Early life adversity, dispositional mindfulness, and longitudinal stress experience during the COVID-19 pandemic

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Abstract

Experiencing severe or prolonged stressors in early life is associated with increased risk for mental and physical disorders in adulthood. Further, individuals who experienced early life stress (ELS) may use dysfunctional coping strategies like stress-related eating, in contrast to more beneficial stress buffering mechanisms e.g. based on mindfulness. Whether these mechanisms contribute to increased levels of perceived stress and symptoms of mental disorders in individuals with ELS in times of crisis is yet unclear.

As part of a larger project, we assessed changes in perceived stress and psychopathological symptoms in a sample of N=102 participants (81% female; mean_{age}=23.49, SD_{age}= 7.11, range 18–62) from October/December 2019 (prior to the Covid-19 pandemic) to April/June 2020 (after the German government introduced Covid-19 related restrictions). Additionally, we assessed ELS and dispositional mindfulness.

Perceived stress and depression significantly increased while anxiety levels decreased. No significant change was observed for somatization. ELS and dispositional mindfulness were not associated with change scores, but with perceived stress and psychopathological symptoms at both assessments.

The increase in perceived stress during the pandemic in a majority of participants demonstrates the impact of the pandemic in the general population.

Keywords: perceived stress, psychopathology, early life stress, mindfulness, Covid-19

37 Introduction

38 Man-made or natural disasters, including health threats such as pandemics, are severe real-
39 life stressors that may impact physical and mental health outcomes and health-risk
40 behaviors. Besides the respective physical dangers of the situation, such severe crises also
41 pose a psychological threat. For example, they might increase psychological distress, as well
42 as the risk for stress-related mental disorders (e.g. post-traumatic stress disorder,
43 depression, anxiety), or may lead to a decrease in general mental well-being. Hence, severe
44 crises usually pose enormous challenges for physical and psychological health and
45 economic uncertainty on the majority of the people affected.

46 The current Covid-19 pandemic (World Health Organization, 2020) represents a situation
47 that meets the aforementioned characteristics of a severe real-life crisis. It includes threats
48 for personal health, as well as psychological distress, including the anxiety to get infected,
49 the loss or expected loss of a loved one, social isolation, loneliness, or economic challenges.
50 Several cross-sectional studies during the last couple of months suggested overall high
51 psychological distress in reaction to the Covid-19 pandemic (Huang & Zhao, 2020; Petzold et
52 al., 2020). For instance, Chinese study participants who ruminated more about the outbreak
53 reported worse mental health status (Huang & Zhao, 2020). In a Danish sample, well-being
54 significantly decreased from 2016 to 2020, which the authors attributed at least in parts to the
55 Covid-19 crisis (Sønderskov, Dinesen, Santini, & Østergaard, 2020). Furthermore, the
56 coronavirus outbreak might lead to additional mental health problems such as increases in
57 subjective stress, anxiety, depressive symptoms, insomnia, denial, anger and fear (Torales,
58 O'Higgins, Castaldelli-Maia, & Ventriglio, 2020). Due to the broad impact such health
59 disasters can have on multiple areas of psychological, physiological, and economic
60 wellbeing, there is a need to identify factors that make certain individuals more vulnerable or
61 resilient for the aforementioned adverse psychological consequences to prevent these in
62 future pandemics.

63 The effects of pre-existing risk and protective factors on changes in health outcomes due to
64 global health crises are ideally being investigated in a longitudinal study design that

65 compares measures prior to the crisis with measures during, or after the crisis. Due to the
66 unexpected beginning of such crisis, however, the implementation of such prospective
67 studies often happens by chance. As a consequence, longitudinal studies investigating
68 changes in health outcomes and health-risk behavior in response to a severe crisis in
69 participants with various pre-existing risk and protective factors that affect stress-regulation
70 systems are currently lacking.

71 These factors might include severe or prolonged exposure to stressors and adversity during
72 childhood or adolescence (early life stress; ELS), which can trigger long-lasting changes in
73 psychobiological stress systems (Koss & Gunnar, 2018) and affect how an individual copes
74 with future stressors. These long-lasting psychobiological and psychosocial adaptations have
75 been associated with a higher risk for mental and physical disorders (Lima, Mello, & Mari,
76 2010), and an increased occurrence of displaying health-risk behavior, including stress-
77 related or emotional eating, later in life (Duffy, McLaughlin, & Green, 2018). However, what is
78 also discussed is that ELS may lead to better coping skills and adaptive changes of
79 neurobiological systems that are advantageous when dealing with demanding situations in
80 the future (Santarelli et al., 2017). However, it is still unclear under which circumstances ELS
81 may act as a vulnerability, or a resilience factor.

