A Global Meta-analysis of Depression, Anxiety, and Stress Before and During COVID-19

Running title: COVID-19 PANDEMIC AND NEGATIVE EMOTIONS

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Abstract

Objective: This meta-analysis compared negative emotions (NEs) as depression, anxiety, and stress, from before the pandemic to during the pandemic.

Methods: A total of 59 studies (19 before, 37 during-pandemic, and three that included both) using The Depression, Anxiety and Stress Scale (DASS) were included. A random effects model estimated the means of NEs for before and during the pandemic.

Results: Studies from 47 countries involving 193,337 participants were included. Globally, NEs increased during the pandemic, and depression had the largest elevation. In Asia, depression and stress were elevated, whereas in Europe, only depression increased, and in America no differences in NEs between before and during the pandemic were observed. The later time phase of the pandemic was associated with lower stress globally, and lower stress and anxiety in Europe. Being younger was associated with more stress globally, and being older was associated with higher anxiety in Asia. Students had higher anxiety globally and higher NEs in all three aspects in Europe compared to the general population. The COVID-19 Infection rate was associated with more stress globally, and stress and anxiety in Europe. During the pandemic, females reported higher levels of depression, anxiety and stress compared to males, most pronounced in Europe.

Conclusion: NEs increased during the pandemic, with younger and student populations, females and Asians having the highest elevations.

Keywords: COVID-19 pandemic; depression; anxiety; stress; DASS; global.

The COVID-19 outbreak, and the following pandemic has imposed a great deal of insecurity and uncertainty on financial, social, physical, and psychological aspects of our lives. Since the incidence of the COVID-19 pandemic, a substantial increase in the prevalence of affective disorders, for example 27% increase in depressive disorders, and 25% increase in anxiety disorders (Santomauro et al., 2021), as well as other mental health burdens such as post-traumatic stress disorder (e.g., Wathelet et al., 2021), insomnia and distress (Wu et al., 2021), and chronic pain (Clauw et al., 2020), have been reported. The development of such health disorders is presumed to be related to NEs (e.g., Davidson, 1998; Hayes, Strosahl, & Wilson, 1999; Clark & Isen, 1982; Forgas & Bower, 1987). NEs are reactions to situations that may be harmful or that impose a burden on individuals, and manifest themselves as depression, anxiety, and stress (VandenBos; APA dictionary, 2007).

However, this substantial increase in the prevalence of affective disorders (e.g., Santomauro et al., 2021; Bueno-Notivol et al., 2020) should not be considered necessarily equivalent to similar increases in the NEs, as the impact of the pandemic on NEs is shown to be not as clear. While some studies show an exacerbation in NEs following the outbreak (e.g., Cavicchioli et al., 2021), others report no pandemic effects on NEs (e.g., on symptoms of anxiety as in O'Conner et al., 2021). Such inconsistency can be seen in either longitudinal or cross-sectional designs, with some reporting an elevation (e.g., Pierce et al., 2020; UK sample), whereas others reporting no significant change (e.g., Johansson et al. 2020; Swedish sample; Katz et al., 2021, US sample, pre-print) or even a reduction in NEs over time (e.g., O'Conner et al. 2021; UK sample). For example, in their study, Robinson et al. (2021) meta-analyzed longitudinal studies on changes in NEs from before to during-pandemic times, and reported a decrease in NEs over time. This contrasts with the results of prevalence studies reporting a substantial increase in the prevalence of affective disorders (e.g., Bueno-Notivol et al., 2020; Santomauro et al., 2021). Therefore, it is not clear whether the NEs have been comparably elevated following the COVID-19 pandemic or not.

This inconsistency in the findings could be due to the methodological challenges e.g., varying impact of the pandemic across cultures; heterogeneity in the data in meta-analyses due to different

instruments used in the primary studies to capture NEs; differences in the pandemic time-course in different countries; the inclusion of both samples from the general public and mental health patients (e.g., as in Robinson et al., 2021), the data extracted mostly from studies from the same or similar regions (e.g., data mostly from western countries as in Robinson et al., 2021; or data mostly from one country, China, as in Bueno-Notivol et al., 2020). Therefore, re-evaluations on the scope of COVID-19 pandemic impact on NEs is warranted. Thus, in this cross-sectional systematic review and meta-analysis on depression, anxiety, and stress in the general public across countries, we aimed to investigate the effects of the COVID-19 pandemic on NEs as depression, anxiety, and stress, from before the pandemic to during the pandemic.

We also tried to tackle some of the existing methodological challenges by: including data from multiple countries; selecting a multi-dimensional NE measurement tool; reducing error variance and heterogeneity by including data from only one NE measurement tool; and lastly, including data mostly from the general population. The main aim of the study was, thus, to estimate the mean differences in depression, anxiety and stress reported in pre- and during-pandemic studies. The advantage of the present meta-analysis is firstly that it uses data sampled by only one measurement tool, thus reducing variability, secondly, it has a large number of participants, and lastly, it is multi-national.

