Determinants of depressive symptoms increase in older persons during the COVID-19 pandemic: evidence from Czech cohort study using repeated assessments

Andrea Dalecká, Hynek Pikhart, Anna Bartošková, Naděžda Čapková, Martin Bobák

ABSTRACT
Background Numerous studies reported higher levels of mental health issues during the COVID-19 pandemic but only a minority used repeated measurements. We investigated change in depressive symptoms in the Czech ageing cohort and the impact of pre-existing and COVID-19-related stressors.

Methods We used data on 2853 participants (mean age 73.4 years) from the Czech part of the prospective Health, Alcohol and Psychosocial factors In Eastern Europe cohort that participated in postal questionnaire surveys before (September 2017–June 2018) and during the pandemic (October 2020–April 2021). Participants reported their depressive symptoms using the Centre for Epidemiological Studies-Depression Scale including 10 (CESD-10) tool. A principal component analysis (PCA) was used to create representative components of the pandemic-related stressors. The impact of the stressors on change in depressive symptoms was tested using multivariable linear regression, after adjustment for age and potential confounders.

Results Three patterns of the pandemic-related stressors ('financial stressors', 'social and perception stressors' and 'death and hospitalisation stressors') were extracted from the PCA. The mean CESD-10 score increased from 4.90 to 5.37 (p<0.001). In fully adjusted models, significantly larger increases in depression score were reported by older people (β=0.052; p=0.006), those with poor self-rated health (β=0.170; p<0.001), those who experienced death or hospitalisation of a close person (β=0.064; p<0.001), social deprivation (β=0.057; p=0.001), delays in healthcare (β=0.048; p=0.005) and those who suffered from COVID-19 (β=0.045; p=0.008).

Conclusion This study confirms an increase in depressive symptoms in older persons during the pandemic and identified several pandemic-related risk factors suggesting that public health policies should address this vulnerable group by adopting the preventing strategies.

INTRODUCTION
Mental disorders including depression are recognised as the leading causes of disease burden. Soon after WHO declared COVID-19 as a pandemic, concerns were raised about its impact on mental health. There is growing evidence that the COVID-19 pandemic resulted in deterioration in mental health, possibly mediated by health concerns and changes in daily life related to long-lasting quarantine measures. Early studies of general population samples and specific subpopulations, such as health workers and college students revealed a substantial increase in the prevalence of depression in these groups. However, the impact of the COVID-19 pandemic on mental health in older population remains inconclusive. It has been reported that older population is less likely to report worsening in mental health compared with younger adults, perhaps linked to the assumption that older individuals may be more resilient and cope more successfully with challenging life events. However, much of the evidence related to COVID-19 is based on cross-sectional data that lack repeated measures of mental health before and during the pandemic.
Several factors that may negatively affect the mental health of the ageing population during the pandemic were distinguished. First, older persons are physically most vulnerable to severe and fatal courses of COVID-19 disease that might lead to a higher perceived threat of getting infected.14 A few studies reported that epidemic risk perception has been associated with both depression and anxiety.15 16 Second, older adults are at greater risk of being socially isolated compared with younger adults under normal circumstances.16 In order to reduce the transmission of the virus, control measures were introduced to reduce face-to-face interactions with other people. Thus, the retirement home residents were not allowed to accept the visitors and face-to-face interaction with other people. The retirement home residents were advised to stay at home. These conditions inevitably contributed to social isolation ('cocooning') for many older people that might magnify loneliness and aggravate mental well-being and depression.9 11 15

Another potential contributing factor is experiencing personal loss due to the pandemic. During the pandemic, people could experience bereavement related to losing a beloved spouse or family member. In previous studies, mental health problems were identified as the most adverse consequence of bereavement.18 In addition, these pandemic-related factors, numerous individual and social predictors of worsened mental health were investigated in older persons. Generally, poor self-rated health, social isolation and increased difficulty in mobility belong among the most substantial predictors of depression in the elderly population.19 20

As previously mentioned, longitudinal studies with prepan- demic measures of mental health are encouraged, as they allow to assess the changes according to a clear temporal sequence. Several longitudinal studies have recently reported no or a little deterioration in mental health and well-being during the COVID-19 pandemic among older people in the UK,21 Netherlands,22 and Sweden.10 By contrast, a multicountry longitudinal study reported a substantial worsening in mental health in all 26 included European countries.23 Notably, most of these studies were conducted in the early months of the pandemic, showing the only short-term effect of the pandemic control measures.

