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LONELINESS PANDEMIC: EVIDENCE FROM SHARE

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ABSTRACT

In Europe, loneliness is a public health issue. Given its high correlation with social isolation, it has been exacerbated by COVID-19, especially for the vulnerable groups like older adults. For 24 European countries plus Israel, this study presents a micro analysis of the effect of loneliness on individuals´ health. We find that loneliness has a negative and significant impact on health and on its variation, before and after the first wave of COVID-19. This impact, in our data context and in the most extreme loneliness case, can be similar to having a disease like cancer. The implicit monetary cost of extreme loneliness is quantitatively significant, ranging from 256 (Bulgaria) to 13304€/month (Switzerland), according to the country.

KEYWORDS: Health Economics, Mental Health, Loneliness, Health Production Function, COVID-19, Older Adults

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RESEARCH QUESTIONS

This work aims to study loneliness and its impact on self-assessed health of Europeans adults aged 50 and over. Two main research questions are addressed: the implicit cost of loneliness in older adults´ health before the pandemic and the impact of loneliness on the health changes suffered after the first wave of COVID-19.

1. INTRODUCTION

On 13 March 2020, WHO (World Health Organization) declared Europe as an active center of COVID-19.[1] This triggered the first lockdown to which European countries adhered according

[1] https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-mission-briefing-on-covid-19---13-march-2020

to their circumstances, mostly between March and April. In this period, although not equally distributed, severe measures such as school, workplace and public transportation closures, cancellation of public events, restrictions on gatherings and international movement and stay home measures were adopted. In order to assess these measures across countries, "Our World In Data" from oxford, developed a COVID-19 stringency index based on policies adopted by each country in each period of time. The Italian government was the first taking the more drastic measures, followed by Malta, France, Iberian Peninsula, and almost all Europe. On 20 March 2020, the only countries that had not yet adopted very strict policies in response to COVID-19 were the UK (United Kingdom), Ireland, Sweden, and Estonia. This situation changed and one month later the pandemic was considered relevant enough throughout all European countries, except for Belarus.[2]

This pandemic, although recent, has been the subject of numerous studies and analyses, given its impact worldwide and was considered a public health emergency (WHO 2020). Severe measures brought profound changes in people's lives, is if the physical distancing imposed by governments and circumstances, generated emotional distancing. Can "social distancing" have two possible interpretations? Let us distinguish between the effects of this pandemic: some more direct like lockdowns, others more indirect, like possible mental health issues derived from unexpected and irregular period.

The virus was not "fair" in its impact, as people of an older age were especially affected, directly and indirectly. Vulnerable groups were the ones that could be most severely ill with Covid-19. Thus, people belonging to these groups, were affected both by living in a pandemic and by having to protect themselves more than others. As expected, older adults compose one of these groups, so this pandemic was more disruptive for them than for younger people. The ageing population trend contributes to deteriorate this problem, as more and more people will take part

[2] https://ourworldindata.org/grapher/covid-stringency-index

in this "vulnerable group". Contrary to what they say, maybe we are not all in the same boat and this should grab our attention.

Demographic projections for EU reveal a decline in the overall population of 5% between 2019 and 2070 as well as a structural age change where the median age is expected to increase by 5 years and one third of the population will be over 65 by 2060. Considering the increase in life expectancy, fertility rates will remain well below the natural replacement rate and projected net migration flows will not suffice to offset the shrinking and ageing population trend (European Union, 2021). Europe is facing, among other changes, a demographic change where ageing is likely to gain more and more relevance.

In an increasingly developed world, where the internet largely revolutionized the way people relate to each other, the issue of loneliness has gained more relevance in this group of the population (Cacioppo et al., 2016). To sum up, in developing countries, we have an increasingly aged but also increasingly lonely population.

The first lockdown in Europe arrived and brought economic, social and health challenges where loneliness and social isolation are included. Loneliness and social isolation in Europe are pre-covid topics, however, research shows that these themes have been exacerbated by the pandemic (European Union 2020). If loneliness and social isolation are so strongly correlated, it is expected that in a time where social isolation was imposed, serious consequences in loneliness levels arise. JRC Science for Policy Report (2021) sums up information about loneliness and social isolation in the European union and, based on survey data before and after the first lockdown, it concludes that the loneliness issue was intensified with the pandemic, stating that in EU in 2016 about 12% of respondents reported loneliness feelings more than half of the time and, after the first months of COVID-19, this proportion increased to about 25%.

Groarke et al. (2020) also study loneliness in the context of COVID-19 and, considering online data collected in the UK, without comparing to previous numbers, conclude that loneliness rates

are high. In a different perspective, Pai and Vella (2021) analyse data from twenty-four studies to understand loneliness during COVID-19 and conclude that, although this was a relevant topic in this period, there were some inconsistencies across the studies, since the increase was not observed in some of the twenty-four studies that were undertaken.

Apart from the last cited paper, the studies suggest that the first wave of the pandemic may have had some impact on loneliness, referring to the research question of this study on the impact of loneliness in this period, on the health of older adults. To better understand this issue, we need to define what loneliness is and what distinguishes it from other concepts or pathologies.

2. LITERATURE REVIEW

The loneliness concept

The word “loneliness” is common and used by everyone, but do people really know its meaning to the point of knowing the consequences that this problem brings? Do people recognize in loneliness a public health issue, as it was, for example, COVID-19?

“Imagine a condition that makes a person irritable, depressed, and self-centred, and is associated with a 26% increase in the risk of premature mortality. Imagine too that in industrialised countries around a third of people are affected by this condition, with one person in 12 affected severely, and that these proportions are increasing (…) Such a condition exists - loneliness” (Cacioppo & Cacioppo, 2019). Mother Teresa, some years before, described it as “the most terrible poverty” (Ansello, 2011).