Current statistical methods in meta-analysis (e.g., standardized mean differences, odds ratio etc.) allow inclusion of outcomes from various measurement tools in meta-analyses. However, for these methods to be valid, the construct being assessed should be the same or similar (e.g., Murad et al., 2019). This assumption can be doubted when outcomes from different tools used in different cultures and language versions are gathered, e.g., due to different factorial structures of tools across languages. Thus, we aimed to only look at the studies that used the Depression, Anxiety and Stress Scale (DASS; Lovibond & Lovibond, 1996). DASS is a well-established emotion assessment tool used both in clinical and general populations (e.g., Norton, 2007; Tran & Fisher, 2013), and is available in 54 languages and has acceptable psychometric properties (http://www2.psy.unsw.edu.au; last

updated July 26, 2018). DASS is comprised of 42 four-point (‘0’ to ‘3’) Likert scale items contributing to three subscales of depression, anxiety, and stress with minimum and maximum total scores of ‘0’ and ‘42’, respectively. DASS-21, is a shorter version of the scale with seven items for each subscale. To interpret the DASS-21 scores, the sums of subscales are multiplied by ‘’2’’ to yield comparable results with the full version (Lovibond & Lovibond 1996). The depression subscale screens dysphoria, hopelessness, self-depreciation, lack of interest, anhedonia, and devaluation of life. The anxiety subscale screens physiological and subjective arousal, skeletal muscle effects, subjective experience of anxious effect, and situational anxiety. The stress subscale measures irritability, difficulty relaxing, impatience, and over-reactivity. For depression, scores within 0-4 are considered as normal, 5-6 as mild, 7-10 as moderate, and 11+ as severe. For anxiety, 0-3 is considered as normal, 4-5 as mild, 6-7 as moderate and 8+ as severe. For stress, total scores within 0-7 is considered as normal, 8-9 as mild, 10-12 moderate and 13+ as severe (Lovibond & Lovibond, 1996).

Prior studies have also shown differences between males and females (e.g., Santomauro et al. 2021; Daniali & Flaten, 2021; Özdin & Özdin, 2020; Niziurski & Shaper, 2021; Hou et al., 2020; Dodd et al., 2021), age groups (e.g., Santomauro et al. 2021; Daniali & Flaten, 2021 & 2021b; Horesh et al., 2020), and the time course of pandemic (e. g., Robinson et al., 2021) on the effects of pandemic on NEs. Moreover, some of the COVID-19 pandemic progress indicators, such as infection rates, have also been shown to affect the mental health of the population (Santomauro et al. 2021). Therefore, these factors were also explored in this meta-analysis to see if the findings are replicated.

The following questions were then addressed as primary aims: a) Is there a difference in depression, anxiety, stress, and/or in overall NEs between before and during the COVID-19 pandemic? b) Are there differences between the continents in depression, anxiety, stress, and overall NEs during the COVID-19 pandemic? c) Are there gender differences in depression, anxiety, stress and/or in overall NEs in studies during the COVID-19 pandemic? Moreover, and as secondary aims, the moderating effects of age, the date of data collection (indicative of the pandemic phase),

the COVID-19 infection and death rates on depression, anxiety and stress in during-pandemic studies were also investigated.

Methods

Search procedure

PsycINFO, PubMed, and Cochrane Library databases were searched from 29.01.2021 to 30.11.2021 (one study, Ruiz et al., 2022, was in press at the time of reviewing process). No specific publication time window was specified for inclusion of studies. Moreover, using the same Boolean key term combinations, the google scholar and grey literature (e.g., arXiv.org) were manually searched to check for pre-prints etc., and relevant hits were added (43 studies). As the main aim of the study was investigating the differences in depression, anxiety and stress between before and after the incidence of the COVID-19 pandemic (i.e., pre and during pandemic studies), different Boolean term combinations were used for pre- and during-pandemic studies in each database. For pre-pandemic studies, the Boolean key term combination of ''DASS-21'' OR ''DASS'' AND ''general population'' AND ''normative data'' were searched. For during-pandemic, the same Boolean key term combination as used for the pre-pandemic search was used; also, the Boolean terms ''COVID-19'' AND ''coronavirus disease 2019'' AND ''DASS-21'' OR ''DASS'' were used in searching each database for during-pandemic studies. No limitation was made in searching of the databases (see the PRISMA checklist in the Supplementary materials). The term ''cornonavirus disease 2019'' was used to sort out studies on other types of coronavirus family (e.g., MERS-CoV). This review was conducted according to PRISMA guidelines (Page et al., 2021).