82 On the other hand, different protective factors can support the individual to handle acute
83 stressful situations. For example, mindfulness – a deliberate, accepting and non-judgmental
84 way of directing one's attention to the present moment (Kabat-Zinn, 2003) – can promote
85 better mental health outcomes (Brown & Ryan, 2003) and may act as a stress buffer (Brown,
86 Goodman, & Inzlicht, 2012). Here, as an additional disadvantage for individuals with ELS,
87 decreased dispositional mindfulness has been associated with exposure to ELS (Whitaker et
88 al., 2014), and might therefore act as a mediator of the relationship between ELS and
89 negative mental health outcomes (e.g. Brett, Espeleta, Lopez, Leavens, & Leffingwell, 2018).
90 Whether dispositional mindfulness is a mediator or modulator of changes in health outcomes
91 and health-risk behavior in response to severe crisis, especially in people with a history of
92 ELS, is yet unclear.

To examine this question in conjunction with the longitudinal impact of the Covid-19 pandemic, this study assessed ELS, current psychosocial stress, common mental health symptoms, and dysfunctional eating behavior just prior to, and then again during the Covid-19 pandemic. In addition, we assessed dispositional mindfulness at the second assessment. We hypothesized that self-reported levels of perceived stress and psychopathological symptoms (i.e. depression, anxiety, and somatization, hypothesis 1), as well as dysfunctional eating behavior (hypothesis 2), would increase from the first to the second assessment. We further expected that the extent of changes in perceived stress and psychopathological symptoms would positively correlate with changes in dysfunctional eating (hypothesis 3). We also hypothesized that participants reporting higher levels of ELS would show a steeper increase in perceived stress and psychopathological symptoms (hypothesis 4). Finally, we explored the role of dispositional mindfulness as a mediator (hypothesis 5.1) or moderator (hypothesis 5.2) in the relationship between the ELS and increases in perceived stress and psychopathological symptoms.

Methods

Participants

The sample of this study was part of a larger research project (<https://osf.io/yd9x5/>), in which we assessed the association between ELS and different indicators of metabolic health outcomes in a sample of 250 German adults. For this study, we recruited a subsample of these participants, who completed the first online assessment between October and December 2019 and consented to be contacted for future studies. The follow-up assessment was online from April to May 2020. Recruitment for the first assessment of the study took place via social media posts, via flyers at the University of Constance and the Constance University of Applied Science, and via a study participant database provided by the University of Constance (SONA). Participants were required to be at least 18 years old, to have sufficient German language skills, and to give written informed consent to pseudonymized data collection and storage. From $N = 250$ (78% female; $mean_{age}=24.39$,

$SD_{age}=8.70$, range 18–67) participants that were included in the statistical analysis of the first assessment, $n = 205$ participants gave their consent to be contacted for future studies. Via e-mail, we invited this cohort to a follow-up survey taking place approximately four weeks after the German government introduced their Covid-19 related restrictions. Out of $N = 125$ data entries at the second assessment, we had to exclude 23 participants due to missing informed consent ($n = 3$) and incomplete ($n = 4$) or repeated ($n = 16$) study participation, resulting in a final sample of $n = 102$ participants (81% female; $mean_{age}=23.49$, $SD_{age}= 7.11$, range 18–62 at second assessment). The sample characteristics are listed in Table 1. Overall, 82% of the sample had completed the Abitur or an equivalent (German university entry requirement), 4% had completed a vocational training, 7% had completed a Bachelor's degree, 6% a Master's degree, and 1% had completed a PhD. At the second assessment, 85% of the sample resided in the German federal state of Baden-Württemberg. Governmental restrictions in Baden-Württemberg in April 2020 included a minimum of 1.5m distance to other persons, closure of shops that were considered non-essential as well as closure of recreational areas like zoos and botanical gardens, religious gathering sites, and playgrounds. Furthermore public gatherings were restricted to a minimum and schools and childcare services were at least partially closed (Steinmetz, Batzdorfer, & Bosnjak, 2020). First governmental restrictions in the German federal state of Baden-Württemberg had been introduced by mid-March 2020. Universities started closing on March, 11th 2020. By the time of this survey financial and organizational regulations regarding the upcoming semester were yet unclear. For study reimbursement, participants were offered to participate in a raffle of three €50 Amazon vouchers at the first and second assessment. Psychology students at the University of Constance further received study participation credits. The study protocol was performed in accordance with the Declaration of Helsinki and was preregistered online at the Open Science Framework (<https://osf.io/pxzt3>).