Over the years, the concept of "loneliness" has gained relevance from a social, economic, medical, and ethical point of view. Its definition, since it is relevant to several areas and it is a topic of increased importance, has been enriched over the years. Loneliness is defined by a perceived lack of control over the quantity and the quality of one’s social activity (Luhmann and Hawkley 2016). In other words, as the difference between one’s desired number of contacts and measurable emotional support, and the ones that are available in one’s own environment

(Perlman and Peplau 1981). Wheeler, Reis, & Nezlek (1983) reinforced the debate of loneliness with the role of quality in one´s relations. Loneliness overlaps quality to quantity and therefore calls for a subjective measure. It varies from person to person, from circumstance to circumstance. A child and an adult can feel both alone for different reasons. Or, looking at an opposite situation, it may happen that two people in very similar circumstances have different approaches to perceived social isolation.

Given the complexity of this concept, various approaches from different areas such as economics, medicine psychology or sociology are necessary to understand what loneliness is, in order to find solutions and interventions that eliminate or reduce its impact on people's lives.

Loneliness associations

Throughout the years, loneliness has appeared linked with other concepts: depression, social isolation, social desertion, mental health, chronic disease, premature mortality, cognitive performance, among others. The association between these concepts is fundamental to study the correlations but must be rigorous so that the concepts are not mixed. Literature analyse these correlations and studies have pointed to concrete associations between loneliness and social isolation, depression, chronic conditions, wealth, social participation, and health.

Loneliness and Social Isolation: From of all these concepts, the one that appears most often associated with "loneliness" is "social isolation". However, it is essential to distinguish the two because, based on the literature, being alone is not the same as being lonely. A person can live alone without feeling lonely or live in a house full of people but reports constants loneliness feelings. Research shows that both usually move in the same direction and are very frequent in older adults (Hwang et al., 2020).

Loneliness and Depression: Lee et al. (2021) investigate the relation between loneliness and depression in a sample of people aged 50 and over and conclude a point increase on the

loneliness scale is associated with an increase of 16% of depressive symptoms and that these symptoms increase in people with higher levels of loneliness, suggesting that loneliness may be a cause for depression.

Loneliness and Chronic Conditions: Loneliness has been associated to different chronic diseases. Petitte et al. (2015) present a systematic review of quantitative studies that studied these associations considering conditions like heart disease, hypertension, stroke, lung disease, and metabolic disorders; by measuring loneliness in people who reported chronic illness. They conclude that in adults who suffer from these diseases, loneliness is a significant biopsychosocial stressor and provided inputs to public health policies, arguing that health care system would take advantage of the reduction of loneliness, considering the negative impact of loneliness in health.

Loneliness, Wealth and Social Participation: Niedzwiedz at. al. (2016) examines the relationship between wealth, social participation (considering separately the type of social participation), and loneliness in older adults as well as if social participation influences the association between wealth and loneliness. Results show that the odds of loneliness decrease in the case of the wealthiest groups and in the case of the most socially active groups. Results also show that social participation can moderate the relationship between wealth and loneliness, contributing to fight the socioeconomic discrepancy.

Loneliness and Health: Considering the WHO definition, “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”. This definition analyses entirely the health topic, incorporating for example mental health, where being healthy or not is more than being sick or not. Yanguas et al. (2018), to study the link between loneliness and health, assume that health is determined by intrinsic and extrinsic factors, where loneliness is included through social vulnerability, being also associated with unfavourable health outcomes.

Cacioppo et al. (2015) and Masi et al. (2015) conclude that there is evidence that mental and physical health can be negatively influenced by loneliness, being this fact the reason why the focus is on a meta-analysis of interventions to reduce loneliness. One year later, McDaid, Park & Fernandez (2016) looked at loneliness in terms of costs to the individuals who feel lonely, their families and the society. Considering people aged over 65, they estimated costs of loneliness to health and social care services to calculate the cost effectiveness of interventions that try to reduce loneliness. Even though analysing possible interventions would be an extension of our study, it is our understanding that this paper is still relevant for this study because it shows that economics plays an important role in the process of moving from theory to practice, of presenting possible interventions to deal with this social problem. By balancing costs and benefits, a viable solution can be found. In addition to this, it demonstrates the relevance of our topic.

Research shows that loneliness influences health in different ways and that sometimes can be the cause of other pathologies, other times may be just a symptom of something worse. In any case, high levels of loneliness are associated with poor health, suggesting an in-depth study of this topic, but always associated with many other topics, among which, the ones here described.

Evaluating loneliness

Assuming that loneliness is relevant enough to develop several investigations, one may ask if and how it is possible to measure, being, as the concept implies, so subjective. This subjectivity involves a self-report that can be more or less direct. In this sense, over the years, researchers have opted for different measures to evaluate loneliness.

Rosen & Rosen (1982) and Ollonqvist et al. (2008) measure loneliness through a direct question to the participants about whether they feel lonely. In a more indirect way, where participants are asked about several questions that together indicate one´s loneliness level, De Jong Gierveld

loneliness questionnaire and UCLA Loneliness Scale are relevant. Seepersad (2005) and Shapira, Barak & Gal (2007) measure loneliness with the 20 item UCLA Loneliness Scale. Researchers have also adapted this scale by selecting less than the 20 items and it was proved to be significant too. Fokkema & van Tilburg (2007) and Martina & Stevens (2006) use the 11 item of De Jong Gierveld loneliness questionnaire.

