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# The evolution and social determinants of mental health during the first wave of the COVID-19 outbreak in Luxembourg

Fabiana Ribeiro<sup>a,\*</sup>, Valerie E. Schröder<sup>b,c</sup>, Rejko Krüger<sup>b,c,d</sup>, Anja K. Leist<sup>a</sup>, the CON-VINCE Consortium<sup>1</sup>

<sup>a</sup> University of Luxembourg, Department of Social Sciences, Esch-sur-Alzette, Luxembourg

<sup>b</sup> Translational Neuroscience, Luxembourg Centre for Systems Biomedicine, University of Luxembourg, Esch-Belval, Luxembourg

<sup>c</sup> Department of Neurology, Centre Hospitalier de Luxembourg, Luxembourg

<sup>d</sup> Transversal Translational Medicine, Luxembourg Institute of Health, Luxembourg

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## ABSTRACT

Studies have been showing a negative impact of pandemic control measures on mental health. However, few studies assessed these effects longitudinally during the peak of the first wave of the COVID-19 pandemic. The goals of this study were to explore whether differential effects of COVID-19 restrictions on mental health could be observed by sex and age in a Luxembourgish nationally representative sample during the initial outbreak of COVID-19. Furthermore, we aimed to assess whether there are differences in risk and protective factors longitudinally at two assessment times. A total of 1,756 respondents aged 18 years and older (50.74% women) reported sociodemographic and socio-economic characteristics, depression, anxiety, stress, and loneliness. Women and younger respondents reported higher rates of severe depression and anxiety symptoms, suggesting higher vulnerability to the pandemic control measures. This study contributes to the investigation of mental health

\* Corresponding author.

E-mail address: [fabiana.ribeiro@uni.lu](mailto:fabiana.ribeiro@uni.lu) (F. Ribeiro).

<sup>1</sup> Bruno Santos<sup>3</sup>, Bianca Dragomir<sup>3</sup>, Joëlle V. Fritz<sup>3</sup>, Claire Dording<sup>3</sup>, Marc P. O'Sullivan<sup>3</sup>, Anne-Marie Hanff<sup>3</sup>, Maxime Hansen<sup>3,2</sup>, Markus Ollert<sup>5</sup>, Morgane Lemaire<sup>5</sup>, Nadia Beaupain<sup>5</sup>, Dirk Brenner<sup>5</sup>, Eleftheria Charalambous<sup>5</sup>, Emilie Charpentier<sup>5</sup>, Manuel Counson<sup>5</sup>, Olivia Domingues<sup>5</sup>, Lisa Hefeles<sup>5</sup>, Gilles Iserentant<sup>5</sup>, Stéphanie Kler<sup>5</sup>, Mareike Neumann<sup>5</sup>, Jean-Yves Servais<sup>5</sup>, Chantal Snoeck<sup>5</sup>, Jonathan Turner<sup>5</sup>, Linda Hansen<sup>2</sup>, João M. Loureiro<sup>2</sup>, Béatrice Nicolai<sup>2</sup>, Alexandra Schweicher<sup>2</sup>, Femke Wauters<sup>2</sup>, Claire Pauly<sup>1,2</sup>, Lukas Pavelka<sup>1,2</sup>, Guilherme R. Meyers<sup>2</sup>, Amna Skrozić<sup>1,2</sup>, Lara Stute<sup>1,2</sup>, Pinar Alper<sup>1</sup>, Piotr Gawron<sup>1</sup>, Soumyabrata Ghosh<sup>1</sup>, Jacek J. Lebidoda<sup>1</sup>, Laurent Heirendt<sup>1</sup>, Enrico Glaab<sup>1</sup>, Armin Rauschenberger<sup>1</sup>, Clarissa Gomesv, Tainà Marques<sup>1</sup>, Borja Gomez Ramos<sup>1</sup>, Valentin Groues<sup>1</sup>, Wei Gu<sup>1</sup>, Ahmed Hemedan<sup>1</sup>, Sascha Herzinger<sup>1</sup>, Anne Kaysen<sup>1</sup>, François Massart<sup>1</sup>, Patrick May<sup>1</sup>, Venkata P. Satapogam<sup>1</sup>, Laure Pauly<sup>1</sup>, Basile Rommes<sup>1</sup>, Kirsten Rump<sup>1</sup>, Reinhard Schneider<sup>1</sup>, Noua Toukourou<sup>1</sup>, Christophe Trefois<sup>1</sup>, Carlos V. Morena<sup>1</sup>, Maharshi Vyas<sup>1</sup>, Xinhui Wang<sup>1</sup>, Andrew Lumley<sup>6</sup>, Sophie Meriaux<sup>6</sup>, Laetitia Huiart<sup>6</sup>, Gloria Aguayo<sup>6</sup>, Christelle Bahlawane<sup>6</sup>, Magali Perquin<sup>6</sup>, Manon Gantenbein<sup>7</sup>, Maura Minelli<sup>7</sup>, Tania Zamboni<sup>7</sup>, Jean-Yves Ferrand<sup>7</sup>, Sandie Boly<sup>7</sup>, Tessy Fautsch<sup>7</sup>, Jérôme Graas<sup>7</sup>, Eve Herkenne<sup>7</sup>, Alessandra Mousel<sup>7</sup>, Daniela Valoura Esteves<sup>7</sup>, Jean-Marc Plessier<sup>6</sup>, Aurélie Sausy<sup>6</sup>, Sneha Seal<sup>6</sup>, Michel Vaillant<sup>8</sup>, Charlene Verschuere<sup>6</sup>, Hermann Thien<sup>9</sup>, Geeta Acharya<sup>9</sup>, Wim Ammerlaan<sup>9</sup>, Ariane Assese-Kama<sup>9</sup>, Katy Beaumont<sup>9</sup>, Lucrèce Beckers<sup>9</sup>, Camille Bellora<sup>9</sup>, Fay Betsou<sup>9</sup>, Brian de Witt<sup>9</sup>, Ana Festas Lopes<sup>9</sup>, Laura Georges<sup>9</sup>, Gael Hamot<sup>9</sup>, Estelle Henry<sup>3</sup>, Margaux Henry<sup>9</sup>, Alexander Hundt<sup>9</sup>, Pauline Lambert<sup>9</sup>, Sabine Lehmann<sup>9</sup>, Monica Marchese<sup>9</sup>, Maeva Munsch<sup>9</sup>, Achilleas Pexaras<sup>9</sup>, Lucie Remark<sup>9</sup>, Estelle Sandt<sup>9</sup>, Margaux Schmitt<sup>9</sup>, Florian Simon<sup>9</sup>, Kate Sokolowska<sup>9</sup>, Johanna Trouet<sup>9</sup>, Henry-Michel Cauchie<sup>10</sup>, Leslie Ogorzaly<sup>10</sup>, Christian Penny<sup>10</sup>, Cécile Walczak<sup>10</sup>, Delphine Collart<sup>10</sup>, Tamir Abdelrahman<sup>11</sup>, Estelle Coibion<sup>11</sup>, Marie France Pirard<sup>11</sup>, Friedrich Mühlischlegel<sup>11</sup>, Nguyen Trung<sup>11</sup>, Guillaume Fournier<sup>11</sup>, Marie Leick<sup>11</sup>, Annika Lutz<sup>12</sup>, Claus Vögele<sup>12</sup>, Judith Hübschen<sup>13</sup>, Christiane Hilger<sup>13</sup>, Philipp Jägi<sup>14</sup>. <sup>1</sup>Luxembourg Centre for Systems Biomedicine, University of Luxembourg, Esch-Belval, Luxembourg; <sup>2</sup>Department of Neurology Parkinson Research Clinic, Centre Hospitalier de Luxembourg, Luxembourg, Luxembourg; <sup>3</sup>Transversal Translational Medicine, Luxembourg Institute of Health, Luxembourg, Luxembourg; <sup>4</sup>University of Luxembourg, Department of Social Sciences - Institute for Research on Socio-Economic Inequality, Esch-sur-Alzette, Luxembourg; <sup>5</sup>Department of Infection and Immunity, Luxembourg Institute of Health, Luxembourg, Luxembourg; <sup>6</sup>Population Health Department Luxembourg Institute of Health, Luxembourg, Luxembourg; <sup>7</sup>Clinical and Epidemiological Investigation Center Luxembourg Institute of Health, Luxembourg, Luxembourg; <sup>8</sup>Competence Center for Methodology and Statistics, Luxembourg Institute of Health, Luxembourg, Luxembourg; <sup>9</sup>Luxembourg Institute of Health/Integrated Biobank of Luxembourg, Dudelange, Luxembourg; <sup>10</sup>Department of Environmental Research and Innovation (ERIN), Luxembourg Institute of Science and Technology (LIST), Belvaux, Luxembourg; <sup>11</sup>Department of Microbiology, Laboratoire national de santé, Dudelange, Luxembourg; <sup>12</sup>Faculty of Humanities, Education and Social Sciences, University of Luxembourg, Esch-Belval, Luxembourg; <sup>13</sup>Department of Infection and Immunity, Luxembourg Institute of Health, Esch-sur-Alzette, Luxembourg; <sup>14</sup>Laboratoires Réunis, Luxembourg.

