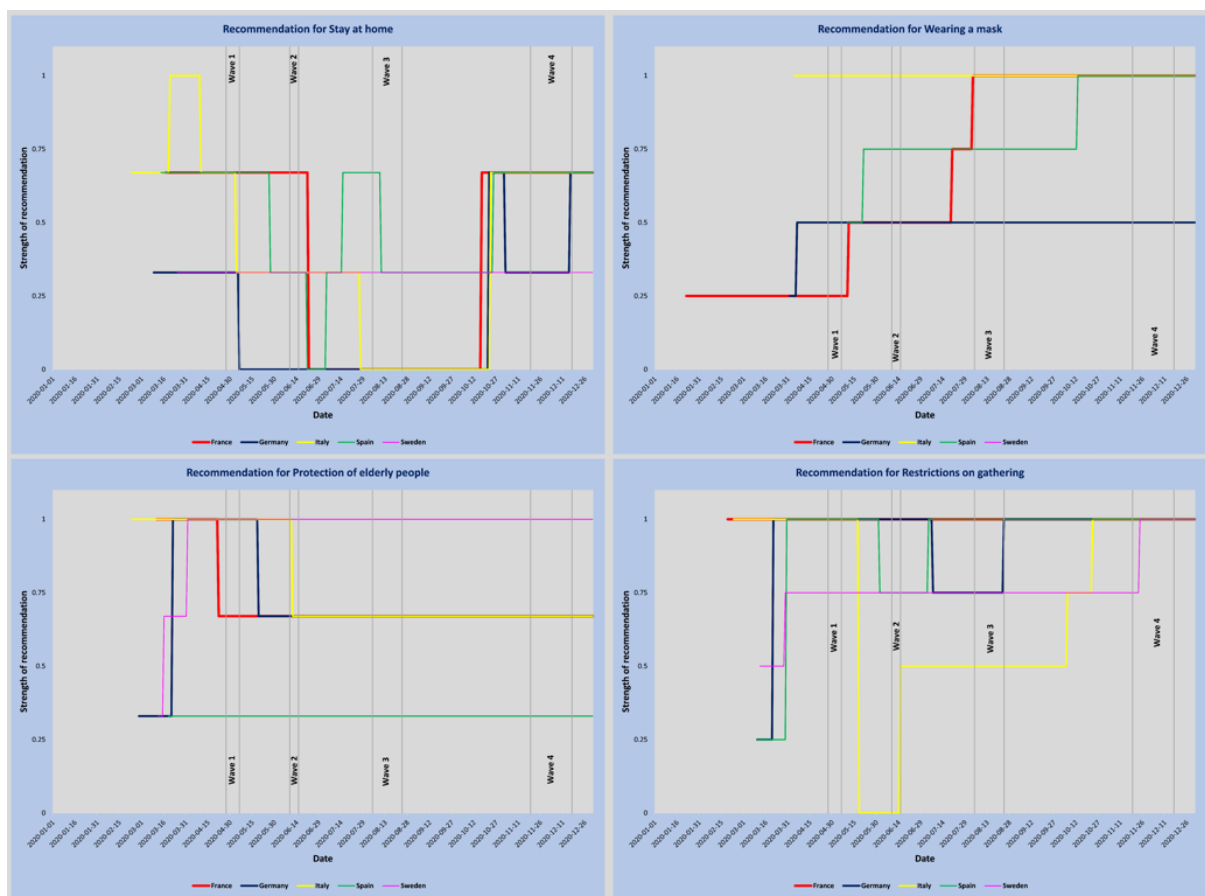
# Online appendix

## Online appendix A: Background, data, and method

### Background on recommendations in the five countries over time

To combat the COVID-19 pandemic, governments and policymakers have made many behaviours and practices recommended and, in some cases, mandatory. Many of these recommendations for the citizens of our five countries (and elsewhere) have been consistent throughout the pandemic so far. For example, the good hygiene practice behaviours of washing and disinfecting hands, not touching one's face, and social distancing have been perennial. Other measures have differed both between the five countries we study and over time during the pandemic. As is well known, Sweden adopted a different approach to combating the pandemic, with the chief epidemiologist stating as late as August 2020 that wearing masks might be counterproductive (Milne and Khan 2020) – a stance in stark contrast to the approach in the four other countries investigated. This is highlighted in Figure A.1, which shows changes over time during the pandemic in official recommendations regarding wearing a mask, staying at home, protecting the elderly, and restrictions on gathering, in the five countries. The data comes from Oxford University's Blavatnik School of Government COVID-19 Government Response Tracker (Hale et al. 2021). The horizontal axis indicates the dates, including the dates of the waves of the COME-HERE data. The vertical axis shows the strength of the recommendation (the higher the number, the greater the strength; what each specific figure indicates is explained in Table A.1). The figure shows some variety in these measures over time, whereas other recommendations are perennial: washing and disinfecting hands; avoiding touching one's face; and social distancing.

Figure A.1: Strength of government recommendations for wearing a mask, staying at home, protecting the elderly, and restrictions on gathering, in the five countries during the pandemic



**Source:** Figure created based on data from the COVID-19 Government response tracker. See Hale et al. (2021) and <https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker>.

**Notes:** Waves indicate when individuals were surveyed in the COME-HERE panel dataset.

Table A.1: COVID-19 strength of recommendations from Figure A.1

<b>Facial coverings</b>	
0	No policy
0.25	Recommended
0.5	Required in some specified shared/public spaces outside the home with other people present, or some situations when social distancing not possible
0.75	Required in all shared/public spaces outside the home with other people present or all situations when social distancing not possible
1	Required outside the home at all times regardless of location or presence of other people
<b>Protection of elderly people</b>	
0	No measures
0.33	Recommended isolation, hygiene, and visitor restriction measures in LTCFs and/or elderly people to stay at home
0.67	Narrow restrictions for isolation, hygiene in LTCFs, some limitations on external visitors and/or restrictions protecting elderly people at home
1	Extensive restrictions for isolation and hygiene in LTCFs, all non-essential external visitors prohibited, and/or all elderly people required to stay at home and not leave the home with minimal exceptions, and receive no external visitors
LTCF	Long term care facility
<b>Stay at home measures</b>	
0	No measures
0.33	Recommend not leaving house
0.67	Require not leaving house with exceptions for daily exercise, grocery shopping, and “essential” trips
1	Require not leaving house with minimal exceptions (e.g., allowed to leave once a week, or only one person can leave at a time, etc)
<b>Restrictions on gathering</b>	
0	No restrictions
0.25	Restrictions on very large gatherings (above 1,000 people)
0.5	Restrictions on gatherings between 101–1,000 people
0.75	Restrictions on gatherings between 11–100 people
1	Restrictions on gatherings of 10 people or less

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## **Online appendix A (cont.): Construction of the three adherence scores**

In waves 3 and 4, respondents are asked 16 questions capturing adherence (see the Data section). We recode the responses in the following way: (0) Never or Not applicable; (1) Almost never; (2) Sometimes; (3) Fairly often; (4) Very often; and (5) All the time. Using the principal component analysis that we present below, we are able to compute three aggregate scores of adherence (Score adh A, Score adh B, and Score adh C) by summing the relevant items.