To address the inconsistence evidence, we investigated: (1) changes in depression symptoms between the prepandemic and pandemic periods in a cohort of older individuals with repeated measurements; (2) the impact of individual factors on changes in depression symptoms and (3) whether COVID-19-related stressors (eg, limiting social contacts; a significant decrease of your household’s income) were associated with changes in depression symptoms.

METHODS
We used data from the Czech arm of the HAPIEE (Health, Alcohol and Psychosocial factors In Eastern Europe) study; the protocol and baseline characteristics have been reported previ- ously.14 In brief, the HAPIEE study is an ongoing prospective cohort study designed to examine the impact of socioeconomic and psychosocial conditions on non-communicable diseases in Central and Eastern Europe. Four cohorts in Russia, Poland, the Czech Republic and Lithuania were established from 2002 to 2005 and consisted of a random sample of men and women aged 45–69 at baseline selected from population registers. Only the Czech cohort collected information on depressive symptoms, including the pandemic period. The Czech subcohort included participants recruited in seven cities (Havlíkov, Karviná, Hradec Králové, Liberec, Jihlava, Kroměříž and Ústí nad Labem). From an original cohort sample of 8856 respondents, 3190 individuals participated in postal questionnaire surveys in September 2017 to June 2018 (before the pandemic) and in October 2020 to April 2021 (during the pandemic). Persons with missing data on the depression score (n=177), with missing data on prevalent depression in the previous wave (n=41) and with missing data on pandemic-related stressors from wave 2 (n=119) were excluded. This resulted in an analytical sample of 2853 participants.

Measures
Depression
Participants reported their depressive symptoms using the Centre for Epidemiological Studies-Depression Scale including 10 items (CESD-10) rated from 0=rarely/never to 3=most/all of the time. The items included the following statements regarding the respondent’s feelings during the last week: ‘I felt depressed’; ‘I felt all was an effort’; ‘My sleep was restless’; ‘I was happy’ ‘I felt lonely’ ‘People were unfriendly’ ‘I enjoyed life’ ‘I felt sad’; ‘I felt people disliked me’; ‘I could not get going’. A total score was calculated as the sum of all items after reversing the positive mood items. The score ranged from 0 to 30 in maximum, higher scores represented greater degrees of depressed mood.24 Next, the change in symptoms was calculated by subtracting the depression score measured during the pandemic from the score measured in a prepandemic wave. The positive value of the change, therefore, indicates an increase in depression symptoms while the negative value of the change indicates a decrease in depression symptoms. Finally, the binary variable of the CESD-10 score was defined to enable to adjust for the pre-existing depression before the pandemic. Any score equal to or above 10 was considered as being depressed.25

Pandemic-related stressors
We defined 13 pandemic-related stressors, representing the situations that participants might experience (yes/no) during the first year of the COVID-19 pandemic. The questionnaire included the following items: loss of job or paid work, job loss in family, a significant decrease of your household’s income, inability to pay bills, lack of money for food, lack of medication, delays in healthcare, limited social contacts, limited leisure activities, concerns about COVID-19, hospitalisation of close person (due to COVID-19 or other disease), death of close person (due to COVID-19 or other disease) and suffering from COVID-19.