Table 1. Descriptive baseline statistics of participants completing the follow-up at the second assessment, and comparison to the sample that was assessed at the first assessment.

Variable	Follow-up sample at first assessment (<i>n</i> = 102)	Full sample at first assessment (<i>n</i> = 250)	Difference <i>p</i>
Age (years)	22.94 ± 7.13	24.39 ± 8.70	<i>p</i> = .106
Sex (female/male/diverse) ^a	83/19/0	194/56/0	<i>p</i> = .522
Gender identity (female/male/none) ^a	81/20/1	191/56/3	<i>p</i> = .828
BMI	22.40 ± 3.47	22.42 ± 4.13	<i>p</i> = .966
Nationality (German/not German) ^a	97/5	231/19	<i>p</i> = .498
Student status (student/other) ^{a, d}	94/8	212/35	<i>p</i> = .145
Education (lower than Abitur/Abitur or higher) ^{a, e}	0/102	8/239	<i>p</i> = .148

Note. If not otherwise specified, a t-test was calculated to test whether the two samples differed in respect to the listed variables. In these cases, data is expressed as *mean ± standard deviation*.

^a Pearson's Chi-squared test was calculated to test whether samples differed in respect to the listed variable. Instead of *mean ± standard deviation*, absolute numbers per cell in the contingency table are given.

^b Gender identity was assessed on a visual analogue scale ranging from -5 (labelled "male"), over 0 (labelled "none") to +5 (labelled "female"). Rating below -1.67 were categorized as "male", ratings between -1.67 and 1.67 were categorized as "none", and ratings greater than 1.67 were categorized as "female".

^d The category "student" involves fulltime and part-time students. *N* = 247 cases reported from the complete sample due to three missing data.

^e Education was assessed in a categorial manner. For this description, we used a binomial variable indicating whether someone passed Abitur (or an equivalent) or not. Passing Abitur (or an equivalent) is the German university entry requirement. *N* = 247 cases reported from the complete sample due to three missing data.

145 Procedure

146 The data was collected via online surveys using the online questionnaire platform Qualtrics
 147 (<https://www.qualtrics.com>). The survey took between 30-45 minutes to complete. During the
 148 first and second assessment, participants provided information on demographic data, and

completed questionnaires on ELS, eating behavior, stress and symptoms of psychopathology. At the second assessment, participants were also asked to provide information on how Covid-19 affected their daily life and completed a questionnaire on dispositional mindfulness.

Questionnaires

Early life stress

To assess ELS, participants completed the German version of the Parental Bonding Instrument (PBI, Parker, Tupling, & Brown, 1979) during the first assessment. Participants were asked to rate both their parents regarding perceived care and overprotection on a 4-point Likert-scale, with higher scores indicating higher perceived care, or overprotection, respectively. In addition, we applied the German version of the Childhood Trauma Questionnaire (CTQ, Bernstein et al., 2003) to assess emotional, physical, and sexual abuse and emotional and physical neglect. Higher scores as measured on a 5-point Likert-scale indicate higher levels of reported childhood trauma on the specific subscales. Both instruments are considered reliable and valid measures of a history of early life stress.

For the statistical analysis, we performed a principal component analysis (PCA) to extract a single ELS factor score from all PBI and CTQ subscales using the R base package *statsv*(R Core Team, 2019). Higher scores indicate higher levels of ELS. Participants with missing values in one of the subscales ($n = 7$) were excluded from the PCA. Details from the statistical analysis of the PCA are presented in the supplementary materials.

Dispositional mindfulness

Dispositional mindfulness was measured during the second assessment using the German version of the Five Facet Mindfulness Questionnaire (FFMQ, Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). The FFMQ consists of 39 items answered on a 5-point Likert-scale and comprises five subscales that operationalize different facets of mindfulness (*observing, describing, non-reactivity, non-judging, acting with awareness*). The FFMQ

shows very good reliability and validity ratings. For the statistical analysis, we used the FFMQ total score as an index of *dispositional mindfulness*.