Study Selection and Data Extraction

The first author (HD) extracted the hits, and the first author and a graduate student assistant separately reviewed all the extracted hits. As two categories of hits (before and during the COVID-19) were extracted, two sets of inclusion/exclusion criteria were schemed as well. The inclusion criteria for during-pandemic studies were as followed: a) only studies that tested depression, and/or

anxiety, and/or stress measured by DASS (either 42-item or 21-item form) after the start of the COVID-19, and b) on healthy adult subjects (i.e., non-clinical samples without any known/reported conditions) were included. For pre-pandemic studies, a) only studies that reported depression, and/or anxiety, and/or stress measured by DASS, b) on healthy adult samples were included. Respecting the exclusion criteria for both pre- and during-pandemic studies, a) studies on patients, b) medical health personnel that were in frontline of medical care service for the COVID-19, c) non-English manuscripts (except one study in Persian, see Supplementary materials Table 1), and d) studies on children and adolescents (age < 18) were excluded. No restrictions on the types of the studies were made, so clinical/experimental or observational studies that compared a healthy sample with a non-healthy or a specific population were also included and if eligible, the parameters from the healthy sample were included. Also, no restriction on the method of sampling for studies were made. Primary target outcomes were depression, anxiety, and stress. The secondary target outcomes were age, sex, sample type, and the date of data collection (for during-pandemic studies). The primary target population was healthy adults from the general population but other samples (e.g., students) were also included. The inclusion process is presented in Figure 1.

Please put Figure 1 here

The search for both pre- and during-pandemic studies resulted in 2043 hits. After removing the duplicates, the title and abstracts of the publications were reviewed by the first author and the grad. student assistant, and 202 studies were included. Next, the manuscripts of the included hits were thoroughly reviewed. The first author (HD) reviewed all the included studies and the 2nd (MAF) and 3rd (MM) authors each randomly reviewed 20% of the included studies. As some of the included studies using DASS-21 had not reported the procedure by which the total sums of the DASS-21 subscales had been calculated (i.e., whether the sums of the subscales have been multiplied by ‘‘2’’ or not), the authors of such studies were contacted and asked for such information. The studies which their authors did not reply to our inquiries were excluded (46 studies). Finally, a total of 59

studies for both pre- (19 studies) and during-pandemic (37 studies), and three studies with both before and during the pandemic samples (Brailovskaia & Magraf 2020; Sherman et al., 2021; and Zinchenko et al., 2021) reporting on *K* = 107 during and *K* = 27 before the pandemic samples (*K* = 134 in total) with some reporting data from more than one country were included. The authors' name, publication year, sample size (including the proportion of females), means and standard deviations (*SD*) for depression, anxiety, and stress for the total sample and for males and females (if reported) respectively, age (mean), sample type, and data collection date (for during-pandemic studies, if reported), the country of the sample (for all studies) were extracted and reflected in Supplementary materials Table 1. The population-adjusted rates (number of infections/deaths per 100K population) of the COVID-19 infection and death rates at the time of data collection of the during-pandemic studies were extracted from https://news.google.com/covid19/map.

Statistical Analyses

Meta-analyses were conducted using the Comprehensive Meta-Analysis V3.3 program (Borenstein et al., 2013). SPSS (v 27.0) was used for descriptive statistical analyses. Since the same measure and scoring procedure was used for all included studies, the unstandardized mean score was used as an effect size measure to test the differences between pre- and during-pandemic times. The weighted mean differences were then compared to the normative standard deviations (*SD*) of depression (*SD* = 7.74), anxiety (*SD* = 5.90), stress (*SD* = 8.40) of DASS-21 (doubled) reported by Henry and Crawford (2005). Later studies reported similar (e.g., Sinclair et al., 2012) and unsimilar (e.g., Bibi et al., 2020) parameters to Henry and Crawford (2005), therefore, the weighted mean differences were also compared to the *SDs* from Scholten et al. (2017), which reported data from four countries including USA, Poland, Russia, and the UK (total *N* = 5890). In their study (Scholten et al., 2017), the average of the *SD*s for four countries for depression (Poland = 4.35, Russa = 3.82, UK = 4.17, and the US = 4.35), anxiety (Poland = 3.68, Russa = 3.68, UK = 3.37, and the US = 4.06), and stress (Poland = 4.86, Russa = 4.52, UK = 4.48, and the US = 4.72) were 4.17, 3.69, and 4.64