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consequences of the pandemic and the pandemic control measures, particularly related to shifts in care task responsibilities, gender and socio-economic inequalities, as well as younger groups' uncertainty about the future.

## 1. Introduction

During the first wave of the COVID-19 outbreak, strong pandemic control measures were put in place in Luxembourg and other countries to prevent the spread of the SARS-CoV-2 virus. While impacts of these measures on the mental health of Luxembourg residents were expected, there was little evidence on the longitudinal evolution of population mental health measures during the confinement and over the gradual easing of the confinement measures during spring 2020. The CON-VINCE study (Snoeck et al., 2020) sought to fill this gap and assess the mental health impact of the pandemic control measures through longitudinal assessments of a nationally representative sample.

Recapitulating, in the first COVID-19 wave that started around 15 March 2020, Luxembourgish residents were strongly advised to stay indoors due to the increasing number of COVID-19 infections. Schools were closed, and all cultural, social and sports activities were cancelled or postponed. In addition, employees were recommended to work from home. These restrictions were eased in three phases: The first phase started on April 20 when recycling centres and construction locations reopened. The second phase began on May 4 when some secondary schools reopened with reduced numbers of students in the classrooms. The elementary schools reopened in the third phase on May 25, as well as cafés and restaurants with a limited number of clients. During this period, companies received government support and had the possibility to subsidize employee salaries via partial unemployment. Public health information regarding COVID-19 cases, deaths, recommended personal measures to prevent infection, and pandemic control measures were clearly disseminated in Luxembourg's social and print media, and about once a month, postal messages on safety and hygiene measures and other COVID-19 related information were disseminated to the Luxembourgish households in the five languages predominantly spoken in the country (Luxembourgish, French, German, English, and Portuguese). Proper access to accurate health information is an essential aspect since reliable and up-to-date information about recovery cases and possible treatments can decrease anxiety and stress (Wang et al., 2020). The first wave of the pandemic was mitigated early in Luxembourg; the health-care system was at all times coping with the number of patients hospitalized due to COVID-19.