Perceived stress

Chronic stress was assessed using the German, 10-item version of the Perceived Stress Scale (PSS, Cohen, Kamarck, & Mermelstein, 1983). Participants rated how stressful and uncontrollable they perceived different situations during the past four weeks on a 5-point Likert-scale. A sum score was calculated with higher scores indicating higher levels of *perceived stress*. Good reliability and internal validity have been reported for the 10-item version.

Psychopathological symptoms

The short German version of the Brief Symptom Inventory (BSI-18, Derogatis, 2000), was used to assess psychopathological symptoms. This 18-item version of the BSI measures symptom severity of depression, anxiety, and somatization during the past 7 days on a 5-point Likert-scale. The instrument exhibits good reliability and validity as well as high correspondence with psychotherapist-ratings.

Eating behavior

Changes in eating behavior in response to stressful or emotional situations was assessed using the German versions of the Salzburg Stress Eating Scale (SSES, Meule, Reichenberger, & Blechert, 2018b) and the Salzburg Emotional Eating Scale (SEES, Meule, Reichenberger, & Blechert, 2018a). The SSES comprises 10 items, and the SEES contains 20 items that are both rated on 5-point Likert scales. In both questionnaires, the participant rates whether he/she eats less, the same amount, or more food in stressful, or difficult emotional situations. While the SSES is a one-factorial questionnaire focusing on stress-related eating, the SEES includes the subscales *happiness-*, *sadness-*, *anxiety-* and *anger-related eating*. Mean scores were used for the statistical analysis, indicating decreased food intake in response to the situation when the score is below 3, unchanged food intake when

the score is equal to three, and increased food intake when the score is greater than three.

Both instruments have been validated and show good reliability.

Covid-19 related measures

At the second assessment, Covid-19 related measures were assessed using a subset of the Psychological Item Pool for Corona Outbreak (PIPICO, Buecker et al., 2020). The PIPICO is a German/English item pool that comprises both, a variety of self-constructed items and adapted items from existing scales, to assess psychosocial effects of the Covid-19 pandemic. In our study, we included questions assessing participants' Corona-related symptoms, and current diseases that increase the risk for complications related to the SARS-CoV-2 virus (risk assessment). Further we asked whether they or members of their household (A) were tested for the virus, and (B) were in quarantine (binary answer). Lastly, we used the PIPICO loneliness scale, which measures loneliness on five questions using a 5-point Likert scale. Instead of referring to the current day, we modified the temporal frame so that participant rated the questions in reference to the last week. For subsequent analyses, we computed a sum score as an index for *loneliness*.

Additional measures

In addition, at the second assessment, the uncertainty subscale of the German version of the Stress and Coping Inventory (SCI, Satow, 2012) was administered. The SCI measures current constraints due to uncertainty in different areas of life, e.g. job, family, living conditions, on a 7-point Likert-scale. We calculated a sum score depicting cumulated *uncertainty strain*.

The exhaustive study protocol is available online at the Open Science Framework project (<https://osf.io/pxzt3>).

Handling of missing values

Missing values were imputed using the item median. If more than 30% of the items of a (sub)scale were missing for a participant, the participant was excluded from the analysis comprising this (sub)scale.

Statistical analysis

We calculated change scores by subtracting the score at the first assessment from the score at the second assessment to obtain the following outcome variables: *perceived stress change*, *depression change*, *anxiety change*, and *somatization change* as well as *stress-related*, *happiness-related*, *sadness-related*, *anxiety-related* and *anger-related eating change*. Analyses were conducted using R version 3.5.3 (2019-03-11), RStudio version 1.1.463, and the packages *psych* (Revelle, 2018), *ez* (Lawrence, 2016), *apa* (Gromer, 2020), *mediation* (Tingley et al., 2014), *ggplot2* (Wickham, 2016) and *patchwork* (Pederson, 2020). The level of significance was set to $\alpha=.05$. A preregistration of the main analyses has been published online on April 29, 2020 (registration DOI: 10.17605/OSF.IO/PXZT3).

To detect potential confounding variables, we conducted Pearson's and Spearman's correlations depending on variable characteristics between the various change scores and the variables age, sex, gender identity, education (at first assessment each), loneliness, uncertainty strain, and Covid-19 related variables. Variables that were significantly associated with the change scores were included as covariates in the subsequent statistical analyses.