3. DATA

Data base

This study analyses individual responses of European older adults, considering 24 European countries and Israel. Through these individual responses, we will be able to construct a health production function and understand, on one hand, how it is influenced by explanatory variables, and on the other hand, whether this influence varied with the first lockdown of the COVID-19. In order to evaluate the impact of the pandemic on health, through mental health, we use two main surveys: one conducted before the first lockdown in Europe, and another conducted after. The SHARE (Survey of Health, Aging, and Retirement in Europe) wave 8 survey (the first) was conducted between October 2019 and March 2020 and the SHARE special corona survey (the second) between June and September 2020.[3] The SHARE special corona survey is an adaption of the SHARE wave 8 survey, where the covered topics (health and health behaviour, mental health, infections and healthcare, changes in work and economic situation, social networks) are targeted to the pandemic situation. Besides these two surveys, we used a dataset also provided by SHARE, the SHARE wave 7 survey, to input a variable regarding to education. All datasets were merged.

[3] SHARE is a social science panel database that collects individual data from people aged 50 or older from 28 European countries and Israel with the objective of evaluating policies regarding to health, society, economics, environment.

When it comes to mental health, age plays an important role. When it comes to covid-19, age plays a role too. Then, SHARE data seems to be the ideal to answer our research question.

Loneliness Indicator

To measure loneliness, we considered initially known and commonly used scales such as UCLA Loneliness Scale and De Jong Gierveld Scale, but the available data was not sufficient to build indicators based on these scales. With SHARE wave 8 survey it was possible to construct a variable that is a short form of the Revised UCLA Loneliness Scale (UCLA-R): the UCLA 3 item loneliness scale. To generate this variable, respondents were asked 3 indirect questions. Research has shown that this scale, constructed to large population surveys, comparable to national studies, widely used to measure loneliness, has a good internal consistency and is a valid and reliable measure (Hughes et al., 2004), (Trucharte et al.,2021). Since these questions were not asked in the SHARE corona special survey, we compared the answers of UCLA-3 item loneliness scale with the answers to the self-assessed loneliness question "How much time do you feel lonely?" that was available in both surveys. These variables are measured differently. UCLA-3 item loneliness scale ranks into a scale between 3 to 9, where 3 means "Not lonely" and 9 "Very lonely". Self-assessed loneliness ranks into a scale from 1 to 3 where 1 means "Hardly or never" and 3 "Often". Therefore, some approximations had to be made to compare the responses to the two variables.[4]

[4] Both variables were transformed into categorical variables and compared reducing UCLA-3 item loneliness scale levels to the 3 levels of self-assessed loneliness assuming that: levels 3 and 4 correspond to "Hardly or never" (level 1), levels 5 and 6 correspond to "Some of the time" (level 2) and levels 7, 8 and 9 correspond to "Often" (level 3).

With the variables evaluated equally and categorically, a chi-squared association analysis was conducted and is illustrated in Table I. Considering the total values per category in each variable, we can observe close values, which alerts to a similarity between the variables. Pearson chi-square statistic is 83262.78 and the p-value = 0.000, Person chi squared test indicates that there is a statistically significant relationship between the variable that measures loneliness according to UCLA-3 item loneliness scale and the variable that measures loneliness according to the direct auto perception of loneliness. Therefore, the self-assessed loneliness is a reliable and appropriate indicator to measure loneliness and it can take part in the answer to the research question that aims to calculate the loneliness cost in older adults' health and the variation in health after the outbreak.

Table 1: *Person chi squared test between 2 loneliness measures*

	UCLA 3 item Loneliness scale			
Self-assessed Loneliness	Hardly or never	Some of the time	Often	Total
Hardly or never	96232	8732	687	105651
Some of the time	11917	13934	2655	28506
Often	735	3266	5624	9625
Total	108884	25932	8966	143782
Pearson Chi2 = 83262.78 Prob = 0.0000				

[5]

4. METHODOLOGY & RESULTS

Covariates

Recalling WHO´s health definition, demographic, socioeconomic, physical, and mental health covariates were included to explain the health production function. Previous research has shown the correlations of the covariates with the dependent variable that measures individual self-assessed health. Table 2 presents the variables employed in the regressions.

[5] Source: SHARE wave 8 survey.

Age and Health: as it was mentioned in the introduction of this study, it is known that people are now living longer. WHO confirms that this fact increases the probability of disease and disability affecting health through conditions like hearing loss, cataracts and refractive errors, physical pain, chronic and pulmonary disease, diabetes, and mental health diseases like depression and dementia. Being this variable central in the framing and motivation of this study, we will analyze whether the relationship between these two variables may not be linear, since our sample is composed of people aged from fifty to slightly more than one hundred; with the hypothesis that the impact of age on health increases over time, creating a depreciation rate. This point will be concretized in a quadratic relationship.

Education, **Income and Health:** Both income and education are socioeconomic indicators and can be strongly correlated with each other: an individual with more education is more likely to achieve a better job and then have a better salary that can open several possibilities in terms of health. Research supports the idea that, comparing with those who have less opportunities, people with a higher education attainment live healthier (Zajacova & Lawrence, 2018), as well as those with a higher income (Zhang1 & Xiang, 2019).

Gender and Health: Gili et al. (2016) study gender differences in mental health during the economic crises and conclude that mental disorders in that period were more accentuated in males. Dagher et al. (2016) analyse the same topic also in the context of the recession and conclude that females reported higher levels of anxiety in the post-recession period, illustrating that literature comes to different conclusions and that there is no consensus in this topic.