Around the world, studies have been indicating an increase in mental health burden due to confinement in cross-sectional samples (Xiong et al., 2020), especially in younger age groups, which is often explained by economic distress, loneliness (Varma et al., 2020), and underdeveloped coping skills to deal with negative emotions during the social distancing (Campos et al., 2020). Moreover, the impact of the COVID-19 outbreak on mental health seems to be more challenging for women than for men (Salameh et al., 2020), mainly explained by biological factors, such as hormonal levels (Albert, 2015; Ozdin and Bayrak Ozdin, 2020), but also by inequalities in work prospects and increased care of significant others (Czymara et al., 2020). However, these findings are increasingly more likely to be found in countries demarcated by socio-economic inequalities between men and women (Fisher and Ryan, 2021).

According to the European Institute for Gender Equality (2020), Luxembourg can be considered a comparatively gender-equal country; it ranks 10<sup>th</sup> in terms with a score of 2.4 points below the Europe average. This factor could be a protective element to diminish the gender-unequal socio-economic and psychological impact due to confinement measures (Agberotimi et al., 2020; Pappas, 2020). Moreover, the World Health Organization (2017) report shows that the Luxembourgish population presented before the pandemics a prevalence of anxiety (4.9%) and depression disorders (5.0%), which could be intensified by the confinement measures, as shown worldwide (Salari et al., 2020; Xiong et al., 2020).

Capitalizing on a longitudinal, population-representative study, we aimed to explore mental health, i.e., stress, anxiety, depression, and loneliness symptoms during the initial social restriction and easing measures due to outbreak of COVID-19 by sex and age. We additionally explored whether risk factors for COVID-19 (i.e., chronic cardiac disease, cancer, autoimmune disease, HIV, use of tobacco) or a self-reported diagnosis of COVID-19 would be related to anxiety, depression, stress, or loneliness levels. Moreover, we aimed to observe the longitudinal development of the impacts on mental health for Luxembourgish residents.

## 2. Methods

### 2.1. Sample size calculation and sampling

Due to the novelty of the COVID-19 and the lack of experience related to SARS-CoV-2 infections and their relation to symptomatic and asymptomatic carriers, the CON-VINCE protocol initially assumed a prevalence of 50% of cases, a confidence interval of 95% and 2.5% of precision, which showed that a minimum of 1,537 participants was required to have reliable prevalence. The sampling strategy included stratification by gender, age, and residency within Luxembourg as represented by electoral districts. Due to pandemic-related restrictions requiring a remote-recruitment of participants, a representative non-probabilistic web panel was used to gather participants in collaboration with a survey company. Moreover, an equal allocation probability in proportion to Luxembourg's population was used without replacement, in this context, the consortium used a deterministic random bit generator within strata (for detailed information, see Snoeck et al., 2020).

### 2.2. Ethics approval and consent to participate

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Ethical approval was obtained from the national research ethics committee (Comité National d'Ethique de Recherche, CNER), under reference 202004/01, and by the Luxembourgish Ministry of Health (reference 831×6ce0d). The study has been submitted for registration on ClinicalTrials.gov (NCT04379297). We acquired electronic informed consent from all participants, and no financial compensation was given for their contribution. All further details are described in Snoeck et al. (2020).

### 2.3. Study design and participants

This longitudinal study included 1,756 participants from the longitudinal CON-VINCE study, which aimed to evaluate the dynamics of the spread of the COVID-19 disease and psychological impact within the Luxembourgish population (Snoeck et al., 2020). Due to the pandemic limitations, the sampling strategy focused on using a non-probabilistic web panel aiming at population representativeness in terms of sex and age. Participants included in this study responded to the baseline (April 15 to May 5, 2020) and a follow-up assessment during the first easing of COVID-19 measures (May 6 to May 20, 2020). Although the CON-VINCE study comprised more follow-ups at the moment of the writing of this article, we decided to include and discuss the first follow-up assessment only because the result patterns are relatively similar with subsequent follow-ups (For frequencies and means of all follow-ups comprising 1, 475 participants, see supplementary material, Tables S1 and S2).

Respondents were aged between 18 and 84 years old (M = 48.27, SD = 15.00), 50.74% of the sample were female (n = 891). Two thirds (66.12%) of the sample were married or in a registered partnership, while 20.67% were single. Furthermore, 40.43% had a secondary degree, 41.00% a bachelor's degree, and 13.50% reported a master or above, characterizing a highly educated sample. Only a very small number of respondents were tested positive for SARS-CoV-2 (asymptomatic; symptomatic carriers did not participate in CON-VINCE; 0.63%) or that a significant other had been diagnosed with COVID-19 (0.17 %).

Regarding employment status, only 1.31% were unemployed at the time of the baseline measurement and 1.59% in the follow-up. Close to half (42.71%) of the respondents reported an annual gross household income between 75.000 and 150.000 euros, and 15.26% were no Luxembourgish nationals. A total of 27.45% reported one risk factor for COVID-19, 8.54% reported two or more risk factors, while two-thirds of the sample (64.01%) did not report any risk factors. Demographic characteristics are displayed in [Table 1](#).

#### 2.4. Procedure

The online survey was conducted in collaboration with a specialized survey company (TNS-Ilres), in which respondents could choose among four languages: French, German, English and Portuguese. Each participant was assigned an identification code to allow for data capturing in a pseudonymized way. All data were collected via a secure web interface and transferred to a secure data centre, stored and encrypted on the secured data cloud of the BioCore of the Luxembourg Centre for Systems Biomedicine (LCSB).

#### 2.5. Material

The baseline and follow-up assessments comprised demographic, socio-economic information, and psychological data. Demographic data included sex, age, nationality, as well as marital status. Socio-economic status was assessed by educational level, current employment status, work sector, and income. Moreover, we also explored if respondents were complying with social distancing recommendations.