To test whether self-reported levels of stress and psychopathological symptom severity (hypothesis 1), as well as stress-related and emotional eating behavior (hypothesis 2) increased from the first to the second assessment, we used separate repeated measures AN(C)OVAs with the dependent variables *perceived stress*, *somatization*, *depression*, *anxiety*, as well as *stress-*, *happiness-*, *sadness-*, *anxiety-* and *anger-related eating*, and the independent variable *time* (pre and post assessment).

To test hypothesis 3 (association of changes in perceived stress and psychopathological symptom severity with changes in eating behaviors) and hypothesis 4 (ELS as a predictor of changes in perceived stress, psychopathological symptom severity, and eating behaviors), we computed multiple linear regression models.

To test whether dispositional mindfulness mediated (hypothesis 5.1), or moderated (hypothesis 5.2) the relationship between ELS and the change scores, we used bootstrapping mediation models, or moderation models respectively, with the change scores as dependent variables, ELS as the independent variable, and *dispositional mindfulness* as the mediator, or moderator, respectively.

Results

Covid-19 related sample characteristics

For general sample characteristics at first assessment see Table 1. At the second assessment, 12% of the participants reported experiencing Covid-19 associated symptoms, 3% had been tested to date with no participant in this sample showing a positive test result. 28% reported to be quarantined and 8% were classified as persons at risk due to being older than 50 years or having relevant chronic diseases. Moreover, 14% reported experiencing an incisive event within the last four weeks, e.g. demise of a loved one, break-up, or severe illness. Regarding living conditions at the second assessment during the Covid-19 pandemic, 26% reported to live with their parents, while 23% lived alone. About 75% of the sample reported to have access to outdoor living space (e.g. a garden or balcony). Overall, participants reported moderate *loneliness* ($mean = 2.58$, $SD = 0.88$) and *uncertainty strain* ($mean = 19.23$, $SD = 7.45$).

Detection of potential covariates

Increased *perceived stress change* was significantly associated with female *gender identity*, $r_s(100) = .20$, $p = .042$, higher *loneliness*, $r_s(100) = .20$, $p = .049$, and higher *uncertainty strain*, $r_s(100) = .23$, $p = .022$.

Increased *depression change* was significantly associated with higher *loneliness*, $r_s(100) = .41$, $p < .001$, higher *uncertainty strain*, $r_s(100) = .25$, $p = .011$, female sex, $r_p(100) = -.20$, $p = .043$, and *being quarantined*, $r_p(100) = -.27$, $p = .006$.

Increased *anxiety change* was significantly associated with higher *income*, $r_S(100) = .21$, $p = .034$.

Increased *happiness-related eating change* was significantly associated with more *incisive life events* within the past four weeks age, $r_P(100) = .20$, $p = .046$.

Increased *sadness-related eating change* was significantly associated with older age, $r_S(100) = .21$, $p = .035$, and increased BMI_{pre} , $r_S(100) = .21$, $p = .032$.

Increased *anxiety-related eating change* was significantly associated with lower *education*, $r_P(100) = -.25$, $p = .012$.

Thus, these variables were evaluated in particular subsequent analyses.

All other criterium were not significantly related to the potential covariates (all $p > .05$), thus no covariates were included in the respective subsequent analyses.

Changes in perceived stress and psychopathological symptoms over time (hypothesis 1)

Changes in levels of perceived stress, depression, anxiety and somatization from first to second assessment are shown in Figure 1.

Figure 1. Changes in levels of perceived stress (A), depression (B), anxiety (C) and somatization (D) from first (pre Covid-19) to second (during Covid-19) assessment. Values are depicted as *mean $\pm$ standard deviation*. * indicates a significant change from pre to post assessment.

297

298 Levels of perceived stress significantly increased by 16% from first to second assessment,
 299 $F(1, 101) = 18.27, p < .001, \eta^2_{\text{partial}} = .15$. Including the variables *gender identity*, $F(1, 98)$
 300 $0.04, p = .84, \eta^2_{\text{partial}} < .01$, *loneliness*, $F(1, 98) = 29.65, p < .001, \eta^2_{\text{partial}} = .32$ and
 301 *uncertainty strain*, $F(1, 98) = 70.86, p < .001, \eta^2_{\text{partial}} = .53$, in the repeated-measures
 302 ANCOVA confirmed the significant effect of time, $F(1, 101) = 18.27, p < .001, \eta^2_{\text{partial}} = .15$.