Table 2 – *List of covariates employed in the regressions*

Variable	**Description**
Health	Ranged in a scale from 1 to 5 where 1 = "Poor health" and 5 = "Excellent health"
Variation in Health	= 1 = "Worsened", 2 = "About the same" 3 = "Improved"
Age	Measured in decades
Gender	= 1 if the respondent is female, = 0 if the respondent is male
Education	Measured in years
Income	Log of income variable
Long Term Illness	= 0 if the respondent does not have, = 1 if the respondent has
Cancer	= 0 if the respondent does not have, = 1 if the respondent has
Chronic Lung	= 0 if the respondent does not have, = 1 if the respondent has
Exchange Rate	Exchange Rate at the end of the year
Loneliness	Ranged in a scale from 1 to 3 where 1 = "Hardly or never" and 3 = "Often"
Variation in Loneliness	= 1 = "Worsened", 2 = "About the same" 3 = "Improved"
Country	Each country corresponds to a code

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Estimation strategy

An Ordered Probit Model was used to estimate a health production function.[7] The outcome of interest that measures self-perceived health, H, ranked from one to five (where 1 = Poor Health and 5 = Excellent Health).

$$H_{it} = X_{it}\beta + \mu_{it} \quad (1)$$

Where X is a matrix of individual characteristics, β is a parameter vector, μ is an error term, i denotes individuals and t time. To focus on the role of loneliness and income, we can write:

$$H_{it} = \beta_1 L_{it} + \beta_2 I_{it} + \Sigma_j \beta_j X_{jit} + \mu_{it} \quad (2)$$

[6] Source of data: SHARE wave 7 survey, SHARE wave 8 survey, SHARE special corona survey.
[7] See Wooldridge, "Econometric Analysis of Cross Section and Panel Data", pages 561-573.

Where L denotes the loneliness variable, I denotes the income variable and Xi are other covariates; βj denotes correspondent parameters to be estimated. If income enters in logarithmic form, the equivalent income change to a loneliness variation is given by:

$$dI = - (\beta_2 / \beta_1)\, dL \quad (3)$$

The maximum social value equivalent to a hypothetical intervention targeting the full population that fully solved the problem of loneliness can be calculated in the following way:

$$SV = - (\beta_2 / \beta_1) \times \bar{I} \times \alpha \times N \quad (4)$$

The benefit is measured by the monetary equivalent of the average citizen times the expected number of people benefiting from such (hypothetical) intervention, where SV is the maximum social value, β_1 the loneliness coefficient, $\bar{I}$ is the average income, α is the percentage of people in the group that reported the highest loneliness, and N the total number of people.

In equation (5) below, To address the change in self-assessed health in the first months of the COVID-19 pandemic, we define ΔH as the variation in the self-perceived health reported after the first wave, where 1 = "Worsened", 2 = "About the same" 3 = "Improved". Matrix X contains covariates that influence the variation in the level of health where loneliness felt after the first wave of the pandemic and the variation in loneliness reported after this wave are highlighted.

$$\Delta H_i = \beta_1 L_i + \beta_2 I_i + \beta_3 \Delta L_i + \Sigma_j \beta_j X_{ji} + \mu_i \quad (5)$$

Summary Statistics

Considering our sample of European people aged 50 and over, based in data the selected surveys, we considered variables for which the information was complete. Besides missing data, some of the data was only available in one of the surveys, which causes an inconstant number of observations per variable. The summary statistic presented in table 3 can be confronted with the variables description available in the previous section. In Europe, until

Covid-19 outbreak, people aged on aging on average 75 years old, reported a good level of health (4 = "good health"). The sample is fairly balanced in terms of gender (56.4% female vs 43.6% male). In terms of education, our sample is composed by developed countries and this can be confirmed by the mean of years of schooling: 11. A variable that also caught our attention is the "Long term illness", more than half the people who participated in these surveys suffer from a chronic health condition

Table 3 – *Summary statistics*

	N	Mean	Max	Min
Health	367374	4.111	5	1
Variation in Health	165322	1.937	3	1
Income (log)	88838	6.599	13.135	-11.723
Loneliness	144345	1.333	3	1
Loneliness (after)	164375	1.365	3	1
Gender	365806	.564	1	0
Cancer	147476	.054	1	0
Chronic Lung	147476	.068	1	0
Long Term Illness	147492	.567	1	0
Age (decades)	364813	7.462	11.4	5
Age^2	364813	5679.158	12996	2500
Exchange Rate	178540	7.898	351.25	1

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Country level scores vs. overall score

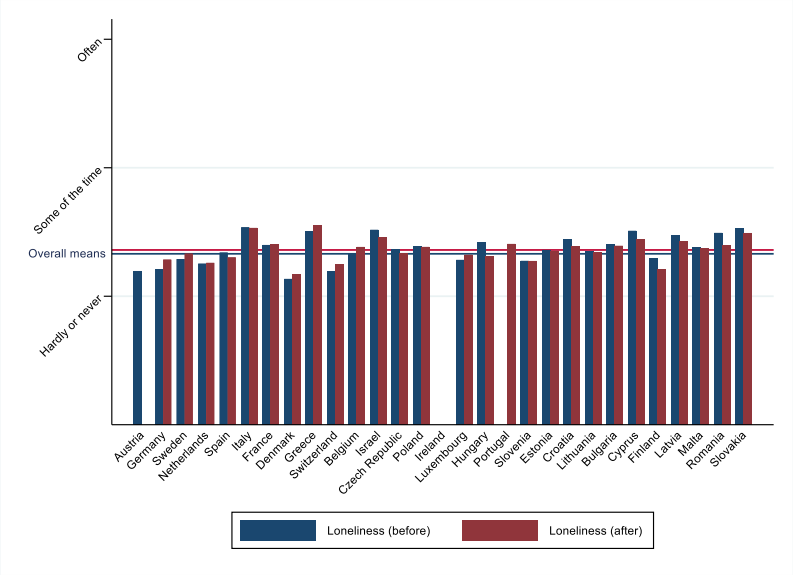
Being loneliness one of our main variables of interest, we started to make a point of situation in terms of loneliness across Europe, before and after the first lockdown.