We explored whether participants presented any psychiatric comorbidity, risk factors for COVID-19 (i.e., chronic cardiac disease, cancer, autoimmune disease, HIV, use of tobacco), whether they were diagnosed with COVID-19, and we administered validated scales described below to gather information on participants' depressive symptoms, stress levels, anxiety level, and feelings of social isolation.

#### 2.6. Mental health assessment scales

##### 2.6.1. Center for epidemiologic studies depression scale-CES-D Scale (Radloff, 1977)

This scale was developed to assess depressive symptomatology within the general population. It comprises 20 self-reported items that evaluate the degree of depressive symptomatology in the last two weeks on a four-point Likert scale, where scores above 16 indicate risk for clinical depression.

##### 2.6.2. Generalised anxiety disorder 7-item -GAD-7 scale (Spitzer et al., 2006)

It is a self-administered screening tool with seven items measuring anxiety levels through a four-point Likert scale. Scores of zero to three are assigned to each item response. The seven responses are added up to a maximum total score of 21. Depending on the attained total score, the scale indicates mild (five), moderate (10), or severe (15) level of anxiety.

##### 2.6.3. Loneliness scale-short version - UCLA scale (Hughes et al., 2004)

This scale was developed to assess feelings of social isolation and loneliness. In this short version, participants are asked to choose the

**Table 1**  
Summary of demographic characteristics at baseline (N = 1,756).

Variables	Baseline N (%)	Follow-up N (%)
Sex at Birth		
Women	891 (50.74)	-
Men	865 (49.26)	-
Age groups		
18-29	222 (12.64)	-
30-39	339 (19.31)	-
40-49	382 (21.75)	-
50-59	362 (20.62)	-
> 60	451 (25.68)	-
Marital Status		
Single	363 (20.67)	-
Married / Registered partnership	1,161 (66.12)	-
Divorced	145 (8.26)	-
Widowed	43 (2.45)	-
Others	44 (2.51)	-
Educational degree		
No formal degree	52 (2.96)	-
Fundamental Education	37 (2.11)	-
Secondary Education	710 (40.43)	-
University degree	720 (41.00)	-
University degree: Master or above	237 (13.50)	-
Employment Status		
Full-time employed	768 (43.74)	754 (42.94)
In retirement or early retirement	430 (24.49)	427 (24.32)
In vocational training/retraining/education	60 (3.42)	67 (3.82)
Looking after home or family	83 (4.73)	84 (4.78)
Other status	76 (4.33)	70 (3.99)
Parental Leave	21 (1.20)	23 (1.31)
Part-time employed	223 (12.70)	238 (13.55)
Permanently sick or disabled	11 (0.63)	8 (0.46)
Self-employed or working for own family business	61 (3.47)	57 (3.25)
Unemployed	23 (1.31)	28 (1.59)
Annual gross income		
0 - 25 000 Euros	27 (1.54)	-
25 000 - 75 000 Euros	416 (23.69)	-
75 000 - 150 000 Euros	750 (42.71)	-
>150 000 Euros	258 (14.69)	-
No answer	305 (17.37)	-
Nationality		
Luxembourgish	1,547 (88.10)	-
Others	209 (11.90)	-
Compliance with COVID-19 measures		
Agree	532 (30.77)	652 (37.24)
Disagree	7 (0.40)	7 (0.040)
Neutral	32 (1.85)	40 (2.28)
Strongly Agree	1117 (64.6)	1022 (58.37)
Strongly disagree	41 (2.37)	30 (1.71)
Health sector worker		
No	1,591 (90.60)	-
Yes	165 (9.40)	-
Psychiatric comorbidity		
No	1,645 (95.20)	-
Yes	83 (4.80)	-
Risk factors for Covid		
No	1,124 (64.01)	-
One	482 (27.45)	-
Two or more	150 (8.54)	-
Tested positive for (asymptomatic carrier of) SARS-CoV-2)		
No	1,745 (99.37)	1,689 (96.18)
Yes	11 (0.63)	67 (3.82)
Significant other diagnosed with COVID-19		
No	1,753(99.83)	1,755 (99.94)
Yes	3 (0.17)	1 (0.06)

suitable answer within three answer options ranging from “hardly never or never” to “often”, for a total number of three items.

#### 2.6.4. Perceived stress scale – 4 item version- PSS-4 (Cohen et al., 1983)

This scale measures stress perception in the last two weeks with four items on a four-point Likert scale.

### 2.7. Statistical analyses

Analyses were performed separately for each of the four mental health scales. Firstly, Chi-square tests ( $\chi^2$ ) were used to explore possible differences in categorical characteristics among the sexes and age groups for baseline and follow-up assessment. Secondly, to analyze the possible changes in mental health due to the implementation of COVID-19 restrictions, repeated-measures ANOVAs were performed to compare mental health within and between demographic groups (sex and age group) during the restrictions. Post hoc comparisons were carried out with Bonferroni method, and results were adjusted for multiple comparisons with Bonferroni corrections.

Finally, we used linear regressions to understand differences in mental health by sex and age groups adjusted for socio-economic and behavioural confounders separately for baseline and follow-up assessment with a significance level set of  $p < .05$ . Statistical analyses were carried out using Stata 16 (StataCorp, 2019).

## 3. Results

### 3.1. Descriptive analysis of sociodemographic and socio-economic characteristics and depression and anxiety classification by sex and age groups

Results from  $\chi^2$  tests showed that women were more likely to be part-time employed (21.77% vs. 3.35%) compared to men, as well as they were more likely to look after home or family (8.75% vs. 0.58%) at baseline,  $\chi^2 (9) = 238.71, p < .001$ . The same pattern was observed in the follow-up. Moreover, a higher share of women was working in the health sector compared to men (13.94% vs. 4.74%),  $\chi^2 (1) = 43.42, p < 0.001$ . Men were more likely to have a higher income (75,000 - 150,000 Euros) compared to women,  $\chi^2 (9) = 238.71, p < .001$ . Furthermore, male respondents were more likely to be married compared to female respondents (72.25% vs. 60.16%),  $\chi^2 (4) = 36.59, p < .001$ .