We first study internal consistency of the scale using Cronbach's alpha. This constitutes a widely used psychometric tool to study the correlation of items within a scale and therefore to know whether the items of a test measure the same construct. Cronbach's alpha equals 0 for independent items and 1 for perfectly correlated items. A high Cronbach's alpha is evidence that item responses are driven by the same latent theoretical construct.<sup>1</sup> It is also possible to investigate the contribution of a given item to a scale by looking at the variation of the Cronbach's alpha when we remove the item. Table [A.2](#) presents the results. The overall Cronbach's alpha is 0.85, indicating good internal consistency.



Table A.2: Cronbach's alpha of adherence

Item	(1) Obs	(2) Sign	(3) Item-test correlation	(4) Item-rest correlation	(5) Average inter-item covariance	(6) Alpha
ADH_1	10979	+	0.53	0.47	0.89	0.85
ADH_2	10979	+	0.59	0.51	0.85	0.84
ADH_3	10979	+	0.48	0.42	0.89	0.85
ADH_4	10979	+	0.55	0.44	0.84	0.85
ADH_5	10979	+	0.53	0.48	0.89	0.85
ADH_6	10979	+	0.50	0.40	0.87	0.85
ADH_7	10979	+	0.60	0.51	0.84	0.84
ADH_8	10979	+	0.58	0.48	0.83	0.84
ADH_9	10979	+	0.67	0.61	0.83	0.84
ADH_10	10979	+	0.54	0.44	0.84	0.85
ADH_11	10979	+	0.65	0.58	0.83	0.84
ADH_12	10979	+	0.62	0.56	0.85	0.84
ADH_13	10979	+	0.55	0.46	0.85	0.84
ADH_14	10979	+	0.49	0.39	0.86	0.85
ADH_15	10979	+	0.61	0.51	0.82	0.84
ADH_16	10979	+	0.56	0.47	0.83	0.84
Test scale					0.85	0.85

**Source:** Waves 3 and 4 of the COME-HERE (COVID-19, MEntal HEalth, REsilience and Self-Regulation) survey.

**Notes:** This table presents the Cronbach's alpha of the set of items from the Adherence scale. Item-test correlation corresponds to the correlation of an item to a generated scale using all the items. Item-rest follows the same procedure but removing the item of analysis from the scale. The average inter-item correlation of all items, excluding one, is shown in column (5). The last column provides the Cronbach's alpha of the scale when the item is removed.

Table A.3 presents the results of the exploratory factor analysis for adherence to test the validity of the questionnaire. We rely on a principal component method with Varimax rotation using the polychoric correlation matrix of items. A first investigation of the scree plot in Figure A.2 of the principal component method leads to to favour three factors. Items loading more than 0.5 on a factor are kept to create a score on the factor.

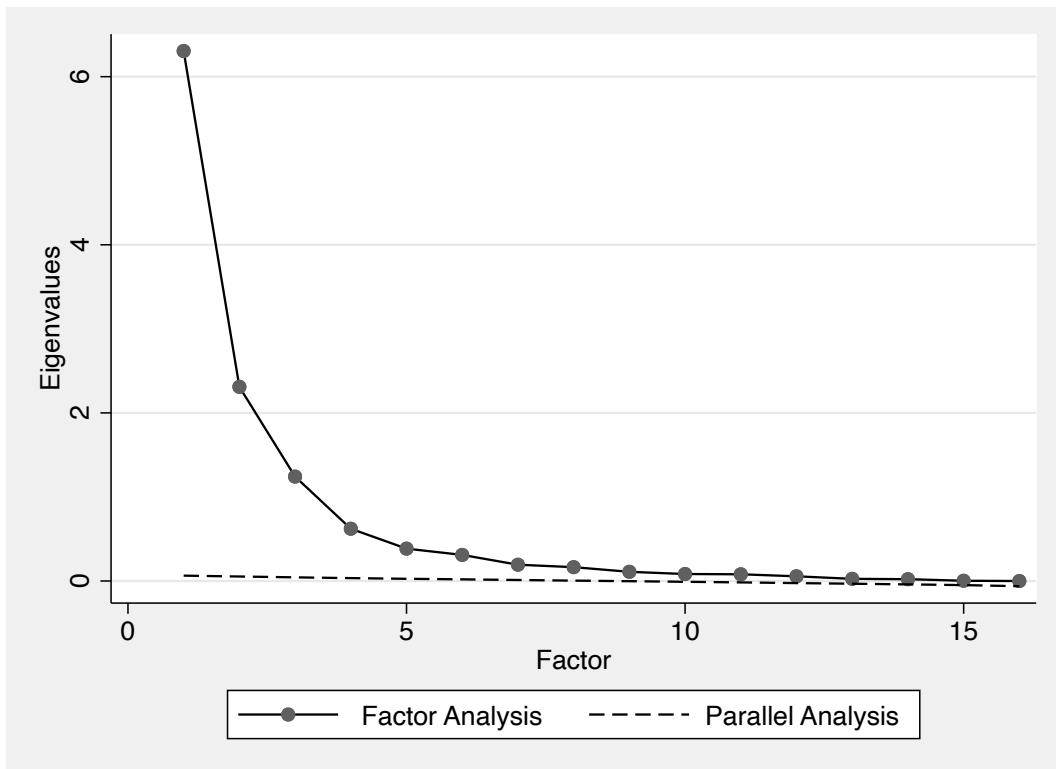
Given the items loading in the first dimension, the first score (Score adh A) seems to correspond to the most explicit recommended measures (ADH\_1, ADH\_3, ADH\_4, ADH\_5, ADH\_6, ADH\_7, ADH\_11, ADH\_12). The second score, Score adh B, represents more implicit measures (ADH\_8, ADH\_10, ADH\_13, ADH\_14). Finally, Score adh C represents items related to mask wearing (ADH\_2, ADH\_14, ADH\_15, ADH\_16). The Kaiser-Meyer-Olkin index for the complete model is equal to 0.89 indicating a meritorious factor solution [Kaiser, 1974]. Almost all items load higher than 0.5 to a factor. ADH\_9 does not display a loading factor higher than 0.5. For this reason, we remove ADH\_9 to construct the scores of adherence in the current analysis.