Covariates
Age was considered as a continuous variable, while sex was defined as a binary variable for men and women. The highest achieved level of education was grouped into three categories (primary/vocational, secondary and university). Social relations were approximated by asking the participants whether they live alone or not (yes/no). Economic activity was assessed by the actual employment status (still working/non-working). Health status was measured by a question on self-rated health categorized into three groups (very poor/poor, average and good/very good).

Statistical analysis
First, we described the changes in depression scores by socio- demographic determinants and pandemic-related stressors using means and SDs. Second, we tested whether mean score of depression changed from before to during the COVID-19 pandemic using a non-parametric Wilcoxon signed-rank test (since depression scores were not normally distributed), and we also tested whether there are differences between groups (based on sex, education, etc) in mean differences of depression scores.
symptoms using Mann-Whitney test and Kruskal-Wallis test with a Bonferroni test to correct for multiple comparisons. The prevalence of the stressors is presented individually for each specific stressor.

We used a principal component analysis (PCA) to identify representative components of the pandemic-related stressors. All of the above-listed stressful events were included into the PCA as potential indicators of pandemic-related stressors. Components were defined based on eigenvalues >1.0, scree plot and meaningful interpretation of the components. We used the Kaiser-Meyer-Olkin measure and Bartlett’s test of sphericity to test the appropriateness of using PCA on our data. The significance level of the Bartlett’s test (<0.05) and the value of the Kaiser-Meyer-Olkin test over 0.5 were considered acceptable. To characterise each stressor component, we considered factor loadings with absolute value >0.5. The Oblimin rotation was applied as there was a reasonable assumption that the indices were correlated. Factor scores for each of the stress patterns were assigned to all participants; with the higher factor scores indicating higher levels of stressful occasions. Thus, the factor scores provide an additional (quantitative) value of the predictor compared with binary variables (stressors present/absent).

Third, we tested the differences between groups in change in depression symptoms using t-test and one-way ANOVA as the differences in scores followed a normal distribution. Fourth, we examined the association between sociodemographic determinants and change in depression symptoms scores using multiple linear regression. Finally, we examined the association between the pandemic-related stress factors scores and change in depression symptoms, again using multiple linear regression. Standardised β were calculated using the following models: model 1 adjusted for age; model 2 adjusted for sex, age, education, living alone, self-rated health, employment status, and being depressed before the pandemic. These covariates were selected as potential confounders based on the previous research. P values less than 0.05 were considered statistically significant. All statistical analyses were conducted in IBM SPSS, V.26.

As a sensitivity analysis, we repeated the same analysis on persons who participated in postal questionnaires not only in 2020–2021 and 2017 but also in previous waves in 2012, 2013 and 2015 to examine long-term changes through repeated measures (n=2334). The change in depression was calculated by subtracting the depression score measured during the pandemic from the average of scores measured in three prepandemic waves.

RESULTS
Demographics of the sample
The analytical sample consisted of 2853 participants, among whom 1688 (59%) were women and 1165 (41%) were men, with a mean age of 73.4 (range, 60.6–88.2; SD, 6.73) in the pandemic wave. Descriptive characteristics of the study subjects are shown in table 1. Most participants (44%) completed secondary education, followed by those who completed primary or vocational education (37%) and who had obtained an university degree (19%). Most participants were non-working pensioners (86%). Married participants or those who were in partnership represented 63% of the population sample and most of the participants did not live alone (71%). During the COVID-19 pandemic, almost half of the sample (46%) reported ‘very good’ or ‘good’ health.

Pandemic-related stressors
The proportions of participants who experienced pandemic-related stressors are shown in table 2. Limitation of contacts with relatives and friends reported 67% of people, followed by experiencing limited leisure activities (50%). Concerns about being infected by COVID-19 were experienced by 49%. Hospitalisation and/or loss (death) of a close person reported 10% and 9%, respectively, and 9% suffered from COVID-19.