In general, the prevalence of severe depression symptoms at the baseline was 19.93%, while for anxiety the prevalence for each classification was 21.18% to mild, 4.10 to moderate, and 1.65 to severe. The prevalence of severe depression symptoms was higher for women (27.83%) compared to men (11.79%),  $\chi^2 (1) = 70.77, p < .001$  at baseline. Similar results were found for anxiety, in which women were more likely to present mild, moderate, and severe anxiety (31.2%) compared to men (16.19%),  $\chi^2 (3) = 74.75, p < .001$ . We observed similar patterns in the follow-up. In addition, women were more likely to have been diagnosed psychiatric comorbidity (6.40% vs. 3.17%),  $\chi^2 (1) = 9.88, p = .002$ . Finally, women were more likely to strongly agree to follow the social distancing recommendations (68.75% vs. 60.31%),  $\chi^2 (4) = 16.18, p = 0.003$ .

Investigating demographic and socioeconomic differences between age groups, young people (18-29 years) were more likely to be in vocational training (25.23%) compared to the other age groups (1.18%),  $\chi^2 (36) = 1.80, p < .001$ . Middle aged participants (40-49 years) were more likely to be working in the health sector (32.12%) compared to younger groups (18-29 years; 14.55%, 30 - 39 years; 25.45%),  $\chi^2 (4) = 46.49, p < .001$ . Younger people (18-29 years) were more likely to be single (48.21%) compared to other age groups (30-39 years; 28.93 %, 40-49 years; 11.29%, 50-59 years; 6.06%, > 60 years; 5.51%),  $\chi^2 (16) = 735.48, p < .001$ . We noticed more men than women in the older age group (29.13% vs. 22.33%),  $\chi^2 (4) = 13.05, p = 0.01$ .

Young groups presented a higher prevalence of severe depression

symptoms (22.29%) compared to the older groups (15.71%) at baseline,  $\chi^2 (4) = 53.17, p < .001$ , with a similar pattern at follow-up. We also noticed that the younger group presented higher baseline prevalence of severe anxiety (31.03%) compared to older respondents aged 30-39 years (20.69%), 40-49 years (13.79%), and > 60 years (6.90%),  $\chi^2 (4) = 13.52, p = .009$ . At follow-up, we did not observe differences in anxiety between age groups.

### 3.2. Comparisons of mental health assessment scales between groups (sex and age groups) across time (baseline and follow-up)

As displayed in Table 2, the 2 (group: men, women)  $\times$  2 (time point: baseline, follow-up) repeated-measures ANOVA showed a main effect of groups, in which pairwise comparisons showed that women scored significantly higher on all mental health scales than men (all  $ps < .001$ ). Time effects were observed for CES, PSS, and GAD 7, confirming lower scores in depression, stress, and anxiety scales between baseline and follow-up scores for both sexes. No interaction effects were found between groups and time for any of the scales. Regarding age groups, the 5 (groups: 18-29, 30-39, 40-49, 50-59, and > 60 years)  $\times$  2 (measurement time point: baseline and follow-up) ANOVAs revealed group effects for all mental health scales, showing higher scores, i.e., more reported depressive, stress, anxiety, and loneliness symptoms by the younger age group (18-29 years old) for CES, PSS, UCLA, and GAD 7.

### 3.3. Associations of demographic characteristics with anxiety, depression, stress, and loneliness levels

We carried out linear regression models controlling for age, sex, education, previous psychological diagnostic. We present the results in Table 3. Adjusted for all demographic and socio-economic confounders, men showed lower scores in depression, stress, anxiety, and loneliness at both baseline and follow-up. Hardly any age differences were visible at baseline, only the younger group reported higher anxiety. However, at follow-up, younger respondents (18-29 years) presented more depression, stress, and anxiety symptoms in the follow-up compared to the oldest respondents aged 60 years and older. Further, respondents aged 30-39 years presented more anxiety and stress symptoms than respondents aged 60 and older. Respondents without formal education showed more loneliness symptoms in the follow-up compared to respondents with higher educational levels.

Moreover, we assessed the associations of risk factors for COVID-19 (i.e., chronic cardiac disease, cancer, autoimmune disease, HIV, use of tobacco), also adjusted for socio-economic factors, with anxiety, depression, stress, and loneliness levels. Participants presenting one or more risk factors for COVID-19 presented higher scores in depression both at baseline and follow-up. However, at the follow-up only participants having two or more risk factors for COVID-19 were more likely to present higher scores for stress and anxiety symptoms.

Finally, a last set of regressions tested the associations of participants being tested positive for the SARS-CoV-2 virus (asymptomatic) one at a time with anxiety, depression, stress, and loneliness levels. After controlling for sociodemographic factors, presence of psychiatric disorders, and risk factors for COVID-19, results showed that participants positively diagnosed with SARS-CoV-2 virus presented higher scores in stress at follow-up.

## 4. Discussion

In this study, we investigated mental health during the first lockdown measures due to COVID-19 in Luxembourgish residents at baseline (one month after the beginning of confinement measures) and a follow-up (two weeks after the baseline at the beginning of easing of confinement measures). In general, stress, depression, anxiety levels were higher in women, indicating that the psychological effects during the COVID-19 pandemic may be more significant for women. In fact, these

**Table 2**  
Descriptive statistics for the psychological scales at baseline and follow-up and results from the repeated-measures ANOVA.

