during the Covid-19 pandemic, as these populations are more vulnerable to social isolation than others [24]. In fact, face-to-face social interaction is considered a key factor for healthy aging [25]. In particular, we use cross-country microdata on anxiety, depression, and insomnia after the COVID-19 outbreak in 27 European countries and Israel. These data come from the COVID-19 questionnaire of the Survey of Health, Ageing and Retirement in Europe (SHARE), which provides microdata for the COVID-19 living situation of people aged 50 and over in a large number of countries. We also use information from the Oxford COVID-19 Government Response Tracker (OxCGRT) on eight confinement measures implemented to restrict mobility and social contacts (measures C1 to C8 in the OxCGRT database). These measures include closure of workplaces, cancellation of public events, restrictions on large gatherings and stay at home rules, among others.

To answer our research question concerning the effects of confinement policies on the mental health of older adults, we used a fully data-driven empirical estimation based on machine learning methods. The motivation behind this empirical approach was to avoid model misspecification, thus yielding more accurate results and more reliable conclusions. Machine learning methods have become increasingly popular in economics. Recent literature has developed statistical models and methods specifically designed to facilitate inference using a variety of machine learning methods in a semi-parametric setting [26, 27]. The empirical methods employed in this paper rely on the theoretical findings by Chernozhukov et al. [27] and Kennedy et al. [28]. In particular, we use these robust machine learning estimators to analyze the influence of a composite confinement index (that includes all measures C1 to C8), and of each confinement policy taken separately, on the worsening in mental health.

General results show that confinement policies are positively correlated with the worsening of mental health for the three mental health outcomes analyzed: insomnia, anxiety and depression. This is in line with previous findings in the literature [29, 30].

Regarding particular policies, we find that closure of public transportation and restrictions on domestic and international travel do not seem to have worsened the mental health of older populations in Europe. Similarly, restrictions on gathering size do not seem to have negatively affected mental health. The only measures that seem to have led to mental health deterioration are stay-at-home rules and workplace closures, which we found to have impacted the three mental health outcomes of insomnia, anxiety and depression.

This paper complements a previous study [19], where we estimated the causal effect of lockdown policies (constructing a composite confinement index) on mental health by combining cross-country variability in the strictness of the policies with cross-individual variability in face-to-face contacts prior to the pandemic across 17 European countries. In the current study, we forego this causal approach. Instead, we expand the range of countries studied to 28 (from the previous 17) and examine the effect of each of the diverse policies that have been implemented (using individual confinement indicators) to identify which policies have had the most detrimental effect on the mental health of citizens. Our results contribute to efforts to understand the effect of individual

confinement policies on mental health, complementing previous work on the effects of these policies on virus transmission. Our more fine-grained analysis will help policy-makers to decide which policies should be implemented, intensified or relaxed, to control the spread of the virus while minimizing impact on population mental health.

2. Materials and Methods

2.1. Data

This study combines two different data sources: the SHARE (Survey of Health, Ageing and Retirement in Europe) corona survey, and the Oxford COVID-19 Government Response Tracker (OxCGRT) database.

After the outbreak of COVID-19, SHARE distributed a special "SHARE CORONA" questionnaire to a subsample of SHARE wave 8 respondents targeted to the COVID-19 living situation of people aged 50 and over. The survey was conducted between June and August of 2020 by means of a computer assisted telephone interview (CATI) with a total of 52,310 respondents from different countries [32]. Countries participating in the survey include 27 European countries (Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Czech Republic, Poland, Portugal, Luxembourg, Hungary, Slovenia, Estonia, Croatia, Lithuania, Bulgaria, Cyprus, Finland, Latvia, Romania, Slovakia, and Malta) and Israel.

In this paper, we draw from this SHARE COVID-19 questionnaire to collect data about individual mental health problems after the onset of the pandemic, as well as information about socioeconomic characteristics and physical health.[1]

We also use data from Oxford COVID-19 Government Response Tracker (OxCGRT) to gather information about the strictness of lockdown policies in Europe. The OxCGRT is a database that collects daily information on the type and intensity of government responses to COVID-19 in a large number of countries. Thus, it provides an objective measure of the degree and reach of several COVID-19 policy measures. As it will be explained afterwards, we focus on those confinement measures available in OxCGRT that aim at restricting mobility and social contacts.

2.2. Variable Definition

Mental Health Outcomes

Our dependent variable is the worsening in mental health of the population. We include three mental health outcomes in our analysis: anxiety, depression, and insomnia. Depression and anxiety are common mental health disorders, while insomnia prevalence

[1] Note that although SHARE is a panel study, the SHARE Corona survey has specific characteristics that prevent us from using longitudinal panel data for the same individuals and variables of interest over time.

has been found to be associated with measurements of worse physical and mental health [33, 34].

In the SHARE Corona questionnaire, individuals are asked about their mental health problems in the last month and whether there had been a worsening on these conditions since the beginning of the pandemic. Accordingly, we categorize these variables as binary variables that take value 1 if respondents answered that they experienced mental health deterioration after the outbreak, and zero if mental problems improved or remained the same.

COVID-19 confinement indicators

Our main explanatory variable is the strictness of several COVID-19 confinement indicators. We focus on eight policies or measures available in OxCGRT, all of them aimed at restricting mobility and social contacts: (C1) closure of schools, (C2) closure of workplaces, (C3) cancellation of public events, (C4) restrictions on gathering size, (C5) closure of public transportation, (C6) stay at home requirements, (C7) restrictions on domestic travel, and (C8) restrictions on international travel. For a given country and day, OxCGRT gives an integer value between 0 and 4 for all the indicators (measures or "confinement policies"), depending on the strictness of the policy, where 0 means no measure applied and 4 means that the maximum level of enforcement was applied. Following Hale et al. and García-Prado et al. [35, 19], we construct daily indicators for each measure. These daily indicators are rescaled (by their maximum value) to create a score between 0 and 100. We also build an additive unweighted composite index that includes all eight measures C1-C8. The index on any given day is calculated as the mean score of the eight individual policy response indicators, each taking a value between 0 and 100. Once the daily measures are created, we use their monthly average for April and May 2020 -the hardest months in terms of mobility restrictions in the countries of our sample- and apply these averages to the analysis of our sample.[2]

Potential Covariates

In the empirical analysis we additionally control for a battery of observable demographic and socioeconomic characteristics that are available in the SHARE COVID-19 survey and might be related with mental health. Demographic variables comprise gender, age and household size at the time of interview. Age was measured according to three groups: 50-65, 66-75 and 75+. Household size was categorized according to household size equal to one person, two people, three/four people or more than four people. Because socioeconomic hardships suffered during the pandemic may affect mental health, we analyze the economic situation of the respondent according to financial distress, which is

[2] We estimated alternative models: creating the index by using the average values per fortnight of April and May and the average of April and the average of May, and all the qualitative and quantitative results hold.