Based on the surveys, we can compare country level scores with overall scores. Graphic 1 compares each country mean level of loneliness with the overall level, before and after the first lockdown. The first conclusion we can draw is that in terms of loneliness there is some

[8] Source of data: SHARE wave 7 survey, SHARE wave 8 survey, SHARE special corona survey.

dispersion in our sample, some reported an increase in loneliness while others reported a decrease, this may be associated to cultural differences, specific pandemic control policies, or even to sample bias. Denmark is the country where people reported less loneliness in the two periods. The country that presented the highest level of loneliness before the first wave was Italy, followed by Slovakia; while after that wave it was Greece (reaching the highest level registered), followed by Italy. Italy is one of the countries with more participants in these surveys, which makes these results even more relevant, being an interesting input for policy and future interventions.

***Graph 1**: Distribution of loneliness mean indicator*[9]



Besides comparing country level scores with the overall score for each period, general European differences between the two periods can also be compared in graphic 1. We find relevant statistical evidence of an increase in the level of loneliness across Europe, from the period before the first lockdown to the period after.[10] Europe´s context in this period, as suggested in the introduction, was propitious to these results. For this reason, loneliness, is a factor, among others, that may explain variations in the health production function.

[9] Source of data: SHARE wave 8 suveys, SHARE special corona survey.
[10] Since there are 25 countries, a two-sample t test with unequal variances considering the mean of the overall score of loneliness for each period was performed**.**

Health production function

In this section, we will answer the first research question, implementing the methodology described above and analysing the coefficients of the health production function estimated by an Ordered Probit Model.[11] From this function we will be able to calculate the loneliness cost in older adults´ health and a social value equivalent to an intervention that would eliminate loneliness. At this point, we are only using data collected before COVID-19 first wave, so that we can construct a model that is not biased by the pandemic and check whether "loneliness pandemic" was or not already an issue in Europe.

In table 4, we can access the impact of each variable, followed by its significance level. Significance column suggests good insights in explaining this function with these covariates, but in this section, we will look up to combine statistical significance with economic intuition. In this regression, country fixed effects are controlled, and coefficients are the same throughout countries. Based on the coefficients signs and relevance, the results presented, in general, go in line with the literature discussed.

(i) *Income and education*: **positive** and **significant** impact on self-accessed health. As expected, both move in the same direction. In terms of Income, we find a significant and positive effect in the perception of a better health, meaning that an increase in income leads to an increase on the health level. Although money cannot buy everything, in terms of health, money can support medical expenses, investment in healthy habits, access to more and better professionals. Education not only moves in the same direction but with the same statistical significance. From education comes the knowledge that is necessary in the health sector, particularly in mental health topics such as "Loneliness" where studies of the problem itself and possible solutions and interventions are available.

[11] The results, estimated by the Ordered Probit Model, were confronted with an Ordered Logit Model, and the conclusion was that the achievement of each variable in individual health is the same, all coefficients move in the same direction in both models (table 1 of the Appendix).

(ii) *Gender:* **positive** but **not significant** impact on self-accessed health. It goes in line with the lack of consensus of gender role in the measurement of health. This result is not surprising, especially nowadays, where the role of man and woman is little differentiated in developed countries.

(iii) *Physical diseases:* **negative** and **significant** impact on self-accessed health. Represented by three dummies: long term illness, cancer, and chronic lung. Having a long-term illness has an impact that equals almost twice as much of having cancer as having a chronic lung. If we could compare two people, completely identical, but with the difference that one of them suffers from one of these pathologies, we would easily attribute a lower level of health to this person. It is very intuitive that physical diseases deteriorate self-perceived health.

(iv) Age^2: **negative** and **significant** impact on self-accessed health. We started in a model where age squared was not included and the age impact on health was negative and significant.[12] After introducing age squared to study the hypothesis of a deterioration rate in health as people get older, we observed that now age has a positive impact on health, nonetheless, this impact mitigates with time and turns out to be negative. Probably, in the previous regression, the variable "age" was capturing this effect too, and that explains why the coefficient that was negative is positive now. Human life expectancy has increased significantly, especially in developed countries like those that make up our sample. In this context, a person aged 50/60/70 is not considered an old person, and since our sample includes people of these ages, the variable that seems most appropriate to measure the impact of age on health is the "age squared" that confirms the depreciation on health as people get older.

(v) *Loneliness***: negative** and **significant** impact on self-accessed health. Results, presented in table 4, show that the impact differs across loneliness levels. When we compare someone who goes from not feeling alone ("Hardly or never") to starting to feel lonely in some circumstances

[12] See table 2 of the Appendix

("Some of the time") with someone who goes from not feeling alone ("Hardly or never") to feeling lonely most of the time ("Often"), we realize that the negative impact more than doubled. If we compare, for example, the impact of loneliness in the more extreme case ("Often") with the impact of cancer or with a chronic lung, we can observe that the impact is very similar. Loneliness is not a clinical issue like the other two pathologies; however, it does not cease to have a relevantly negative impact like the other two, deserving, therefore, attention and prevention. In that sense, an extension to this analysis was performed.