		Assessments		Time	Group	Time x group
		Baseline M (SD)	Follow-up M (SD)			
PSS	Sex					
	Female	5.00 (2.93)	4.83 (2.96)	F (1, 1754) = 14.02, <i>p</i> = < .001	F (1, 1754) = 43.61, <i>p</i> = < .001	F (1, 1754) = 0.35, <i>p</i> = .56
UCLA	Female	4.70 (1.45)	4.78 (1.57)	F (1, 1754) = 1.31, <i>p</i> = 0.25	F (1, 1754) = 66.01, <i>p</i> = < .001	F (1, 1754) = 2.80, <i>p</i> = .09
	Male	4.26 (1.22)	4.24 (1.28)	F (1, 1754) = 25.88, <i>p</i> = < .001	F (1, 1754) = 110.70, <i>p</i> = < .001	F (1, 1754) = 0.46, <i>p</i> = .50
GAD-7	Female	3.99 (3.87)	3.67 (3.73)	F (1, 1754) = 19.27, <i>p</i> = < .001	F (1, 1754) = 118.02, <i>p</i> = < .001	F (1, 1754) = 0.65, <i>p</i> = .42
	Male	2.38 (2.83)	2.14 (2.70)			
CES	Female	12.03 (9.25)	11.61 (9.54)			
	Male	8.12 (6.45)	7.52 (6.48)			
PSS	Age groups					
	18-29	5.70 (2.67)	5.73 (2.74)	F (1, 1751) = 10.36, <i>p</i> = < .001	F (4, 1751) = 17.66, <i>p</i> = < .001	F (4, 1751) = 0.88, <i>p</i> = .47
	30-39	4.77 (2.78)	4.63 (2.80)			
	40-49	4.46 (2.77)	4.17 (2.74)			
	50-59	4.56 (2.96)	4.34 (2.85)			
	> 60	4.16 (2.74)	3.88 (2.72)			
UCLA	18-29	4.94 (1.29)	5.02 (1.41)	F (1, 1751) = 1.46, <i>p</i> = < .23	F (4, 1751) = 12.82, <i>p</i> = < .001	F (4, 1751) = 0.28, <i>p</i> = .89
	30-39	4.62 (1.38)	4.63 (1.50)			
	40-49	4.26 (1.30)	4.28 (1.36)			
	50-59	4.45 (1.36)	4.45 (1.47)			
	> 60	4.36 (1.39)	4.42 (1.48)			
GAD-7	18-29	4.32 (4.09)	4.05 (3.83)	F (1, 1751) = 25.22, <i>p</i> = < .001	F (4, 1751) = 17.11, <i>p</i> = < .001	F (4, 1751) = 0.56, <i>p</i> = .56
	30-39	3.68 (3.53)	3.39 (3.43)			
	40-49	3.15 (3.16)	2.94 (3.30)			
	50-59	3.20 (3.83)	2.75 (3.43)			
	> 60	2.31 (2.86)	2.11 (2.75)			
CES	18-29	13.55 (9.13)	13.45 (9.77)	F (1, 1751) = 16.29, <i>p</i> = < .001	F (4, 1751) = 19.67, <i>p</i> = < .001	F (4, 1751) = 2.42, <i>p</i> = .05
	30-39	10.81 (8.21)	10.48 (8.94)			
	40-49	9.48 (7.60)	9.09 (8.09)			
	50-59	10.31 (9.30)	9.12 (8.43)			
	> 60	8.23 (6.60)	7.84 (6.79)			

Note. PSS: Perceived Stress Scale; UCLA: Loneliness Scale-short version; GAD-7: Generalised Anxiety Disorder 7-item; CES: Center for Epidemiologic Studies Depression Scale.

results were consistent both in the baseline and follow-up. Previous studies have shown that anxiety and depression disorders are more frequent in women (Albert, 2015; Salameh et al., 2020). We also observed that socio-economic factors that could also be associated with the decreasing of mental health were found, confirming earlier studies (King et al., 2020). For instance, women were more likely to be part-time employed, look after home or family, work in the health sector, and have lower income.

Although this study was conducted in Luxembourg, a country that takes measures to produce equality between men and women, there were still socio-economic differences related to gender visible, i.e., women were on average reporting lower income than men. Further, in line with gender norms in this context that characterize women as the caregivers, since women were reporting higher rates of having caretaker duties. In this and other contexts, gender norms define which work is valued, explaining gender gaps in earnings, particularly in female-dominated professions (Perales, 2013). Since the first wave of the pandemic, policy measures were implemented in Luxembourg to buffer the impact of childcare closings, the so-called leave for family reasons. Further measures could aim to ensure a more gender-equal use of the leave for family reasons and implement labour regulations that increase possibilities for working mothers and fathers to improve their work-family balance.

Besides the sex differences, we also observed that younger respondents were more likely to present severe depression at both baseline and follow-up and severe anxiety at baseline. Further, younger respondents reported more symptoms of stress, depression, and anxiety, especially in the follow-up compared to older respondents (> 60 years). A possible explanation for these results could be younger respondents being exposed to higher vulnerability and uncertainty about one's future regarding careers in a changed world, employment, and possible economic crisis (Kazmi et al., 2020). This seems reasonable since we observed that those participants between 18-29 years were more likely to be in vocational training compared to the other age groups.

Considering the consequences of the pandemic on social contacts, daily routines, employment, and mobility prospects, the higher symptoms of depression, anxiety, stress, and loneliness presented by younger respondents can reflect the suddenly dramatically changed conditions and prospects of today's younger generations (Varma et al., 2020). Along with general psychological support to increase resilience during the pandemic, policy measures should provide employment opportunities and stabilize the younger generations' careers to reduce uncertainty and instability of training and work trajectories, preferably already during, but even more importantly for the time after the pandemic. Since the lack of treatment could intensify the anxiety and depression symptoms, in addition, these disorders can lead to fatigue and low concentration, as a consequence impairing performance and increasing the risk of work accidents (Haslam et al., 2005).