respectively (see Supplementary materials page 11). Hedges' g measure of effect size was used to calculate gender differences for studies reporting results separately for men and women. The mean weighted score was calculated for studies conducted in pre- and during-pandemic respectively, and the overall mean of NEs was computed by CMA as a mean of depression, anxiety and stress per study. Studies were weighted by the inverse of the variance components comprised of both random variation (sampling error) and true variation between studies in the meta-analysis calculations (Borenstein et al., 2009). For all meta-analysis calculations, a random effects model was estimated provided a minimum of three samples were available. For group comparisons mixed effects analysis was conducted. To examine variation between samples, a homogeneity test was performed adopting a fixed effect model (Q statistics; Borenstein et al., 2009). A significant result (Q) indicates heterogeneity and the need to further examine moderators that may explain the true variance between studies (Hedges & Olkin, 1985). The I^2 index informs about the proportion of the true variance beyond the sampling error (Borenstein, Higgins, Hedges, & Rothstein, 2017). After identifying the studies that had not multiplied the sums by ''2'', the 'non-multiplied' sums were then multiplied by ''2'' before data was included in the datasheet. The effects of age, sample type (whether the general public or other samples), population adjusted infection and death rates (per 100K population), and sampling time (indicating the phase of the pandemic in which the samples were recruited) in during-pandemic NEs were tested as moderators to further investigate the source of variations in NEs. To include the sampling date, the number of the month in which the sample was recruited, starting from ''1'' assigned to 'January 2020', up to ''17'' assigned to 'May 2021' (17 months since January 2020), was entered to the dataset as a continuous variable. The sampling date of the during-pandemic studies was used to extract the COVID-19 population-adjusted infection and death rates (i.e., the total number of infection/death cases divided to the country population and then multiplied by 100,000: $\frac{infection/death\ N}{Country\ population} \times 100{,}000$). The starting date of data collection was used to extract the rates. For the studies which only mentioned a month (and no days) in which the data collection was conducted, the middle of that month was used to extract the rates. For the studies

that reported a period for the sampling date, (e.g., from April to June 2020), the end of the sampling period was used to extract the rates. All moderators were continuous, expect for sample type (General public or Other) which was dichotomous, therefore, meta-regression analyses employing a random effects model with full maximum likelihood estimation were performed.

Risk of Bias and Quality Assessment

To assess the quality of the included studies, a tool used by Pettersen et al. (2021) was used. More information about the tool and the methods used to assess the quality of the studies can be found in Supplementary materials page 4-5.

Transparency and Openness

We adhered to the PRISMA 2020 guidelines for systematic reviews (Page et al., 2021), and preregistered the project at PROSPERO (see Supplementary materials, the PRISMA checklist for the link to the pre-registration protocol). The aims of the study did not change during the project, however, a few revisions were made to the registered protocol, mostly due to the need for extending the review period. The list of the excluded studies is available in the PRISMA checklist provided in the Supplementary materials. All data and research materials (including our coding scheme) will be made available at a stable link to repository.

Results

Descriptive Characteristics

NEs were reported using DASS or DASS-21 from 134 (K = 107 during the pandemic and K = 27 before the pandemic) samples including 193,337 participants from 47 countries, with some countries having more than one sample. The majority of the studies were taken from the general population, and 13 samples were from specific populations (e.g., students, elderlies, ophthalmologists, and athletes; see Supplementary materials, Table 1). Sixty-nine samples (16 before and 53 during samples) were European (141,292 participants), 38 samples (six before and 32 during samples) Asian (38,127 participants), 20 samples (four before and 16 during samples) American (12,348 participants), four during-pandemic African samples (1,393 participants) and three

Australian (one pre and three during-pandemic samples including New Zealand; 177 participants; see Supplementary materials, Table 2). Twenty-seven samples were pre-pandemic (71,236 participants) and 107 were during-pandemic (122,101 respondents). The publication years ranged, for during-pandemic studies, from 2020 to 2022, and for pre-pandemic studies from 2005 to 2019. The mean age for pre-pandemic samples was 32.90 (*SD* = 11.28) and for during-pandemic samples was 34.09 (*SD* = 7.87). For during the pandemic studies, 42 samples reported their data collection date, of which 21 (50%) samples had been collected in March 2020 (see Supplementary materials Table 1). Characteristics of the individual studies are provided in Supplementary materials, Table 1.

Pooled Mean Difference in Negative Emotions Between Pre- and During-Pandemic Times

There was significantly higher levels of depression, anxiety and stress during the pandemic compared to before the pandemic (Table 1). The comparison of Pre - During $mean_w$ differences with the reported normative *SDs* of depression (*SD* = 7.74), anxiety (*SD* = 5.90), and stress (*SD* = 8.40) of DASS-21 by Henry and Crawford, 2005, and *SDs* of depression (*SD* = 4.17), anxiety (*SD* = 3.69), and stress (*SD* = 4.64) reported by Scholten et al. (2017) showed that globally, the increase in depression from before to during pandemic (*Pre – During* $Mean_w$ *Diffs* = 3.72) was almost equal to half a *SD* as compared to Henry and Crawford (2005) and about 80% of one *SD* as compared to Scholten et al. (2017). The increase in anxiety (*Pre – During* $Mean_w$ *Diffs* = 1.47) and stress (*Pre – During* $Mean_w$ *Diffs* = 2.86), were both statistically significant and equal to one-third of a *SD* as compared to Henry and Crawford (2005) and about 40% of one *SD* for anxiety, and 60% of a *SD* for stress as compared to Scholten et al. (2017) (see Table 1). The variance between studies was significant for all categories (Depression, Anxiety, Stress, & Overall) as shown by the significant Q-values (Table 1) indicating the possible role of moderators. Corresponding results for each continent are presented in Table 2. In Asia depression and stress significantly increased, depression by more than a half of a normative *SD* compared to Henry and Crawford (2005), and more than one *SD* as compared to Scholten et al. (2017); and stress more than one-third of a normative *SD* as compared to Henry and Crawford