Three types of the pandemic-related stressors were extracted from the data using PCA and were labelled as ‘financial stressors’, ‘social and perception stressors’ and ‘death and hospitalisation stressors’. The principal components explained 33.8% (eigenvalue 3.72), 16.2% (eigenvalue 1.79) and 10.8% (eigenvalue 1.18) of the total variation, respectively. ‘Delays in healthcare’ and ‘suffering from COVID-19’ were excluded from the PCA because of their low factor loadings on the extracted patterns. Bartlett’s test of sphericity was significant (<0.001) and the Kaiser-Meyer-Olkin test measured a value of 0.829 that indicate substantial correlation within the individual components of the pandemic-related stressors suggesting the data are appropriate for the factor analysis. The variable loadings are presented in online supplemental table 2.

Depressive symptoms scores before and during COVID-19
The mean CESD-10 score increased from 4.90 to 5.37 (p<0.001) (online supplemental table 1). The distribution of depression symptoms within demographic categories was consistent with patterns observed before COVID-19. For example, before and during the pandemic, women reported significantly higher depression scores than men (before: 5.09 vs 4.63; and during: 5.62 vs 5.01 for women vs for men, respectively). Married participants or those who were in partnership reported

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Descriptive characteristics of the study sample and changes in depression symptoms scores before and during COVID-19 pandemic (N=2853)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Category</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Age</td>
<td>≤65 years</td>
</tr>
<tr>
<td></td>
<td>66–75 years</td>
</tr>
<tr>
<td></td>
<td>≥76 years</td>
</tr>
<tr>
<td>Education</td>
<td>Primary, vocational</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
</tr>
<tr>
<td></td>
<td>University</td>
</tr>
<tr>
<td>Marital status</td>
<td>Married/partnership</td>
</tr>
<tr>
<td></td>
<td>Si/Div/Sep/Wid</td>
</tr>
<tr>
<td>Living alone</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Self-rated health</td>
<td>Very good or good</td>
</tr>
<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Poor or very poor</td>
</tr>
<tr>
<td>Employment status</td>
<td>Still working</td>
</tr>
<tr>
<td></td>
<td>Non-working</td>
</tr>
<tr>
<td>Depression before pandemic</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>
lower depression scores than those who were single, divorced, separated or widowed (before: 4.63 vs 5.50; and during: 5.01 vs 5.99 for married/partnership vs single/divorced/separated/widowed, respectively). Participants who lived alone were more likely to report higher depression scores (before: 4.60 vs 5.51; and during: 5.06 vs 6.11 for those living with somebody vs those living alone, respectively) (online supplemental table 1).

Risk factors associated with depressive symptom changes
Higher levels of depressive symptoms were observed in all demographic groups during COVID-19 compared with the prepandemic period, apart from those who were still working or who had the CESD score ≥10 before the pandemic. The largest increases in depression score were reported in the oldest age group (mean change of 0.91; p<0.001) and in people with poor or very poor health (mean change of 0.98; p<0.05) (table 1). In addition, a substantial increase in depression scores was found in people who experienced death or hospitalisation of a close person (mean change of 1.43; p<0.001 and 0.98; p<0.001, respectively) and in people who suffered from COVID-19 (mean change of 0.93; p<0.05) (figure 1). In addition, older people were associated with significantly higher CESD score change compared with younger individuals in both models. Those who reported average self-rated health (β=0.073; p<0.001) and those who reported poor or very poor self-rated health (β=0.170; p<0.001) had significantly higher CESD scores during the pandemic compared with the youngest age group and those who reported good or very good self-rated health in the fully adjusted model but not in the age-adjusted model. By contrast, individuals who suffered from depression before the COVID-19 pandemic were more likely to report significantly lower depression scores than during the pandemic in age-adjusted as well as in the fully adjusted model (β=−0.444; p<0.001) (table 3).

Sensitivity analysis revealed similar results, although, several significant associations were not replicated. For example, the higher change in depression score was no longer predicted by average or poor/very poor self-rated health nor by suffering from COVID-19 (online supplemental table 3).