Table 4: *Health production function*

Health	Coef.	p-val.	Sig
Income(log)	.217	0	***
Loneliness(before):			
- Some of the Time	-.241	0	***
- Often	-.599	0	***
Gender	.006	.524	
Age	.062	.399	
Age2	-.017	0	***
Cancer	-.514	0	***
Chronic Lung	-.536	0	***
Long Term Illness	-.98	0	***
Education	.032	0	***

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In table 5, we find the **cost of loneliness in older adults´ health**, specified for each country. Besides the differences in the self-perceived loneliness by country, analyzed above, the differences in income, considering the exchange rates, play a role too. Following the methodology presented and after interpreting the negative impact of loneliness on health with table 4, we can compute two types of loneliness costs in terms of income if health level remains constant. In other words, to keep the same individual health level, what is the overall monthly income adjustment needed to compensate changes in answering the question "How much time do you feel lonely? Often, some of the time, or hardly never?". Both costs are combined in table

[13] Source of data: SHARE wave 7 and 8 Surveys. *p<0.05, **p<0.01, p<***0.001. N = 58,582. A complete version of the table where country coefficients are included is provided in table 3 of the Appendix

5: the first cost, presented in column “Mean (1-2)”, refers to the situation of moving from the lowest level of loneliness (“Hardly or never”) to the intermediate level (“Some of the time”); the second, illustrated in column “Mean (1-3)”, starts in the level where people move from the lowest level (“Hardly or never”) to the highest level reported (“Often”).

Switzerland and Luxembourg are the countries that present the highest costs: in the first column -5353 and -5351 and in the second column -13,304 and -13,301; respectively, exceeding the European average by more than triple in both cases. Germany, Finland, France, and Netherlands present high costs too. These set of countries are among those with a higher cost of living in Europe, and therefore people should earn more money on average, which means that in these countries an increase in income in absolute terms has less weight than the same increase in the poorest countries. However, there are exceptions like Sweden or Denmark, that are considered rich countries in Europe and present a low cost of loneliness in older adults´ health. This can be explained by the fact that income of participants who responded to these surveys do not diverge much from the income of participants in other countries.

Croatia and Romania are the countries that present the lowest costs: -103 and-107, -256 and -265, respectively. Although these countries have reported above-average loneliness levels before and after the first lockdown, they are in the group of European countries with the lowest net average monthly salary, which can help to understand the low costs described.[14]

[14] Detailed information of net average monthly salary in: List of European countries by average wage – Wikipedia https://en.wikipedia.org/wiki/List_of_European_countries_by_average_wage

Table 5: *Cost of loneliness in older adults´ health*

Country €/month	Mean (1-2)	Mean (1-3)	N
Belgium	-2771	-6887	10375
Bulgaria	-215	-534	562
Croatia	-103	-256	2105
Cyprus	-1451	-3607	355
Denmark	-537	-1335	5063
Estonia	-1008	-2504	10082
Finland	-3170	-7878	802
France	-2950	-7332	5639
Germany	-3327	-8268	5913
Greece	-1065	-2647	5586
Israel	-670	-1665	2025
Italy	-1876	-4663	7577
Latvia	-823	-2046	601
Lithuania	-780	-1939	859
Luxemb.	-5351	-13301	790
Malta	-1203	-2990	441
Nether.	-2831	-7037	1175
Poland	-545	-1355	3161
Romania	-107	-265	968
Slovakia	-1083	-2692	543
Slovenia	-1283	-3190	5086
Spain	-1472	-3658	3757
Sweden	-284	-705	3753
Switz.	-5353	-13304	3994

Besides the costs per country, an additional overall mean for European countries was computed separately. This mean was computed assigning the same weight to each individual health production function.Without changing individual level of health, on average, if European older adults changed their loneliness report from “Hardly or never” to “Some of the time”, we would have to compensate this change with an increase in the overall monthly income of 1,695 euros; but if the change was from “Hardly or never” to “Often”, this value would increase to 4,213 euros. This means that loneliness has a cost equivalent to the increase in the expected overall

monthly income and that the cost is significantly higher in the second scenario. This conclusion is also true for the analysis at the country level.

This cost analysis can also be done considering the hypothetical case of Portugal. Even though Portugal did not participate in the SHARE wave 8 survey, assuming the estimated coefficient to be valid also for Portugal and considering the income levels of the Portuguese participants of the SHARE Special Corona Survey, we made a simulation of a plausible cost of loneliness in the health of Portuguese older adults in the pre-pandemic period. In table 6, it is estimated this approximation for Portugal. In the two possible loneliness level changes reported, from "Hardly or never" to "Some of the time" and from "Hardly or never" to "Often", Portuguese income equivalent of loneliness is slightly below the European costs´ mean: in the first case 327 euros below and in the second is 814 euros.

Table 6: *Portugal simulation cost*

Country €/month	Mean (1-2)	Mean (1-3)	N
Portugal	-1368	-3399	1500

Maximum social value of a loneliness intervention

To calculate this value at a country level, given the income disparities, we considered Italy case. The average income reported in Italy was 1689 euros/month. 8,345% of the Italian population who participated in these surveys reported the highest level of loneliness. If we plan to do an intervention that involves randomly one hundred adults, not knowing each one´s loneliness level, 8.345 adults will have a benefit of 1,012 euros per person and 8,443 in total. This corresponds to the maximum social value of an intervention that would eliminate extreme loneliness case, selecting randomly one hundred people in Italy. It is also the value by which people in extreme loneliness should be compensated, given their loss of health through increased loneliness. No studies that exactly matched this case were found, which may be a

future investigation.

COVID-19 impact on loneliness and health

In this section, to answer to the second research question, we analyse loneliness effects in self-assessed health caused by the first wave of COVID-19. Different estimations were designed to study different impacts of loneliness considering loneliness reported before the pandemic, loneliness reported after the first outbreak and the variation of loneliness in this period, measured independently of the two other variables.

In this analysis the dependent variable is the variation in the self-assessed health, that can take three levels: 1 if the health of the participant worsened, 2 if it remained the same and 3 if it improved. In most cases, there were no changes in self-assessed health, but the percentage of people whose health has worsened is more than three times that of people whose health has improved.[15] In the latter case, where health has improved, the reason for this improvement will hardly be explained by the pandemic.