(2005), and about one normative *SD* as compared to Scholten et al. (2017), from before to during the pandemic (Depression *Pre – During Mean*$_w$ *Diff* = 4.92; Stress *Pre – During Mean*$_w$ *Diff* = 4.50), whereas in Europe, only the increase in depression (*Pre – During Mean*$_w$ *Diffs* = 3.46) was significant which was similarly close to half a normative *SD* compared to Henry and Crawford (2005), and about 80% of one *SD* compared to the *SD* reported by Scholten et al. (2017). In America, no differences between before and during the pandemic NEs were significant. Lastly, in Europe, Asia, and America, depression was the NE with the largest increase, followed by stress and then anxiety from before to during the pandemic times, even though the increases in NEs in America did not reach significance (Table 2). There was significant variation between studies for all categories also when studies were analyzed per continent (Table 2).

Please put Table 1 here

Please put Table 2 here

Age, Pandemic Phase, Infection and Death Rates, and Negative Emotions

To test if the moderators age, sample type (whether the general public or students), the time-phase of the pandemic (sampling time), and the COVID-19 adjusted infection and death rates predicted NEs during the pandemic, nine separate meta-regressions were performed with NEs as dependent (each entered in separate regressions) variables. America was not analyzed separately due to insufficient number of samples ($K = 7$). Australia and Africa were also not separately analyzed due to the same reason ($K < 3$). The global results showed that none of the moderators predicted global depression, however, sampling time and age negatively, and infection rate positively, predicted stress globally; sample type also negatively predicted anxiety globally (meaning that non-general samples, mostly students, had higher anxiety globally) (see Table 3).

In Europe, age and the sample type negatively predicted depression, anxiety, and stress, meaning that being a student and younger predicted higher NEs. The sampling time (indicative of the pandemic phase) was negatively associated with anxiety (close to significant $p = .06$) and stress, meaning that the later date of the pandemic was associated with lower NEs in Europe. Lastly, the

COVID-19 infection rate was positively associated with higher stress and anxiety in Europe. In Asia, it was only the age that positively predicted anxiety (see Table 3)

Please put Table 3 here

Standardized Mean Differences (Hedges' g) of Negative Emotions Between Males and Females

Globally, females had higher depression, anxiety, and stress than males in both before and during the pandemic (Table 4). The *Hedges' g* for male and female mean differences in depression, anxiety and stress during the pandemic was between 0.22 to 0.31 suggesting a small effect size (Cohen, 1988) (Table 4). To test the gender differences in NEs from before to during the pandemic, males and female mean differences were analyzed separately, and the results showed that even though both genders' NEs increased from before to during the pandemic, females had significantly higher increases in depression and anxiety from before to during the pandemic, compared to males (see *Pre – During Mean$_w$ Diffs* column in Supplementary materials, Table 3). The male and female differences in NEs were then tested across continents (Asia, America and Europe for depression; and Asia and Europe for anxiety, stress and overall score, due to insufficient number of samples ($K < 3$) from America, Africa, and Australia; Table 5). In Europe, females had significantly higher NEs than males in all three NE dimensions. In Asia and America no significant gender differences in NEs were observed (Table 5). Analyzing the male and female differences separately across continents showed that in Europe, females had significantly higher depression and anxiety compared to before pandemic times, while males only had significantly higher depression. No increase in NEs for males nor females reached significance in Asia, however, the increase in depression for Asian females from before to during the pandemic was close to significance ($p = .06$) (Supplementary materials Table 4).

Please put Table 4 here

Please put Table 5 here

Risk of Bias Assessment Results

The inter-rater reliability for the sum of ratings was .85 (lower bound = .80, upper bound = .90). Moreover, the Intra-class correlation range between the coders for individual items was .44 to .85. The results of the risk of bias and quality assessments showed that out of 59 included studies, eight were scored as with poor quality, 41 as with satisfactory, and 10 ranked as with excellent quality. The overall score for each assessment item varied from 101 up to 180, with item '1' (concerning the response rate) and item '4' (concerning the missing data) with the lowest rankings of the total scores of 101 and 108, respectively, and item '6' (concerning the statistical analyses) with the highest ranking with the total score of 190 (see Supplementary materials Table 5). The quality assessment scores did not predict NEs, which indicated that the results were not affected by the quality of the meta-analyzed studies.

Discussion

The present meta-analysis investigated the global effects of the COVID-19 pandemic on depression, anxiety, and stress on data from 47 countries.