We also observed that increased depression, stress, and anxiety scores were positively associated with participants reporting two or more risk factors for COVID-19. These findings confirm previous studies (Sayeed et al., 2020; Zhou et al., 2020), in addition, those participants who were tested positive for the SARS-CoV-2 virus (oligo-symptomatic or asymptomatic) in the follow-up were also more likely to present increased symptoms of anxiety. One explanation for these results is that, even in the absence of clinical symptoms of COVID-19, respondents who were tested positive for the virus may feel more vulnerable (Hatch et al., 2018), resulting in a worse quality of life (Zhou et al., 2020).

In general, we observed a high adherence to pandemic measures in the two moments of assessment when compared to other countries, such as Ireland, Germany, USA, and UK (Coroiu et al., 2020). With the gradual easing of confinement measures, we observed reductions in stress, anxiety, and depressive symptoms in the follow-up compared to baseline, which could be due to the reduced uncertainty with the Luxembourgish government's clear information about measures, reinforcing that effective health communication diminishes insecurity,

**Table 3**  
Association between demographic variables and the psychological scales during the first and second surveys (N = 1756).

Variables	Baseline				Anxiety				Follow-up				Loneliness			
	Depression		Stress		Anxiety		Loneliness		Depression		Stress		Anxiety		Loneliness	
	β	t	β	t	β	t	β	t	β	t	β	t	β	t	β	t
<b>Sex</b>																
Women (Reference)																
Men	-3.37	-8.54***	-0.66	-4.61***	-1.44	-8.33***	-0.37	-5.41***	-3.51	-8.78***	-0.65	-4.62***	-1.38	-8.42***	-0.46	-6.20***
<b>Age groups</b>																
18-29	2.37	2.21*	1.00	2.58**	0.95	2.02*	0.07	-0.38	3.28	3.08**	1.57	4.18***	1.04	2.39**	0.40	2.01*
30-39	0.83	0.89	0.40	1.20	0.49	1.21	-0.02	-0.13	1.43	1.57	0.68	2.13*	0.78	2.10*	0.22	1.31
40-49	-0.15	-0.17	0.19	0.60	-0.08	-0.22	-0.26	-1.69	0.40	0.46	0.28	0.92	0.42	1.18	0.07	-0.54
50-59	0.67	0.83	0.21	0.71	-0.06	-0.17	-0.07	-0.49	0.47	0.60	0.36	1.28	0.16	0.48	0.06	1.860.42
> 60 (Reference)																
<b>Marital Status</b>																
<b>Single (reference)</b>																
Married/ Registered partnership	-1.32	-2.28*	-0.24	-1.12	0.21	0.85	-0.36	-3.61***	-1.89	-3.21***	-0.14	-0.67	-0.31	-1.31	-0.36	-3.29***
Widowed	-0.09	-0.07	0.35	0.74	-0.09	0.15	-0.08	-0.39	-0.98	-0.74	-0.04	-0.08	-0.86	-1.59	-0.38	-1.56
Divorced	-1.05	-1.26	-0.28	-0.93	-0.19	-0.53	-0.12	-0.82	-1.66	-1.94*	-0.09	-0.29	-0.65	-1.85	-0.08	-0.49
Others	-1.39	-1.14	-0.008	-0.02	-0.05	0.09	-0.02	-0.09	-1.02	-0.82	-0.36	-0.81	-0.	-0.20	-0.24	-1.05
<b>Educational degree</b>																
<b>No formal degree (reference)</b>																
Fundamental Education	-3.60	-2.24*	0.006	0.01	-0.99	-1.42	-0.36	-1.31	-3.81	-2.33*	0.51	-0.89	-1.12	-1.67	-0.61	-2.03*
Secondary Education	-3.75	-2.81**	-0.44	-0.92	-1.20	-2.07*	-0.26	-1.14	-	-2.92**	-0.52	-1.08	-1.31	-2.36	-0.45	-1.78
									-3.95							
University degree	-3.11	-2.46**	-0.32	-0.68	-1.05	-1.90	-0.35	-1.58	-3.91	-3.03**	-0.63	-1.38	-1.47	-2.79	-0.50	-2.11*
University degree: Master or above	-2.72	-2.12*	-0.70	-1.51	-1.26	-2.25*	-0.54	-2.43**	-3.58	-2.75**	-0.84	-1.83	-1.46	-2.73	-0.69	-2.87**
<b>Employment Status</b>																
<b>Full-time employed (reference)</b>																
In retirement or early retirement	-1.87	-2.18*	-0.33	-1.07	-1.10	-2.94**	-0.29	-1.96*	-0.96	-1.12	-0.18	-0.60	-0.41	-1.20	0.06	0.36
In vocational training/retraining/education	1.39	1.22	0.21	0.50	0.54	1.10	0.11	0.61	0.51	0.45	0.05	0.13	0.49	1.07	0.13	0.62
Looking after home or family	-1.38	-1.43	-0.19	-0.56	-0.65	-1.57	-0.21	-1.29	-1.03	-1.04	-0.33	-0.94	-0.47	-1.17	0.08	0.44
Other status	0.36	0.39	-0.28	0.84	-0.11	-0.27	0.15	0.97	1.79	1.88	0.62	1.85	0.43	1.11	-0.09	-0.54
Parental Leave	0.44	0.26	0.47	0.76	-0.19	-0.26	0.84	2.86**	2.01	1.22	0.75	1.28	0.22	0.33	0.58	1.89
Part-time employed	-1.08	-1.74	-0.21	-0.91	-0.24	-0.91	-0.06	-0.58	-0.56	-0.91	0.13	0.58	0.29	-1.18	0.12	1.10
Permanently sick or disabled	5.20	2.28*	0.41	0.50	1.46	1.47	0.68	1.75	4.10	1.50	0.80	0.83	1.27	1.14	0.80	1.59
Self-employed or working for own family business	1.03	1.04	0.27	0.74	0.62	1.44	-0.0005	0	-0.16	-0.15	-0.35	-0.94	-0.03	0.07	-0.11	-0.56
Unemployed	1.95	1.21	1.19	2.02*	1.77	2.51**	0.15	0.529	1.38	0.90	0.66	1.21	0.74	1.19	0.51	1.80
<b>Annual gross income</b>																
<b>0 - 25 000 Euros (reference)</b>																
25 000 - 75 000	0.12	0.99	-0.30	-0.54	0.43	0.64	0.04	0.16	-0.72	-0.46	-0.49	-0.87	0.75	1.17	0.11	0.39
75 000 - 150 000	-0.90	-0.56	-0.57	-1.02	0.11	0.17	-0.11	-0.40	-1.30	-0.82	-0.98	-1.75	0.53	0.83	-0.04	-0.15
>150 000 Euros	-1.53	-0.34	-1.07	-1.84	0.07	0.11	-0.31	-1.14	-1.56	-0.95	-1.13	-1.95*	0.66	0.99	-0.18	-0.60
No answer	-1.25	-0.42	-0.71	-1.25	-0.03	-0.04	-0.12	-0.46	-2.06	-1.29	-0.83	-1.46	0.37	0.57	-0.18	-0.61
<b>Nationals</b>																
<b>Yes (reference)</b>																
No	-0.04	-0.08	0.56	2.74**	-0.07	-0.29	0.43	4.45***	-1.09	-1.89*	0.43	2.11*	0.05	0.24	0.25	2.31*
<b>Work field</b>																
<b>Others (reference)</b>																
Health sector	-0.08	-0.12	-0.40	-1.66	-0.03	-0.10	-0.04	-0.34	-0.39	-0.59	-0.32	-1.35	-0.17	-0.62	-0.02	0.87
<b>Psychiatric disorders</b>																
<b>No (reference)</b>																
Yes	8.52	10.12***	2.04	6.65***	3.55	9.7***	0.55	3.79***	8.73	10.17***	1.85	6.09***	3.46	9.85***	.40	2.53**
<b>Risk factors for Covid</b>																
<b>No (reference)</b>																
One	1.81	4.31***	0.20	1.31	0.56	3.08**	0.04	0.49	1.22	2.84**	0.14	0.94	0.18	1.05	0.06	0.80
Two or more	1.48	2.19*	-0.06	-0.23	0.59	2.01*	0.09	0.82	2.19	3.18**	0.59	2.41*	0.66	2.35*	0.18	1.39
<b>Tested positive for (asymptomatic carrier of) SARS-CoV-2</b>																
<b>No (reference)</b>																
Yes	0.90	0.40	0.32	0.39	-0.30	-0.30	0.12	0.31	1.71	1.80	0.78	2.31*	0.61	1.58	0.24	1.36