DISCUSSION
To date, relatively few longitudinal studies examined mental health changes in ageing populations. Significant increases in

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>N (%)</th>
<th>Change in depression score, mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of job</td>
<td>No</td>
<td>2791 (97.8)</td>
<td>0.46 (4.58)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>62 (2.2)</td>
<td>0.76 (3.90)</td>
</tr>
<tr>
<td>Job loss in family</td>
<td>No</td>
<td>2777 (97.3)</td>
<td>0.48 (4.56)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>76 (2.7)</td>
<td>−0.21 (4.76)</td>
</tr>
<tr>
<td>Significant decrease</td>
<td>No</td>
<td>2781 (97.5)</td>
<td>0.46 (4.55)</td>
</tr>
<tr>
<td>of household’s income</td>
<td>Yes</td>
<td>72 (2.5)</td>
<td>0.54 (4.92)</td>
</tr>
<tr>
<td>Inability to pay bills</td>
<td>No</td>
<td>2827 (99.1)</td>
<td>0.46 (4.57)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>26 (0.9)</td>
<td>0.62 (3.28)</td>
</tr>
<tr>
<td>Lack of money for food</td>
<td>No</td>
<td>2822 (98.9)</td>
<td>0.47 (4.58)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>31 (1.1)</td>
<td>−0.23 (3.24)</td>
</tr>
<tr>
<td>Lack of medication</td>
<td>No</td>
<td>2818 (98.8)</td>
<td>0.46 (4.57)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>35 (1.2)</td>
<td>0.46 (4.39)</td>
</tr>
<tr>
<td>Delays in healthcare</td>
<td>No</td>
<td>2494 (87.4)</td>
<td>0.42 (4.51)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>256 (12.6)</td>
<td>0.76 (4.90)</td>
</tr>
<tr>
<td>Limited social contacts</td>
<td>No</td>
<td>932 (32.7)</td>
<td>0.23 (4.52)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1921 (67.3)</td>
<td>0.58 (4.58)</td>
</tr>
<tr>
<td>Limited leisure activity</td>
<td>No</td>
<td>1439 (50.4)</td>
<td>0.39 (4.73)</td>
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<tr>
<td></td>
<td>Yes</td>
<td>1414 (49.6)</td>
<td>0.54 (4.39)</td>
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<tr>
<td>Concerns about COVID-19</td>
<td>No</td>
<td>1469 (51.5)</td>
<td>0.34 (4.34)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1384 (48.5)</td>
<td>0.59 (4.79)</td>
</tr>
<tr>
<td>Hospitalisation of close person</td>
<td>No</td>
<td>2571 (90.1)</td>
<td>0.41 (4.60)</td>
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<tr>
<td></td>
<td>Yes</td>
<td>282 (9.9)</td>
<td>0.98 (4.22)</td>
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<tr>
<td>Death of close person</td>
<td>No</td>
<td>2596 (91.0)</td>
<td>0.37 (4.54)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>257 (9.0)</td>
<td>1.43 (4.65)</td>
</tr>
<tr>
<td>Suffered from COVID-19</td>
<td>No</td>
<td>2600 (91.1)</td>
<td>0.42 (4.48)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>253 (8.9)</td>
<td>0.93 (5.37)</td>
</tr>
</tbody>
</table>

Concerned about COVID-19 (β=0.057; p<0.001). In addition, those who stated that COVID-19 impacted delays in healthcare and those who suffered from COVID-19 also reported a significantly larger increase in depression score (β=0.048; p=0.005 and β=0.045; p=0.008, respectively). The associations remained statistically significant after adjusting for potential covariates. However, being delayed in healthcare was not significantly associated in the age-adjusted model. (table 3).