Globally, depression, anxiety, and stress were elevated during the pandemic compared to before the pandemic. The before-during pandemic mean differences in depression was equal to about half a normative *SD* in depression reported by Henry and Crawford (2005), and about 80% of a normative *SD* in depression reported by Scholten et al. (2017), while the before-during pandemic mean differences in anxiety and stress were about one-third of a normative *SD* compared to Henry and Crawford (2005); and about 40% of one *SD* for anxiety and 60% of a *SD* for stress as compared to *SDs* reported by Scholten et al. (2017). Therefore, depression is the NE with the largest increase following the COVID-19 pandemic, even though anxiety and stress also increased. In other words, during the COVID-19 pandemic, individuals reported on average, at least about half a *SD* (as a medium effect size; Cohen 1988) more dysphoric symptoms, hopelessness feelings, self-depreciative and devaluative thoughts, lack of interest, and anhedonia. Regarding anxiety, individuals reported at least around one-third of a normative *SD* more physiological arousals, skeletal muscle effects,

subjective anxious effects, and situational anxiety; and regarding stress symptoms, individuals had at least one-third of a normative *SD* more irritability, difficulty relaxing, impatience, and over-reactivity during the pandemic compared to before the pandemic. This confirms the detrimental effects of the COVID-19 pandemic and its related burdens on individuals' well-being (e.g., Bueno-Notivol, 2021; Holingue et al., 2020; Eisenbeck et al., 2022).

Heightened NEs have been reported during previous pandemics (Ebola: Van Bortel et al., 2016; SARS; Chew et al., 2020; MERS CoV: AlNajjir et al., 2017), even though the scale of the pandemics were smaller. Therefore, the spread of communicable diseases can cause great psychological harms to the public. Being exposed to uncontrollable events for a long time triggers feelings of helplessness and lack of motivation, which may lead to NEs such as depression and anxiety (e.g., Seligman 1972; Asmundson & Taylor, 2020). The uncertainty about the course of the pandemic, several phases of home confinement and quarantine, conflicting and rapidly changing rules, re-inflations in the infection rates emergence of new variants of the virus, socio-economic losses such as unemployment (Kazmi et al., 2020), and lack of social support (Ni et al., 2020), plus constant concerns about the well-being of own or others are just some sources of NEs in general populations.

A meta-analysis by Bueno-Notivol et al. (2021) reported the prevalence of depression during the pandemic was seven times higher than before the pandemic reported by Dunstan et al. (2017). However, caution is needed in drawing of conclusions, as the main source of the heterogeneity was reported to be due to the inclusion of data from different measurement tools. This is not a concern in the present study, as only outcomes from one assessment tool have been extracted. Santomauro et al. 2021 reported that the increase in the prevalence of depressive and anxiety disorders from before to during the pandemic times were 27% and 25%, respectively. Consensually, our findings show that the mean of depression has gone up from 7.06 in before the pandemic times, to 10.78 during the pandemic times, suggesting a 40% increase or approximately half a normative *SD* compared to normative *SD*s reported by Henry and Crawford (2005), which is considered a medium

effect (Cohen, 1988). This study also showed that in addition to depressive and anxiety symptoms, stress was also elevated during the pandemic.

Even though all three NEs have been elevated globally from before to during the pandemic, in Europe only depression, and in Asia depression and stress were significantly elevated. In America no significant difference in NEs between before and during the pandemic were observed. This finding suggests continental differences in the effects of COVID-19 pandemic on NEs. Moreover, compared to anxiety and stress, depression had the highest elevation from before to during the pandemic. Santomauro et al. 2021 also reported the prevalence of depressive disorders to be higher than the anxiety disorders during the pandemic. Wang et al. (2021) meta-analyzed the prevalence of depression, anxiety and stress among college students during the pandemic and similarly reported depression with the largest prevalence rate, followed by anxiety and stress. However, most of the population in their meta-analysis were Chinese college students, who were reported to have lower prevalence of NEs as compared to non-Chinese students.

Our between-continental sub-analyses, however, posed Asians as having the highest degrees of elevations in all NEs, specifically depressive and stress symptoms, as compared to European and Americans. This contradicts findings from some studies where western countries have a higher prevalence of affective disorders (e.g., De Vaus et al. 2018). Our data do not explain the reason for this continental difference and further work is required. It is also not clear whether the heightened NEs in Asia is transient or not, even though our data suggested that the passage of time may alleviate the heightened NEs. Our findings are contrasting with the studies suggesting higher depression and anxiety during the COVID-19 pandemic for countries with higher income and human development indexes (e.g., Tyler et al., 2020).

No statistically significant heightened NE during the pandemic was observed in American samples, even though the NEs during the pandemic were still higher than the NEs from pre-pandemic. This can be due to the lower number of samples (e.g., four before-pandemic samples) for

American countries. Therefore, we assume our sub-analyses of the American data are not conclusive.