Besides the variation in health, participants were also asked about the variation in the level of loneliness felt. The variation in loneliness is conditioned to the loneliness reported before, if one already had a high level of loneliness ("Often"), there is little room to increase, while if that level was close to zero (“Hardly or never") the little margin, in this case, is to decrease. However, a person who reported before the “Often” level before the pandemic, may consider that although he/she had already reported this level, after the pandemic this feeling increased. Table 7 shows that there were 2,435 people in this situation. Thus, in this table we have access to these comparisons, and we can study the impact of COVID-19 on reported loneliness. Although before the pandemic the level of loneliness with more people being the "Hardly or never", the following level "Some of the time" is almost equally represented. There was a substantial number of people reporting an increase in the level of loneliness and a very small

[15] See Graphic 1 in Appendix

number reporting a decrease, composed, in the majority of those who already reported a level almost equal to zero.

Table 7: *COVID-19 impact on loneliness*

	Variation in Loneliness			
Loneliness (before)	Worsened	No	Improved	Total
Hardly or never	465	6,697	6,007	13,169
Some of the time	320	6,877	5,344	12,541
Often	114	3,137	2,435	5,686
Total	899	16,711	13,786	31,396

16

In table 8 we can observe the different regressions estimated to measure the variation in health.

(i)*Income*: **positive** and **significant** impact on the variation of health, across the different models. Those with higher income suffered a smaller variance in this period. During this first lockdown, resources were scarce and basic elements of individual protection such as masks or disinfectant were priced much higher than what we found today.

(ii) *Education*: **not significant** in any model**.** In terms of education the situation was more equitable, having years of education does not help to explain the variation in health.

(iii) *Long term Illness*: **negative** and **significant** impact on the variation of health, across the different models. However, physical diseases in the explanation of these variation do not have all the same impact although in this case, having cancer was not relevant. One possible explanation is that these people were already in a health situation with little room to worsen.

(iv) *Age^2:* **negative** and **significant** impact on the variation of health, across the different models. This means that there is a deterioration rate in the variation of health caused by aging.

[16] Source of data: SHARE wave 8 survey, SHARE special corona survey

Table 8: *Variation in health after COVID-19*

	A)	B)	C)	D)
Income (log)	.061***	.024**	.106***	.089***
	(.012)	(.012)	(.023)	(.024)
Loneliness (bef.):				
-Some of the time	-.112***		-.017	-.003
	(.016)		(.023)	(.023)
-Often	-.255***		-.065**	.008
	(.024)		(.029)	(.03)
Loneliness (aft.):				
-Some of the time		-.246***		
		(.015)		
-Often		-.571***		-.216***
		(.024)		(-.216)
Change in Loneliness:				
-No				
			-.019	.005
-Increased			(.072)	(.073)
			-.392***	-.328***
			(.073)	(.073)
Gender	-.005	-.571*	.057**	
	(.013)	(.013)	(.022)	
Age	.334***	-.571**	.558***	.557***
	(.097)	(.099)	(.157)	(.157)
Age squared	-.032***	-.024***	-.046***	-.045***
	(.007)	(.007)	(.01)	(.01)
Cancer	.015	.018	-.038	-.033
	(.031)	(.031)	(.046)	(.046)
Chronic lung	-.056*	-.049*	-.125***	-.116***
	(.029)	(.029)	(.041)	(.041)
Long term illness	-.212***	-.196***	-.248***	-.245***
	(-.212)		(.022)	(.022)
		(.013)		
Education	.001	0	-.003	-.004
	(.002)	(.002)	(.003)	(.003)
Country FE	YES	YES	YES	YES

[17]

[17] Source of data: SHARE wave 7 and 8 Surveys. *p<0.05, **p<0.01, p<***0.001.

A) only loneliness reported before COVID-19, B) only loneliness reported after COVID-19, C) loneliness reported before COVID-19 and variation in loneliness, D) loneliness reported before, variation in loneliness and loneliness reported after COVID-19.

(v) *Loneliness*: **negative** and **significant** impact on the variation of health but naturally different between models since for each model there is a different combination of loneliness variables. The variable that measures self-perceived loneliness after the first lockdown is very relevant to explain the variation in health, in the most extreme cases of loneliness, having a negative impact similar to having a long-term illness. However, those who reported that loneliness increased in this period suffered even more in terms of health. This result confirms the hypothesis that we raised at the beginning of the study, on the one hand about loneliness having a negative impact on health, on the other hand, on the COVID-19 intensifying this problem.

5. LIMITATIONS/FURTHER RESEARCH

COVID-19 has been the subject of many studies.[18] On the one hand there is a lot of information available, on the other hand, there is still much to be discovered while the pandemic is not over. Thus, it is a topic with a very high degree of uncertainty associated and must be open to further research as new data emerges.

Although the pandemic was a global issue, as the Oxford COVID-19 stringency index presented in the introduction shows, each country dealt with the issue with a different degree of severity. In our particular topic, loneliness, from the fact that is a subjective measure and people evaluate themselves, some reporting bias can present. Besides that, there is also a discrepancy between the studies of the problem of loneliness and those of its "solution" so it would be interesting, considering the high costs presented in this paper, to analyze possible interventions.

In addition, it is important to have in mind the distinction between long and short-term effects. From the first survey to the second, only a few months and a corona wave passed. This study is not intended to capture the long-term effects of the pandemic on health, but it would be interesting to further research the study of these.

[18] Some more direct such as epidemiological studies, others that investigate indirect effects of the virus in several areas: economics, psychology, education.

To finish, one more limitation relates to a possible sample bias. Unfortunately, it is possible that people who died from the first to the second questionnaire indicated severe levels of loneliness that were not captured and that may have had serious consequences.

6. CONCLUSION

The focus of this study is to analyze loneliness and its impact, particularly on health, before and after the first wave of the pandemic, considering the adult population of Europe. Evaluating the impact of loneliness on health embodies one of the theoretical definitions of loneliness that defines it as a "public health issue" and gives us tools for possible interventions, thus moving from theory to practice.