Table A.3: Exploratory factor analysis

Variable	Label	Factor 1	Factor 2	Factor 3	Uniqueness	SMC	KMO
ADH_1	Kept a distance of two meters to other people	0.64			0.37	0.47	0.91
ADH_2	Wore a mask			0.86	0.05	0.74	0.83
ADH_3	Avoided shaking hands/kissing other people	0.81			0.13	0.68	0.88
ADH_4	Avoided close contact with sick people	0.61			0.30	0.49	0.89
ADH_5	Washed or disinfected my hands regularly	0.74			0.22	0.60	0.92
ADH_6	Coughed and sneezed into the crease of my elbow	0.52			0.47	0.37	0.92
ADH_7	Were particularly careful around vulnerable persons	0.67			0.28	0.54	0.93
ADH_8	Called rather than visited a doctor		0.85		0.18	0.67	0.86
ADH_9	Avoided touching my face				0.35	0.52	0.94
ADH_10	Stayed at home, when I felt sick		0.86		0.14	0.67	0.83
ADH_11	Avoided going out for not immediately necessary activities	0.56			0.17	0.66	0.86
ADH_12	Avoided unnecessary social contacts	0.70			0.16	0.68	0.87
ADH_13	Kept a list of people I had close contact with		0.85		0.17	0.65	0.86
ADH_14	Wore a mask in public transport, shops and similar public places			0.81	0.24	0.60	0.82
ADH_15	Wore my disposable mask only once and for max 8 hours			0.60	0.39	0.50	0.93
ADH_16	Washed my reusable mask after every day of use at 60°C			0.51	0.45	0.44	0.93
							0.89

**Notes:** This table presents the main component analysis (MCA) using Polychoric correlations. The analysis is performed with Varimax rotation and we specify a one factor solution. KMC: Kaiser-Meyer-Olkin index. SMC: Squared multiple correlation.

Figure A.2: Scree plot



**Notes:** This graph plots the eigenvalues of the factor analysis without restricting the number of factors. The comparison of the eigenvalues to unity first determines the number of factors to retain. We perform a parallel analysis that determines how many factors should be retained based on how many eigenvalues are not parallel to the dashed line generated by a random correlation matrix with the same numbers of observations and variables as the original data.

## References

Kaiser, Henry F. 1974. "An index of factorial simplicity." *Psychometrika* 39 (1): 31-36.

## Online appendix A (cont.): Descriptive statistics for well-being

Table A.4: Descriptive statistics for well-being variables

	Mean	Std. Dev.	Min	Max
Depression – PHQ-9 score	6.16	6.17	0	27
Anxiety – GAD-7 score	5.43	5.26	0	21
Stress – PSS score	15.29	7.39	0	40
Loneliness – ULS-8 score	16.23	5.26	8	32
Observations	22878			

Figure A.3: Histogram of depression (PHQ-9)

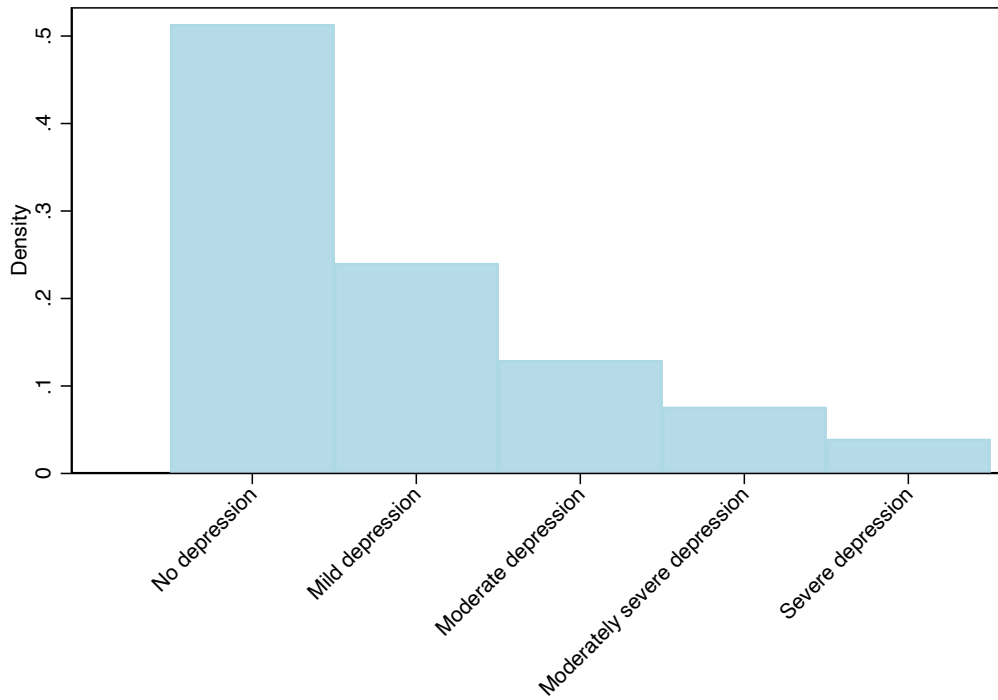


Figure A.4: Histogram of anxiety (GAD-7)

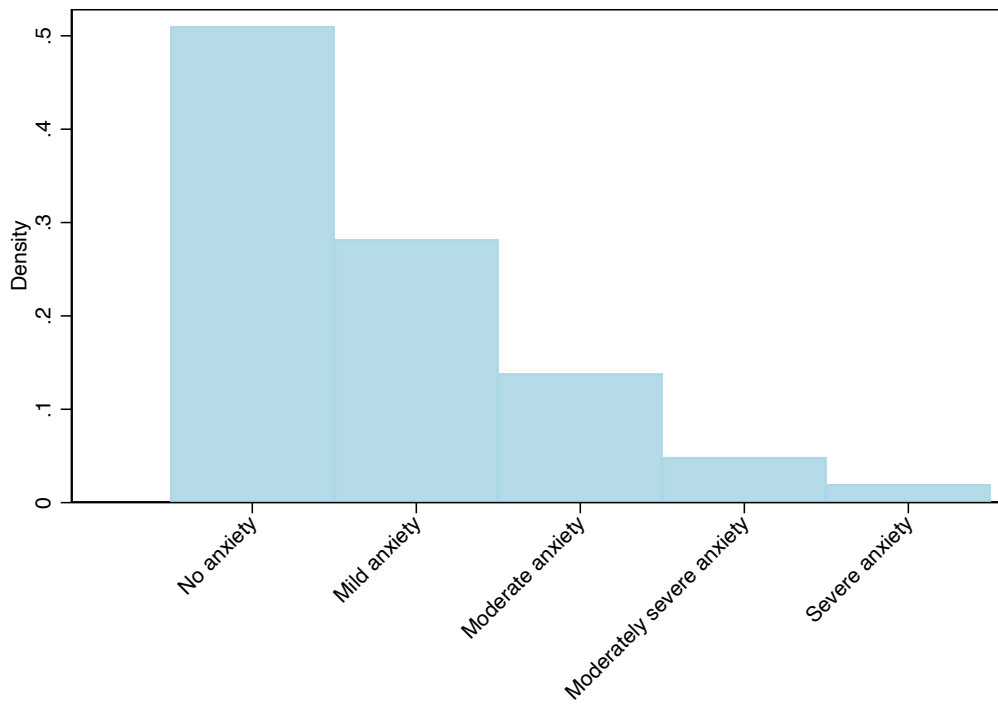


Figure A.5: Histogram of stress (PSS)