During the pandemic, a later sampling date was associated with lower stress globally, and stress and anxiety (marginally) in Europe. This suggests that during the pandemic, individuals experienced less stress globally and less stress and anxiety in Europe over time, which is in line with the studies suggesting a modulating effect of time on NEs during the pandemic. Robinson et al. (2021) meta-analyzed longitudinal during-pandemic studies on NEs and reported a decrease over time. However, such an effect was not observed in studies from Asian countries in our data. The insignificant effects of time have also been reported from European studies. Johansson et al. (2021), measured NEs in three different pandemic phases and reported small insignificant reductions in anxiety and stress and increases in depressive symptoms over time. Our study, on the contrary, did show an adaptive effect of time, for stress levels globally and across Europe, for at least the first six months since the beginning of the outbreak, as most of the meta-analyzed samples have been collected during this time bracket.

Moreover, our meta-regressions indicated an effect for adjusted (per 100K population) COVID-19 infection rates on NEs, and no effects for adjusted (per 100K population) death rates. Globally, infection rate positively predicted stress, and anxiety and stress in Europe, meaning that the higher the infection rates were, the individuals had globally more stress and more stress and anxiety in Europe. The effects of the COVID-19 infection rate on depressive and anxiety disorders have been shown previously (Santomauro et al. 2021), and our study replicates those findings. Such findings are not unexpected as the strictness level of lockdowns and infection control measures has been highly dependent on such rates. No such effects for infection rates were seen in Asian and American samples. Lastly, the COVID-19 death rates failed to predict NEs. The nonsignificant effect of the COVID-19 death rates could be due to the high collinearity between the death and infection rate moderators (Santomauro et al. 2021).

Globally, age was a negative predictor of stress, and in Europe, Age negatively predicted all NEs. Higher NEs and in general worse mental health in younger individuals during the pandemic have been shown in prior studies (e.g., Santomauro et al. 2021; Daniali & Flaten, 2021 & 2021b; Horesh et al., 2020) which suggest that younger people have experienced higher NEs during the pandemic than older individuals. This is probably because of the greater negative socio-economic effects of the pandemic over the lives of younger adults, such as uncertainty about future jobs, being less financially stable, and other economic challenges, to name a few (e.g., Santomauro et al. 2021). Additionally, the social life of young adults is more affected by the aftermath of the pandemic, for example in terms of limited access to formal education (e.g., Santomauro et al. 2021). They are also more exposed to the COVID-19 social media which is shown to be associated with higher NEs during pandemic (e.g., Shiina et al., 2020). The association of older age with lower NEs could also be related to richer life experience of older adults, more stable life states, and also a possible reduced fear of sickness and death among older adults (e.g., Ardelt et al., 2013; Fortner et al., 2000). Scott, Poulin and Silver (2013) showed that after the 9/11 attacks in the US, older individuals were less stressed about future attacks and had less PTSD symptoms as compared to younger ones. Therefore, and in line with de Bruin (2021), it's possible that in times of uncontrollable crises, older individuals implement constructive strategies (e.g., proactive coping i.e., attempts undertaken before a stressful event occurs to change its effects; Aspinwall and Taylor, 1997) to positively regulate their NEs or distance themselves from the stressful event or related thoughts (Neubauer et al., 2019). Similarly, and according to the *socioemotional selectivity theory* put forth by Carstensen, Isaacowitz and Charles, (1999), the acknowledgement of having less time left in life leads seniors towards more meaningful activities and positive experiences which may help them experience less NEs.

Contrary to Europe, in which age was a negative predictor of NEs, in Asia age was positively associated with higher anxiety. To the best of our knowledge, this is the first meta-analysis suggesting differences between continents on the moderating effects of age on effects of the COVID-19 pandemic on NEs. Even though studies have suggested a protective effect for being older

towards NEs in COVID-19 times (e.g., Horesh et al., 2020), our results suggest existence of geographical differences.

Students experienced more stress during the pandemic as compared to the general population samples, and in Europe, students experienced higher NEs in all three aspects compared to the general public samples, implying a lower effect of pandemic on NEs in samples taken from the general population than other more specific samples (e.g., students, athletes etc.). This is in line with the findings on the negative association of age and NEs, suggesting that being younger and being a student is related to higher NEs during the pandemic. This finding also calls for caution when generalizing findings from student samples to general populations, which has been quite commonly done during the pandemic, probably due to the ease of access to student samples. However, in our continental sub-analyses, such between-sample differences in NEs were only seen in Europe, and no differences between samples were seen in Asian studies, which is also in consensus in what is seen on the moderating effects of age on NEs during the pandemic in Asia. Therefore, such differences between general and student samples are most pronounced in European populations. Out of 59 included studies, only 13 of them had samples not taken from the general public, therefore the majority of the samples included in this meta-analysis were from the general population.