Note: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

consequently increasing mental health (van der Bles et al., 2020). Socio-economic differences by sex were stable throughout observation.

The study's strength is the longitudinal assessment of a sample of Luxembourg residents that is representative concerning age and sex. Considering the large share of the Luxembourgish workforce that are cross-border commuters and the large share of migrants, future assessments should oversample these population strata to arrive at a more complete picture of the Luxembourgish workforce. Further, while established mental health measures were validated in the four languages of the survey, the survey did not assess in detail the respondents' perceptions and beliefs that could put the mental health assessment in context.

Although our study comprised a large sample of the Luxembourgish population and presented reliable outcomes, some limitations need to be considered when interpreting the results. Firstly, our study was launched already 30 days after the beginning of confinement measures and thus – even if timely – was not able to capture the impact of the restriction measures immediately after their implementation. Further, it would have been desirable to have assessments of mental health before and at the beginning of the confinement measures. Nevertheless, the longitudinal design permitted us to monitor mental health during the gradual lifting of the restrictive measures in a nationally representative sample. Another limitation of this study was the use of mental health scales only assessing self-reported symptoms, instead of clinical assessment and diagnosis carried out by psychiatrists, which was not possible due to the pandemic restrictions at the time. Furthermore, some authors suggest that self-administered scales could be influenced by social desirability when reporting symptoms (Paulhus, 1984) or/and self-selection bias, which could mean that those individuals who were indifferent about the pandemic were less likely to join the study. Nevertheless, self-reported online scales have been shown as a reliable method for assessing clinical progress (Davies, 2016), giving flexibility of time to complete the questionnaire, anonymity of the participant (Ong and Weis, 2000), and timely data collection at the time of the COVID-19 restriction measures.

As a conclusion, in Luxembourg, during the first wave of the COVID-19 pandemic, women were more likely to report higher severity of depression, anxiety, and stress, with a persistent gender gap also after the easing of the confinement measures. Younger respondents reported symptoms of impaired mental health that were more stable over time compared to older respondents. Considering that both strong policy measures were provided to soften the economic impact of the pandemic, and the number of infections and deaths due to or with COVID-19 was low during the first wave in Luxembourg, the mental health impact of the pandemic and the pandemic control measures particularly in less affluent and more severely hit countries should not be underestimated.

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## Authors' statement

RK is PI of the CON-VINCE study and responsible for funding acquisition and project administration. VS, RK, AKL & the CON-VINCE Consortium were involved in the methodology of the CON-VINCE study survey and coordinated the field data collection. FR conceptualised the present study, analysed the data, and drafted the manuscript. AL contributed to the manuscript drafting, and revision. All authors contributed and approved the final draft of the manuscript.

## Declaration of Competing Interest

The authors declare that they have no competing interests.

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## Supplementary materials

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