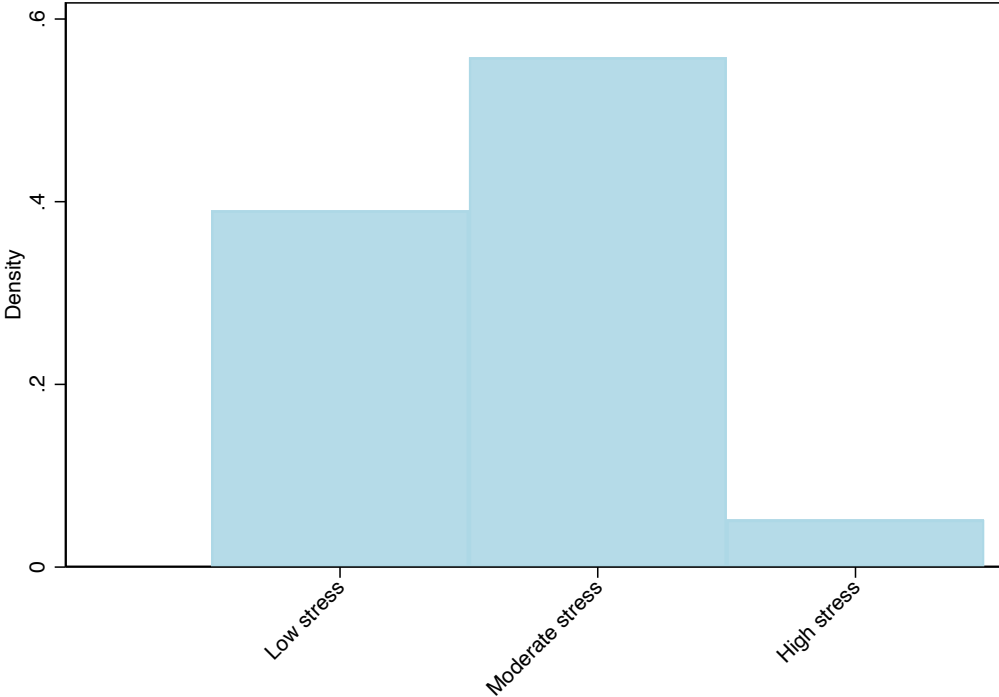
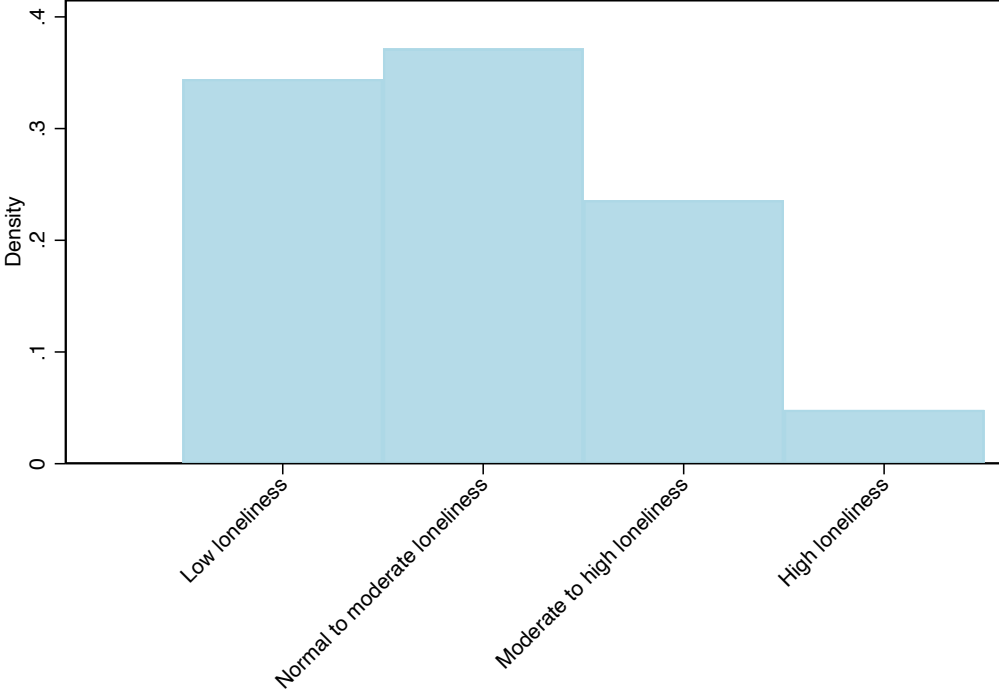


Figure A.6: Histogram of loneliness (ULS-8)



## Online appendix A (cont.): Control variables

### Individual-level controls

We use information on gender, age, marital status, the composition of the household, education, working from home, income, income change, confidence in the government and in health services, and knowledge of the disease.

We create a series of dummies capturing the age groups (less than 24, 25–34, 35–44, 45–54, 55–64, and 65+).

Marital status is coded in four categories (single, never married; single, divorced or widowed; in a relationship / married but living apart; in a relationship / married and cohabiting).

To capture household composition, we use the number of children and the number of individuals aged 65+ living in the household. We also include a dummy for when we do not know whether there are old people in the household.

### *Socioeconomic status*

Socioeconomic status is captured by education level, whether the individual works at home, income, and income change.

The education indicator has three categories: low (i.e., primary education; general education (secondary) school), medium (O-levels or equivalent; A-levels or equivalent; vocational education / training) and high education level (master's degree; PhD, MD, etc.).

Job status captures whether the individual works at home, does not work at home, or does not work.

Information on household income is given in brackets (0–1,250 Euros; 1,250–2,000 Euros; 2,000–4,000; 4,000–6,000 Euros; 6,000–8,000 Euros; 8,000–12,500 Euros; >12,500 Euros). We use the middle of the brackets and compute equivalised income by household size. We then standardize income by country. We also create a dummy capturing missing values.



In addition, we employ two dummies for whether individual income decreased or decreased since the previous wave.

### *Confidence*

We use two scales capturing the level of confidence in the government and in health services. The questions are the following: “How much confidence do you have that the government of your country of residence can handle COVID-19 well?” [scale from 1 (“None at all”) to 7 (“Full confidence”)] and “How much confidence do you have that the health service of your current country of residence can cope during COVID-19 ?” [scale from 1 (“No confidence”) to 7 (“Full confidence”)]. We standardize these scales by country.