Globally, females had higher elevations in NEs during the pandemic compared to males. Higher NEs in females during the pandemic have been reported before (e.g., globally: Santomauro et al. 2021; Turkish Sample: Özdin & Özdin, 2020; German and the US samples: Niziurski & Shaper, 2021; Chinese: Hou et al., 2020; Australian: Dodd et al., 2021) and mostly explained through the discrepancies that exist between male and female social status in pandemic times (e.g., Santomauro et al. 2021; Dodd et al., 2021). The higher NEs in females during the pandemic have been attributed to the multifactorial sources of distress females are usually put through; for instance, female caregivers are exposed to higher risk of contracting SARS-CoV-19; during the pandemic, females have experienced more partner violence; and females usually receive less income than males (e.g., Conner et al., 2020).

However, male and female disparities have also been reported prior to the pandemic (McLean & Anderson, 2009). Girls are more prone to develop affective disorders than boys (e.g., Lewinsohn et al., 1998; Muris & Ollendick, 2002); and females have higher lifetime prevalence of affective disorders such as general anxiety, compared to males (e.g., Kessler et al., 1994; Líndal & Stefánsson, 1993). The results of our meta-analysis, along with other similar findings illustrate females' mental health to be more negatively affected by the pandemic than males.

European females were shown to have higher elevations of NEs from before to during the pandemic as compared to Asians and Americans, which could be an indication of continental or regional disparities in gender differences in NEs during the pandemic, which should be further investigated in future studies.

Our data only allowed to test the before-during difference for depression in American samples, which showed no significant increase in depression from before to during the pandemic times. However, this should be re-tested in future studies comprising larger American samples.

Conclusion

The results of this meta-analysis documented higher NEs in the general population during the pandemic compared with pre-pandemic times. Even though the effects of the pandemic and the strategies implemented to handle the crisis highly differ across countries, individuals still have experienced higher depression, anxiety, and stress over the course of the pandemic. Our results confirm the increase of NEs in general population during the pandemic and highlight the importance of predicting and implementing customized strategies and schemes to maintain and secure a healthy level of mental health for the general public as the results of our study, in line with former studies, suggest that the mental health of the population, and in particular young adults and females, should also be taken into serious account. Our findings also highlight the need for the implementation of multifaceted (social, economic, well-being etc.) programs and policies with a specific focus on

rehabilitation and empowerment of females and younger adults during the pandemic. The national and international public health policy makers are therefore called to design programs and strategies to improve and secure a certain level of mental health for the general public during the pandemic (e.g., Lei et al., 2020).

Limitations

This study bears limitations with regards to interpreting and generalizing the results. First is the inclusion of only one assessment tool. Even though such strategy reduces the error variance (Murad et al., 2019), and that DASS is a globally and widely used NE assessment tool, only looking at one assessment tool reduces the number of studies eligible for inclusion (e.g., low number of included studies from America and Australia). Moreover, among NE assessment tools, DASS is known to over-report symptoms (e.g., Bueno-Notivol et al., 2021), which should also be considered. Even though the current study showed increases in NEs from before to during the pandemic times, we still do not know whether individuals are at a higher risk of developing clinical affective disorders (e.g., depression) during the pandemic or not (e.g., Cavicchioli et al., 2020), even though other studies have reported increases in prevalence of such disorders (e.g., Santomauro et al. 2021). This should be further investigated through future studies focusing on clinical aspects of NEs. Furthermore, most of the studies included were cross-sectional, therefore making it difficult to draw causal conclusions. Additionally, the results may bear some level of bias, as most of the studies included have been on samples taken by convenience and non-probability methods. It should be also noted that the association of later pandemic phase with lower NEs is not necessarily true for every country, as the pandemic could have different stages in different countries at the same time. A large proportion of the samples were from younger individuals with the mean age of 33 for pre-pandemic and 34 for during-pandemic studies, with probably higher education levels. Also, online sampling methods which have been commonly used during the pandemic, may have affected the results. However, as the results for the assessment of the risk of bias and the quality of the meta-analyzed studies showed, no study was rated as with a ‘very poor and unreliable’ quality, and most of them were

rated as satisfactory or excellent. We did not have a publication time limitation for pre-pandemic studies, and the publication year for the pre-pandemic studies ranged from 2005 to 2019, which could have affected the representativeness of NE means for pre-pandemic times. However, out of 27 meta-analyzed samples, only seven samples were from before 2015 (two from 2005, and five between 2011 to 2014; see Supplementary materials Table 1). Therefore, most of the samples were collected after 2015. Moreover, the weighted mean differences of pre to during pandemic NEs were compared with two sets of normative *SD* in NEs, one with higher *SD*s reported from 2005 by Henry and Crawford, and one with lower *SD*s from 2017 reported by Scholten et al. (2017; data collected from four countries in 2015). Also Lastly, low number of samples from America, Africa and Australia limited drawing conclusions and the generalizability of our findings.

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Conflict of Interest

Authors declare no conflict of interest.

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Note: References marked with an asterisk indicate studies included in the meta-analysis.

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