In the pre-first wave period, it can be concluded that the results obtained go in line with the literature. When it comes to individual perceived health, education and income play a protective role while age, physical diseases and loneliness have the opposite effect. The negative impact of extreme loneliness can be compared to having a disease like cancer. Loneliness presents a high-cost terms of income (mean = 4213 euros/month in the most extreme case). However, income and loneliness are not perfect substitutes, since "money does not make company".

In the post-first wave period of covid-19 in Europe, some of the indicators that had a protective role before, now no longer have. Loneliness, however, is not one of these cases since its effect was relevant in explaining negative changes in health in this period, especially in the cases where people reported an increase in loneliness level between the two periods.

Loneliness has a very significant impact in self-assessed health, whether in a period of crisis or in a "normal" period. Loneliness is gaining increasing relevance in developed countries where apparently everything is fine. This study is not intended to capture the long-term effects of the pandemic on health, but it would be interesting to further research the long-term effect of COVID-19 on loneliness. Being a public health issue, loneliness topic should draw everyone's attention like COVID-19 did.

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APPENDIX

Table 1: *Health Production Function: Ordered Logistic Regression (with country coefficients)*

Health	Coef.	St.Err.	t-value	p-value	Sig
Income	.406	.02	20.74	0	***
Loneliness					
Some of the time	-.42	.02	-21.19	0	***
Often	-1.066	.033	-32.51	0	***
Gender	.026	.017	1.51	.132	
Age	.116	.127	0.91	.362	
Age^e	-.032	.009	-3.67	0	***
Cancer	-.908	.038	-23.77	0	***
Chronic Llung	-.953	.036	-26.76	0	***
Long Term Illness	-1.697	.018	-94.98	0	***
Education	.056	.002	24.55	0	***
Country					
Sweden	1.931	.065	29.74	0	***
Netherlands	.517	.084	6.15	0	***
Spain	.174	.053	3.29	.001	***
Italy	-.218	.041	-5.32	0	***
France	.05	.039	1.27	.203	
Denmark	1.997	.059	34.09	0	***
Greece	.378	.043	8.79	0	***
Switzerland	.667	.043	15.42	0	***
Belgium	.371	.038	9.71	0	***
Israel	.256	.081	3.17	.002	***
Czech Republic	2.045	.091	22.39	0	***
Poland	.5	.075	6.70	0	***
Luxembourg	-.007	.085	-0.08	.939	
Hungary	2.621	.179	14.60	0	***
Slovenia	.328	.045	7.36	0	***
Estonia	-.75	.04	-18.82	0	***
Croatia	.885	.097	9.10	0	***
Lithuania	-.213	.072	-2.98	.003	***
Bulgaria	.883	.118	7.51	0	***
Cyprus	.343	.195	1.76	.078	*
Finland	.167	.083	2.01	.044	**
Latvia	-1.29	.096	-13.40	0	***
Malta	.184	.106	1.73	.084	*
Romania	.596	.106	5.62	0	***
Slovakia	.526	.094	5.61	0	***

Table 2: *Health Production Function: Ordered Probit Regression (without Age^2)*

Health	Coef.	St.Err.	t-value	p-value	Sig
Income	.216	.011	18.91	0	***
Loneliness	0	.	.	.	
Some of the time	-.243	.011	-21.40	0	***
Often	-.602	.019	-32.34	0	***
Gender	.005	.01	0.51	.61	
Age	-.193	.006	-33.27	0	***
Cancer	-.513	.022	-23.52	0	***
Chronic_lung	-.535	.02	-26.58	0	***
Long Term Illness	-.98	.01	-96.89	0	***
Education	.033	.001	25.20	0	***
Country FE	YES				

Table 3: *Health Production Function: Ordered Probit Regression (with country coefficients)*

Health	Coef.	St.Err.	t-value	p-value	Sig
Income	.217	.011	18.96	0	***
Loneliness					
Some of the time	-.241	.011	-21.22	0	***
Often	-.599	.019	-32.09	0	***
Gender	.006	.01	0.64	.524	
Age	.062	.073	0.84	.399	
Age^2	-.017	.005	-3.49	0	***
Cancer	-.514	.022	-23.58	0	***
Chronic Lung	-.536	.02	-26.62	0	***
Long Term Illness	-.98	.01	-96.94	0	***
Education	.032	.001	25.02	0	***
Country					
Sweden	1.072	.037	28.80	0	***
Netherlands	.309	.046	6.73	0	***
Spain	.097	.03	3.25	.001	***
Italy	-.111	.023	-4.77	0	***
France	.045	.022	2.01	.045	**
Denmark	1.086	.033	32.77	0	***
Greece	.205	.025	8.34	0	***
Switzerland	.391	.025	15.76	0	***
Belgium	.221	.022	10.06	0	***
Israel	.151	.046	3.31	.001	***
Czech Republic	1.102	.053	20.68	0	***
Poland	.251	.043	5.84	0	***
Luxembourg	-.009	.047	-0.19	.847	
Hungary	1.417	.102	13.83	0	***
Slovenia	.18	.026	7.04	0	***
Estonia	-.422	.023	-18.30	0	***
Croatia	.467	.055	8.53	0	***
Lithuania	-.119	.042	-2.84	.005	***
Bulgaria	.475	.066	7.19	0	***
Cyprus	.203	.105	1.94	.053	*
Finland	.125	.048	2.61	.009	***
Latvia	-.758	.055	-13.76	0	***
Malta	.13	.06	2.17	.03	**
Romania	.297	.061	4.90	0	***
Slovakia	.295	.053	5.56	0	***

Graph 1: *Variation In Health After The First Lockdown*