### *Knowledge of the disease*

Finally, knowledge of the disease is measured using the following question: “How would you rate your knowledge level on COVID-19?” with responses ranging from 1 (“Very poor knowledge”) to 7 (“Very good knowledge”). We standardize the variable by country.

### **Aggregate-level controls**

We combine our COME-HERE data with aggregate data from the Oxford University’s Blavatnik School of Government COVID-19 Government Response Tracker (Hale et al. 2021). Important for our analysis is the Tracker’s Stringency Index that records how strict the lockdown type policies are, that restrict the behaviour of people in a country. This is calculated using all of the tracker’s containment and closure policy indicators and an indicator recording public information campaigns (which are as follows: school and university closures; workplace closures; the cancelling of public events; restrictions on public gatherings; public transport restrictions; stay at home orders; restrictions on internal movement; restrictions on foreign travel; and evidence about coordinated public information campaigns).

In addition to the stringency index, we also use information on the number of daily confirmed deaths due to COVID-19 the day before the interview in each country of interest. Economic models of rational epidemics have demonstrated the importance of endogenous varia-

tions in self-protective behaviours in epidemic dynamics (Geoffard and Philipson 1996; Toxvaerd 2020). Self-protection efforts react endogenously to the epidemics, so that an increase in the incidence rate is likely to increase self-protection efforts.

## References

Geoffard, Pierre-Yves, and Tomas Philipson. 1996. "Rational epidemics and their public control." *International Economic Review* 37 (3): 603–624.

Hale, Thomas, Noam Angrist, Rafael Goldszmidt, Beatriz Kira, Anna Petherick, Toby Phillips, Samuel Webster, Emily Cameron-Blake, Laura Hallas, Saptarshi Majumdar, and Helen Talow. 2021. "A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker)." *Nature Human Behaviour* 5 (4): 529–538.

Toxvaerd, Flavio M. O. 2020. "Equilibrium social distancing." *Working Papers in Economics*, University of Cambridge.

## Online appendix A (cont.): Correlation between well-being indicators

Table A.5: Correlation matrix between well-being variables

	Depression score (PHQ-9)	Anxiety score (GAD-7)	Stress score (PSS)	Loneliness score (ULS-8)
Depression score (PHQ-9)	1			
Anxiety score (GAD-7)	0.83***	1		
Stress score (PSS)	0.67***	0.69***	1	
Loneliness score (ULS-8)	0.62***	0.55***	0.64***	1

**Source:** Waves 1 to 4 of the COME-HERE (COVID-19, MEntal HEalth, REsilience and Self-Regulation) survey.

**Notes:** \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

## **Online appendix B: The U-shaped relationship between psychological well-being and following the recommendations**

### **Results for population groups defined using well-being level at baseline or well-being evolution over time**

This appendix reports additional regression results to investigate whether the U shape is driven by some heterogeneity in the well-being / compliance relationship between individuals heterogeneous in their baseline well-being and / or in their observed transitions across well-being states. For instance, the negative slope of the U shape (on the left) may be produced by individuals always oscillating between medium and high levels psychological well-being, while the positive slope may correspond to individuals always oscillating between low and medium levels of psychological well-being. Hence, the mixing of these two populations characterised by correlations of opposite signs between well-being and compliance would eventually explain the U shape.

To investigate this explanation, we first keep waves 1 and 2 only and re-estimate the OLS-FE model restricting the sample to individuals who are in very good health in wave 1. Here, the correlation of interest is identified only by worsenings of psychological well-being indicators between wave 1 and 2 for individuals who are in very good mental health at baseline. Results of the OLS-FE model are provided in Figure B.1. For the top-left figure, the sample contains individuals with no depression in wave 1, while for the top-right figure, it contains individuals with no anxiety in wave 1. The samples of the two bottom figures are defined in a similar way. We still find a U shape for anxiety and loneliness, but the correlations remain negative for transitions to severe stress or depression states. However, the confidence intervals are large, as we observe a small number of such transitions.

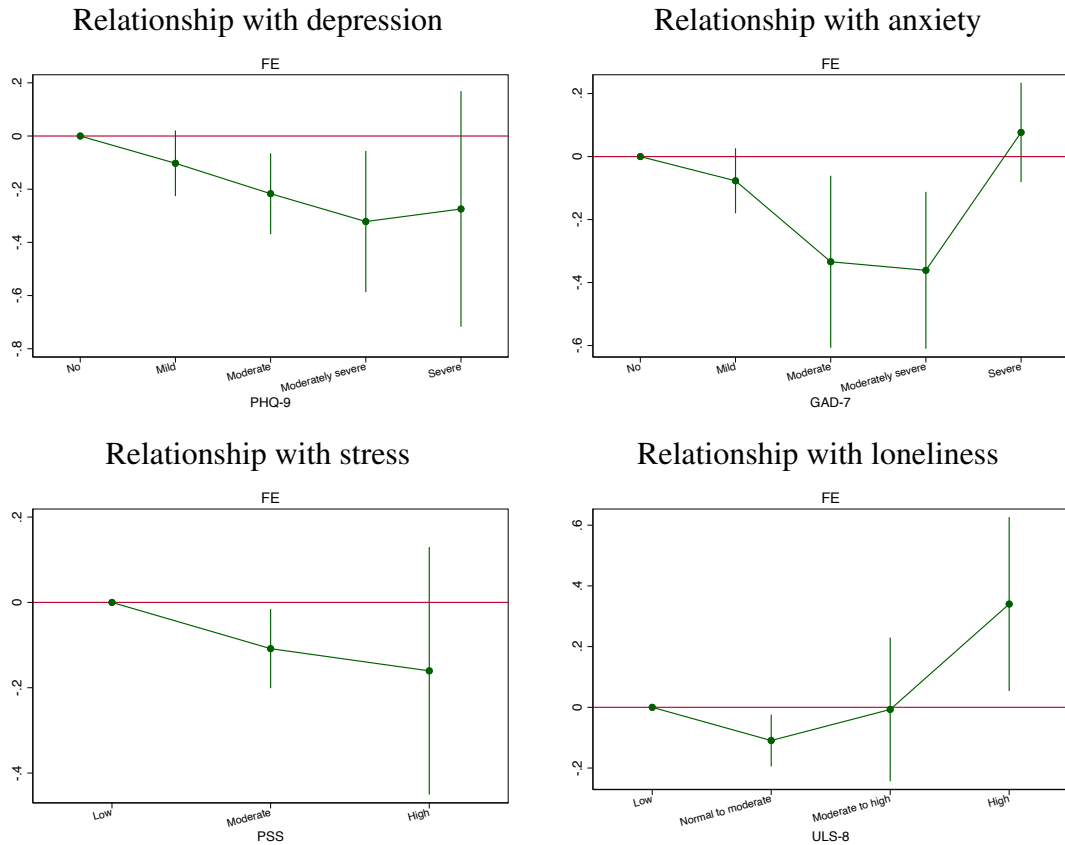
In Figure B.2, we restrict the sample to individuals who are *not* in very good mental health in wave 1. In the top-left figure, the sample contains individuals with mild to severe depression in wave 1. In the top-right figure, it contains individuals with mild to severe anxiety in wave 1.