In addition, older people were associated with significantly higher CESD score change compared with younger individuals in both models. Those who reported average self-rated health (β=0.073; p<0.001) and those who reported poor or very poor self-rated health (β=0.170; p<0.001) had significantly higher CESD scores during the pandemic compared with the youngest age group and those who reported good or very good self-rated health in the fully adjusted model but not in the age-adjusted model. By contrast, individuals who suffered from depression before the COVID-19 pandemic were more likely to report significantly lower depression scores than during the pandemic in age-adjusted as well as in the fully adjusted model (β=−0.444; p<0.001) (table 3).

Sensitivity analysis revealed similar results, although, several significant associations were not replicated. For example, the higher change in depression score was no longer predicted by average or poor/very poor self-rated health nor by suffering from COVID-19 (online supplemental table 3).
depression symptoms in older persons, compared with prepan-
demic levels, were reported in the UK, German and Finish 
cohorts. In line with these results, our findings provide 
evidence for a substantial deterioration in depression symptoms 
from autumn 2020 to early 2021 compared with the prepandemic 
period (2017) using a representative sample of the older Czech 
population. The largest increases in symptoms were observed 
among the oldest participants, people with poor or very poor 
health, people who experienced hospitalisation and/or death of 
close persons and people who suffered from COVID-19.

We aimed to determine the impact of the pre-existing and 
pandemic-related stressors on depression symptoms using 
repeated measures. We found that the magnitude of mental 
health changes varied by sociodemographic characteristics. 
Contrary to previous European research suggesting that older 
adults cope with the COVID-19 crisis better than younger indi-
viduals, our study showed that changes in depression scores 
were strongly associated with age; the highest depression 
changes were observed in the oldest age group (≥76 years) of 
the participants compared with younger individuals. This 
could be explained by the exacerbated fear of becoming severely ill or 
dying for COVID-19 with increasing age. On the other hand, 
the inconsistency of findings in previous studies might also be 
explained by the fact that depression outcomes among popu-
lation are predicted by the scale of sociodemographic indica-
tors that vary substantially between countries and might have a 
positive or negative impact on depression inequalities by age. In 
addition, the policy responses to the COVID-19 crisis also 
differed between the countries, as did the enforcement and 
adhherence to these measures. Therefore, it might be hypothe-
sised that the preventive measures adopted in different coun-
tries could unequally affect different age groups. We did not 
equivocally confirm the previous assumption that women are 
more likely to experience worsened depression symptoms than men.

A consistent finding is that people with fair or poor overall 
health before the pandemic were substantially more likely 
to report larger changes in depression symptoms from before 
the pandemic. Again, the result might suggest a relationship 
between COVID-19 comorbidities and increased fear of the 
severe health implications during COVID-19 disease. This 
assumption is supported by the finding that increased depression 
symptoms were observed in persons who were more concerned 
about being infected by COVID-19. The positive association 
between COVID-19 risk perception and fear of COVID-19 was 
observed in the existing literature. Not surprisingly, persons 
who were diagnosed with COVID-19 disease were also more 
likely to experience a decline in mental health, which is aligned 
with findings from previous studies.

Postponing medical appointments for COVID-19-related 
reasons in older people was observed in the previous European 
study. Our results showed that those who experienced delays 
in healthcare due to the pandemic reported higher depression 
change from before the pandemic, suggesting that disruption of 
healthcare services during the pandemic contributed to deterio-
rating mental health. By contrast, our results did not reveal any 
association between financial stressors and depression symp-
toms despite the fact financial stress has been suggested as an 
important determinant of depression during the pandemic. It 
should be noted that the prevalence of financial stressors in the 
participants was very low (5.7%). It might be only hypothesised 
whether older people used their retirement savings and assets 
that could postpone their financial crisis. Follow-up observation 
would be beneficial to examine whether this stressor pronounced 
later during the pandemic. Lastly, social isolation and loneliness 
are well-documented determinants of poor mental and physical

Figure 2 Changes in depression score (95% CI) between before and during pandemic by pandemic-related stressors. (A) financial stressors; 
(B) social and perception stressors, death and hospitalisation stressors. Differences between groups tested using t-test, presented via p values on 
right. Differences between repeated measures (before and during depression scores) tested using Wilcoxon test, Presented as *p≤0.05, **p≤0.001. 
Note: Decrease of income corresponds to a significant decrease of your household’s income.
health. Our results supported the previous evidence suggesting that experiencing social stressors leads to increased depression change in older persons. These consistent results illustrate the importance of meaningful interventions preventing the mental well-being of elderly populations.