The samples of the remaining figures are defined accordingly. We find a U shape for our four well-being indicators.

Last, we also re-estimate our model restricting the sample to individuals whose psychological well-being remains stable or worsens over the four waves. Individuals whose health improves at some point are thus deleted from the sample from the moment this improvement occurs. The results, reported in Figure [B.3](#), are consistent with a U shape (except for depression for which the effect is nonmonotonic but not U shaped).

Taken together, these figures are rather supportive of the existence of a U-shaped relationship, independently of the patterns of transitions across well-being states that may characterize specific groups of the population.

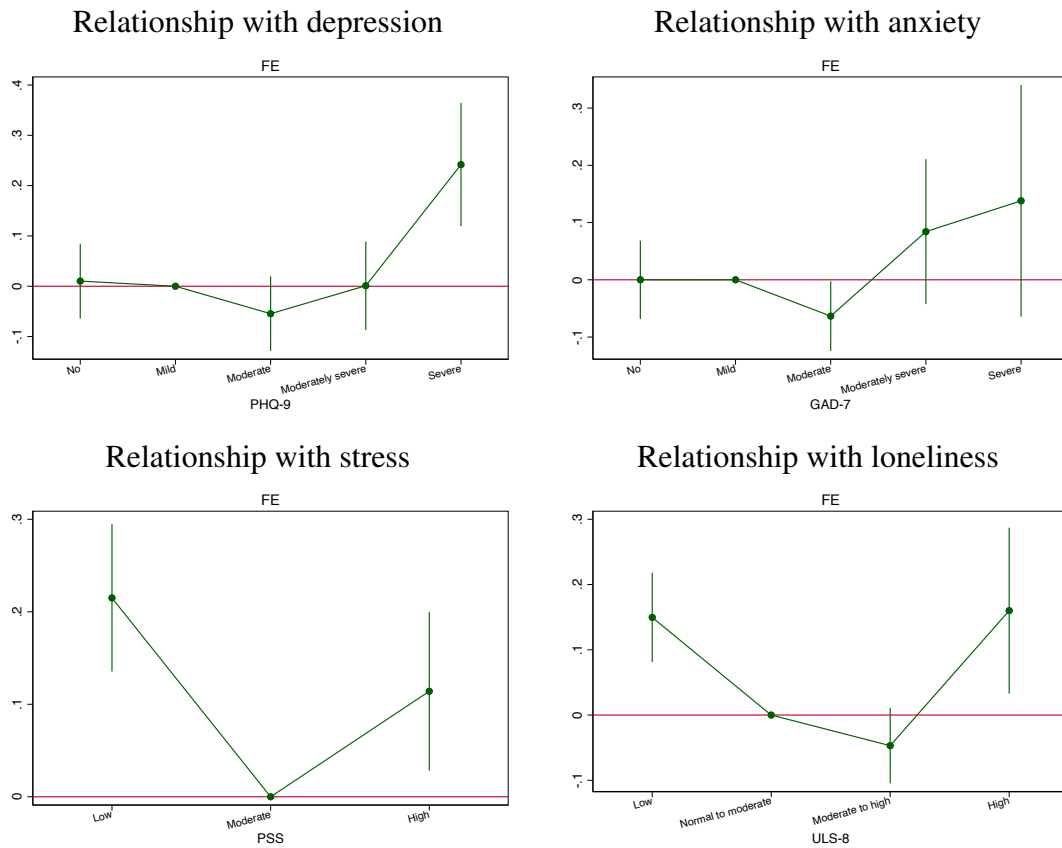
Figure B.1: Relationship between psychological well-being and following the recommendations in waves 1 and 2, for individuals with a very high level of psychological well-being in wave 1 (OLS-FE)



**Source:** COME-HERE (COVID-19, Mental Health, REsilience and Self-Regulation) survey.

**Notes:** The samples contain observations from waves 1 and 2, for individuals who, in wave 1, have no depression (for the top-left figure), no anxiety (for the top-right figure), no stress (for the bottom-left figure), and no loneliness (for the bottom-right figure). The graphs present the effects of psychological health on following the recommendations. These effects are derived from regressions of following recommendations on depression categories for the top-left figure, anxiety categories for the top-right figure, stress categories for the bottom-left figure, and loneliness categories for the bottom-right figure. The reference category is no depression for the top-left figure, no anxiety for the top-right figure, no stress for the bottom-left figure, and no loneliness for the bottom-right figure. The following controls are included: job status, income, income evolution, confidence in the government and in health services, knowledge, aggregate-level controls, and country-wave and individual fixed effects. Standard errors are clustered at the date of interview and country level.

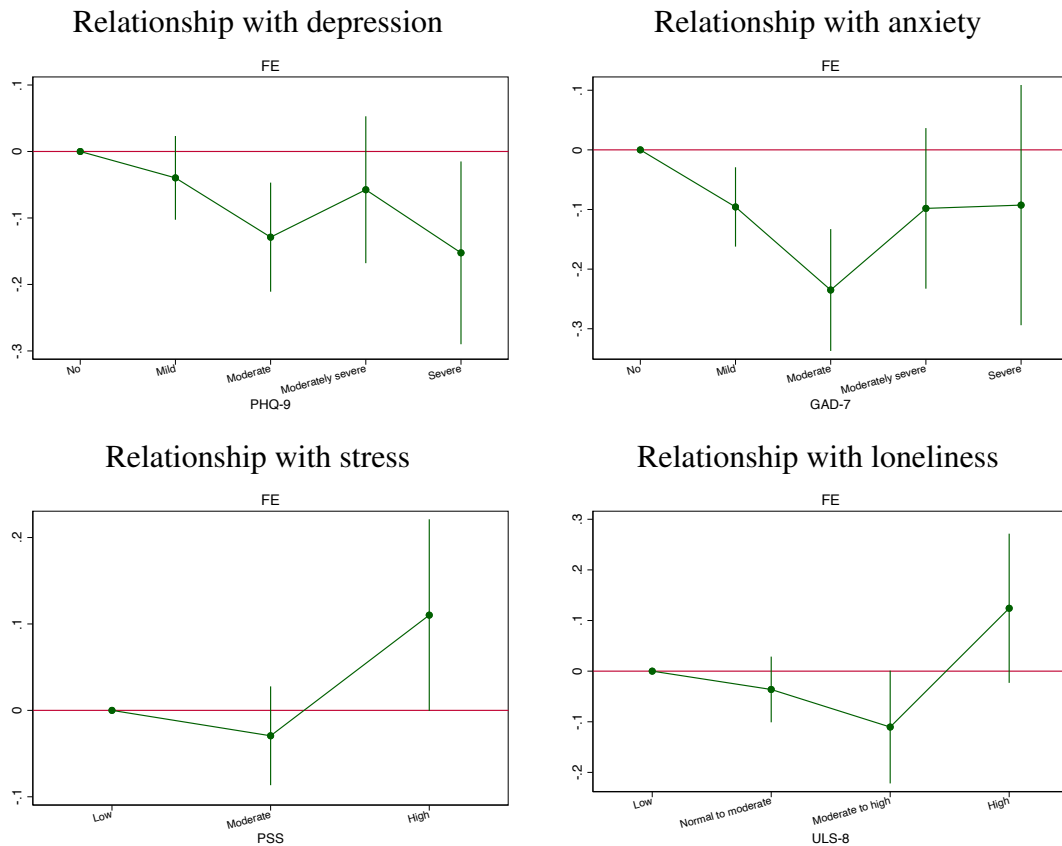
Figure B.2: Relationship between psychological well-being and following the recommendations in waves 1 and 2, for individuals who do *not* report very good psychological well-being in wave 1 (OLS-FE)



**Source:** COME-HERE (COVID-19, Mental Health, Resilience and Self-Regulation) survey.

**Notes:** The samples contain observations from waves 1 and 2, for individuals who, in wave 1, have mild to severe depression (for the top-left figure), mild to severe anxiety (for the top-right figure), moderate or high stress (for the bottom-left figure), and normal-to-moderate to high loneliness (for the bottom-right figure). The graphs present the effects of psychological health on following the recommendations. These effects are derived from regressions of following recommendations on depression categories for the top-left figure, anxiety categories for the top-right figure, stress categories for the bottom-left figure, and loneliness categories for the bottom-right figure. The reference category is mild depression for the top-left figure, mild anxiety for the top-right figure, moderate stress for the bottom-left figure, and normal-to-moderate loneliness for the bottom-right figure. The following controls are included: job status, income, income evolution, confidence in the government and in health services, knowledge, aggregate-level controls, and country-wave and individual fixed effects. Standard errors are clustered at the date of interview and country level.

Figure B.3: Relationship between psychological well-being and following the recommendations, for the sample of individuals whose psychological well-being deteriorates or remains the same over time (OLS-FE)



**Source:** COME-HERE (COVID-19, Mental Health, Resilience and Self-Regulation) survey.

**Notes:** The sample contains observations of individuals whose health remains the same or deteriorates over time. An individual is dropped from the sample from the wave in which his health improves. The graphs present the effects of psychological health on following the recommendations. These effects are derived from regressions of following recommendations on depression categories for the top-left figure, anxiety categories for the top-right figure, stress categories for the bottom-left figure, and loneliness categories for the bottom-right figure. The reference category is no depression for the top-left figure, no anxiety for the top-right figure, no stress for the bottom-left figure, and no loneliness for the bottom-right figure. The following controls are included: job status, income, income evolution, confidence in the government and in health services, knowledge, aggregate-level controls, and country-wave and individual fixed effects. Standard errors are clustered at the date of interview and country level.



## Online appendix C: Specific health behaviours

### Relationship between psychological well-being and the CBS and adherence scores

Unlike for following the recommendations and for specific behaviours, we do not often observe a U-shaped correlation for the CBS and adherence *scores*. In fact, we often (but not always) find that poorer psychological health goes hand in hand with better health behaviours as measured by these scores.

More precisely, when we regress the CBS score (for reasonable behaviours) on psychological health (Table C.1 (OLS)), we observe that higher levels of anxiety or stress are associated with a higher CBS score. However, the relationship between depression and the CBS score is nonmonotonic but not U-shaped, and the link between loneliness and the CBS score is not significant.

Regarding the adherence scores, results often indicate that poorer psychological health is positively correlated with higher adherence (Tables C.2 (OLS-FE) and C.3 (lag model)). In the OLS-FE models, this is the case for nine models out of 12. In the lag models, results are less clear since this is the case in only five models out of 12. Note that the lag model shows that loneliness has a U-shaped effect on two adherence scores (Scores adh A and C).

Given that the correlation between following the recommendations and the scores is low,<sup>2</sup> the difference in shapes between following the recommendations (U shape) and the scores is not surprising.

Table C.1: Relationship between psychological well-being and the CBS score (reasonable), in wave 1 (OLS)

	(1) CBS score (reasonable)	(2) CBS score (reasonable)	(3) CBS score (reasonable)	(4) CBS score (reasonable)
Mild depression	0.985*** (0.198)			
Moderate depression	0.276 (0.236)			
Moderately severe depression	1.015*** (0.329)			
Severe depression	2.784*** (0.401)			
Mild anxiety		1.590*** (0.222)		
Moderate anxiety		1.545*** (0.248)		
Moderately severe anxiety		3.021*** (0.294)		
Severe anxiety		4.494*** (0.415)		
Moderate stress			0.559** (0.225)	
High stress			1.376*** (0.339)	
Normal to moderate loneliness				0.177 (0.236)
Moderate to high loneliness				0.132 (0.398)
High loneliness				0.578 (0.429)
Model	OLS	OLS	OLS	OLS
Country-Wave Fixed Effects	Yes	Yes	Yes	Yes
Obs	7312	7312	7312	7312

**Source:** Wave 1 of the COME-HERE (COVID-19, MEntal HEalth, REsilience and Self-Regulation) survey.

**Notes:** This table presents the results of the regression of the CBS score on depression categories in column (1), anxiety categories in column (2), stress categories in column (3), and loneliness categories in column (4). The reference category is no depression in column (1), no anxiety in column (2), no stress in column (3), and no loneliness in column (4). The following controls are included: gender, age, marital status, household composition, education, job status, income, income evolution, confidence in the government and in health services, knowledge, aggregate-level controls, and country fixed effects. Standard errors are clustered at the date of interview and country level.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