Our study has several major strengths. The HAPIEE study is well-established longitudinal cohort recruited in a representative sample of older individuals living in the Czech Republic. Data were collected via a postal questionnaire so that participants who were unable to access the internet were not excluded. In addition, depression symptoms were measured several times in the prepandemic time and, therefore, the data allow examination of changes between the pre-pandemic time and, therefore, the data allow examination, depression symptoms were measured several times in the pandemic. It may be a case that increased depression symptoms drove elevated social isolation. However, this bias was mitigated by adjusting the models for pre-existing stressors measured before the pandemic.

CONCLUSION
This longitudinal study confirms an important increase in depressive symptoms during the COVID-19 pandemic and identified several pandemic-related risk factors for mental health worsening. The observed rise in depression symptoms and many of the identified factors might be prevented or mitigated. We found that individuals who experienced social isolation (‘cocooning’) were in a higher risk of mental health deterioration, which highlights the importance of considering social support as part of the governmental response to the pandemic. Better accessibility and increased expenditure to prevention and treatment of mental health issues may be needed in future crises. This study provides evidence of the susceptibility of the older individuals to mental distress suggesting that pandemic emergency policies should address this vulnerable population group.

Table 3
Regression analysis of changes of depression score (β) before and during COVID-19 pandemic by individual risk factors (N=2853)

<table>
<thead>
<tr>
<th>Age-adjusted model</th>
<th>Fully adjusted model*</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>P value</td>
</tr>
<tr>
<td>Age (SD=6.77)</td>
<td>0.076</td>
</tr>
<tr>
<td>Sex (ref. male)</td>
<td>0.022</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0 (ref) –</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.019</td>
</tr>
<tr>
<td>University</td>
<td>0.007</td>
</tr>
<tr>
<td>Living alone (yes vs no)</td>
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</tr>
<tr>
<td>Self-rated health</td>
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<tr>
<td>Very good or good</td>
<td>0 (ref) –</td>
</tr>
<tr>
<td>Average</td>
<td>–0.005</td>
</tr>
<tr>
<td>Poor or very poor</td>
<td>0.023</td>
</tr>
<tr>
<td>Working status (yes vs no)</td>
<td>–0.027</td>
</tr>
<tr>
<td>Depression before COVID pandemic (yes vs no)</td>
<td>–0.392</td>
</tr>
<tr>
<td>Financial stressors‡</td>
<td>–0.005</td>
</tr>
<tr>
<td>Social and perception stressors†</td>
<td>0.046</td>
</tr>
<tr>
<td>Death and hospitalisation stressors†</td>
<td>0.067</td>
</tr>
<tr>
<td>Delays in healthcare (yes vs no)</td>
<td>0.027</td>
</tr>
<tr>
<td>Suffer from COVID-19 (yes vs no)</td>
<td>0.038</td>
</tr>
</tbody>
</table>

Outcome variable (change in depression score) standardised; SD=4.56. Bold values represent statistically significant effects (p<0.05).
*Model adjusted for sex, age, education, living alone, self-rated health, employment status and depression before COVID-19 pandemic.
†Latent continuous variable
‡Ref. reference group.

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Contributors AD, MB and HP conceived and designed the cohort study. AD and AB proposed the methodological design of this work. AD analysed the data and wrote the first draft of the manuscript. MB, HP and NC contributed on designing of the overall research study. All authors provided critical revisions. All authors read and approved the submitted manuscript. AD is a guarantor of this work.

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Data availability statement Data are available upon reasonable request.

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REFERENCES