Table C.2: Relationship between psychological well-being and the three adherence scores, in waves 3 and 4 (OLS-FE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Score adh A	Score adh A	Score adh A	Score adh A	Score adh B	Score adh B	Score adh B	Score adh B	Score adh C	Score adh C	Score adh C	Score adh C
Mild depression	0.057** (0.023)				0.085*** (0.021)				-0.003 (0.022)			
Moderate depression	0.011 (0.037)				0.132*** (0.035)				0.008 (0.034)			
Moderately severe depression	0.070 (0.044)				0.211*** (0.039)				0.062 (0.044)			
Severe depression	0.328*** (0.053)				0.417*** (0.056)				0.217*** (0.046)			
Mild anxiety		0.042* (0.025)				0.052** (0.026)				0.023 (0.017)		
Moderate anxiety		0.073* (0.043)				0.146*** (0.040)				0.063* (0.036)		
Moderately severe anxiety		0.151*** (0.049)				0.166*** (0.051)				0.069 (0.045)		
Severe anxiety		0.499*** (0.096)				0.418*** (0.079)				0.286*** (0.066)		
Moderate stress			-0.001 (0.018)				0.107*** (0.025)				0.013 (0.023)	
High stress			0.162*** (0.047)				0.108*** (0.042)				0.063 (0.042)	
Normal to moderate loneliness				0.048** (0.021)				0.120*** (0.020)				0.015 (0.020)
Moderate to high loneliness				0.061** (0.031)				0.190*** (0.030)				0.086** (0.034)
High loneliness				0.092** (0.044)				0.116** (0.050)				0.089* (0.053)
Model	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE	OLS-FE
Country-wave fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00

**Source:** Waves 3 and 4 of the COME-HERE (COVID-19, Mental Health, Resilience and Self-Regulation) survey.

**Notes:** The explained variable is score A in columns (1) to (4), score B in columns (5) to (8), and score C in columns (9) to (12). The adherence scores are standardized (for the full sample). The explanatory variable are depression categories in columns (1), (5), and (9), anxiety categories in columns (2), (6), and (10), stress categories in columns (3), (7), and (11), and loneliness categories in columns (4), (8), and (12). The following controls are included: job status, income, income evolution, confidence in the government and in health services, aggregate-level controls, and country-wave and individual fixed effects. Standard errors are clustered at the date of interview and country level. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

Table C.3: Relationship between lagged psychological well-being and the three adherence scores, in waves 3 and 4 (lag model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	score adh A	score adh A	score adh A	score adh A	score adh B	score adh B	score adh B	score adh B	score adh C	score adh C	score adh C	score adh C
Mild depression	0.519** (0.227)				0.891*** (0.120)				0.053 (0.100)			
Moderate depression	-0.124 (0.268)				1.686*** (0.158)				0.159 (0.166)			
Moderately severe depression	0.073 (0.346)				2.432*** (0.198)				-0.041 (0.194)			
Severe depression	1.092* (0.574)				3.381*** (0.315)				0.568** (0.223)			
Mild anxiety		0.815*** (0.182)				1.177*** (0.140)				0.373*** (0.117)		
Moderate anxiety		0.459 (0.289)				2.005*** (0.139)				0.297* (0.162)		
Moderately severe anxiety		1.459*** (0.412)				2.658*** (0.217)				0.603*** (0.181)		
Severe anxiety		2.625*** (0.543)				3.127*** (0.475)				0.884*** (0.318)		
Moderate stress			0.003 (0.175)				1.773*** (0.099)				0.128 (0.104)	
High stress			1.122*** (0.289)				1.069*** (0.203)				-0.008 (0.165)	
Normal to moderate loneliness				-0.687*** (0.140)				0.665*** (0.119)				-0.274*** (0.105)
Moderate to high loneliness				-1.444*** (0.281)				1.322*** (0.125)				-0.427*** (0.149)
High loneliness				0.843** (0.388)				1.366*** (0.264)				-0.185 (0.228)
Model	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag	Lag
Country-Wave	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00	10874.00
Adjusted R2	0.09	0.10	0.09	0.10	0.18	0.18	0.18	0.16	0.44	0.44	0.44	0.44

Source: Waves 3 and 4 of the COME-HERE (COVID-19, MEntal HEalth, REsilience and Self-Regulation) survey.

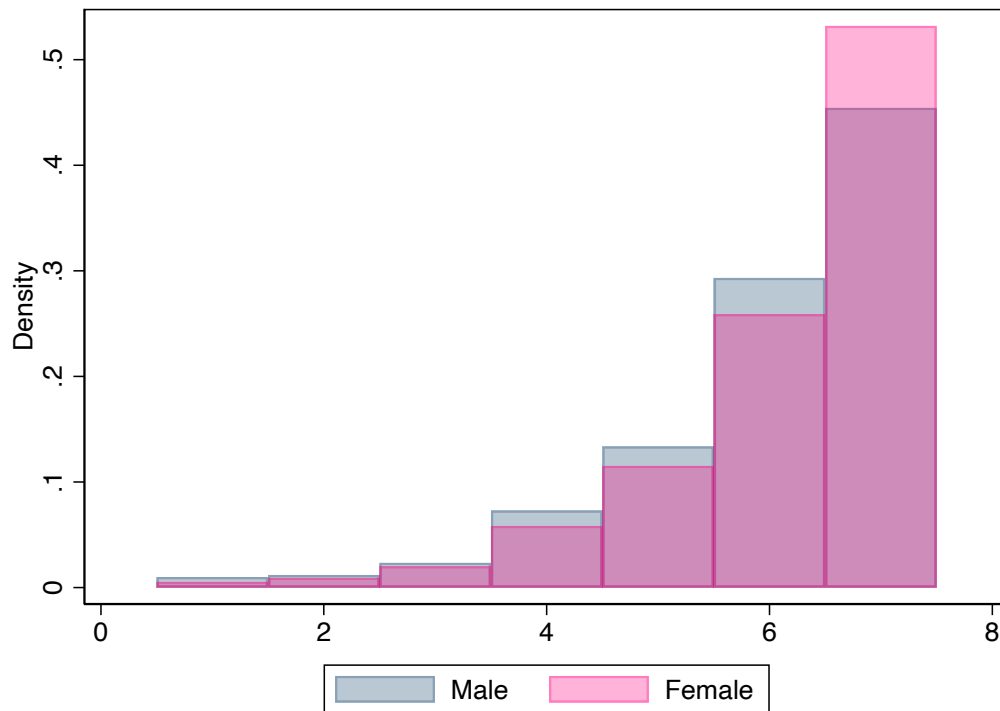
Notes: The explained variable is score A in columns (1) to (4), score B in columns (5) to (8), and score C in columns (9) to (12). The adherence scores are standardized (for the full sample). The explanatory variable are depression categories in columns (1), (5), and (9), anxiety categories in columns (2), (6), and (10), stress categories in columns (3), (7), and (11), and loneliness categories in columns (4), (8), and (12). The following controls are included: gender, age, marital status, household composition, education, job status, income, and loneliness evolution, confidence in the government and in health services, knowledge, aggregate-level controls, and country-wave fixed effects. Standard errors are clustered at the date of interview and country level.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

## Online appendix D: Understanding the U shape

### Following the recommendations, by gender

Figure D.1: Histogram for following the recommendations, by gender



**Source:** Waves 1 to 4 of the COME-HERE (COVID-19, MEntal HEalth, REsilience and Self-Regulation) survey.