303 Likewise, depression levels significantly increased from first to second assessment by over
 304 19%, $F(1, 101) = 8.29, p = .005, \eta^2_{\text{partial}} = .08$. Including the variables *loneliness*, $F(1, 97) =$
 305 $42.65, p < .001, \eta^2_{\text{partial}} = .55$, *uncertainty strain*, $F(1, 97) = 19.64, p < .001, \eta^2_{\text{partial}} = .36$,
 306 *sex*, $F(1, 97) = 0.26, p = .608, \eta^2_{\text{partial}} < .01$, and *being quarantines*, $F(1, 97) = 0.74, p =$
 307 $.393, \eta^2_{\text{partial}} = .02$, in the repeated-measures ANCOVA confirmed the significant effect of
 308 time, $F(1, 101) = 8.29, p = .005, \eta^2_{\text{partial}} = .08$.

309 In contrast, levels of anxiety significantly decreased from first to second assessment, $F(1,$
 310 $101) = 7.43, p = .008, \eta^2_{\text{partial}} = .07$. Including the variable *income*, $F(1, 99) = 0.85, p = .360,$
 311 $\eta^2_{\text{partial}} = .28$, confirmed the significant effect of time, $F(1, 100) = 7.63, p = .007, \eta^2_{\text{partial}} =$
 312 $.07$. For somatization, no significant change over time was observed, $F(1, 101) = 0.91, p =$
 313 $.341, \eta^2_{\text{partial}} < .01$.

Taken together hypothesis 1 was confirmed for perceived stress and symptoms of depression, but not for somatization, while the time effect for anxiety was contrary to our expectations. These time effects remained significant after including confounding variables.

No changes in stress-related and emotional eating over time (hypothesis 2)

We found a significant increase in *anxiety-related eating* from first ($mean = 2.52$, $SD = 0.74$) to second assessment ($mean = 2.75$, $SD = 0.55$), $F(1, 101) = 10.11$, $p = .002$, $\eta^2_{partial} = .09$. Including *education*, $F(1, 99) = 5.39$, $p = .022$, $\eta^2_{partial} = .10$, and *gender identity*, $F(1, 99) = 0.20$, $p = .657$, $\eta^2_{partial} < .01$, as covariates, did not change the significance of the main effect of time, $F(1, 101) = 10.11$, $p = .002$, $\eta^2_{partial} = .09$. Other types of stress-related or emotional eating showed no significant changes over time. Including confounding variables did not change these results.

In sum, our second hypothesis was only confirmed for anxiety-related eating, but not the stress-related or other emotional eating behaviors.

No relation between changes in perceived stress and psychopathological symptoms and stress-related and emotional eating over time (hypothesis 3)

The multiple regression models including *stress-related eating change* as criterium showed that change in stress or symptoms of psychopathology did not predict changes in *stress-related eating* (all $p > .05$). Including the previously introduced covariates in the models did not change interpretation of the results. The same applied to the models using change in *happiness-, anger, or anxiety-related eating* as criterium.

When evaluating the model using change in *sadness-related eating* as criterium, only *depression change*, $B = -0.04$, $SE = 0.02$, $t = -2.59$, $p = .011$, was a significant predictor (overall model: $R^2_{adjusted} = .05$, $F(1, 99) = 6.71$, $p = .011$). Including the covariates *loneliness*, $B = -0.09$, $SE = 0.08$, $t = -1.14$, $p = .258$, *uncertainty strain*, $B = 0.01$, $SE = 0.01$, $t = 1.22$, $p = .228$, *sex*, $B = 0.01$, $SE = 0.17$, $t = 0.01$, $p = .995$, *being quarantined*, $B = 0.09$, $SE = 0.14$, $t = 0.64$, $p = .521$, *age*, $B = 0.01$, $SE = 0.01$, $t = 0.07$, $p = .947$, and *BMI*, $B = 0.03$, $SE = 0.02$, $t = 1.62$, $p = .110$, in the model *depression change* as a predictor, $B = -0.03$, $SE = 0.02$, $t = -$

1.70, $p = .092$ was not significant any more (overall fit of the model: $R^2_{adjusted} = .05$, $F(7, 93) = 1.76$, $p = .106$).

No effect of ELS on changes in perceived stress and psychopathological symptom severity (hypothesis 4)

ELS did not predict change in perceived stress or any of the psychopathological symptoms (all $p > .05$). Including the previously introduced covariates did not change these results.

No mediating or moderating effect of dispositional mindfulness on the relationship between ELS and changes in perceived stress and psychopathological symptom severity (hypothesis 5)

The mediation (hypothesis 5.1) and moderation (hypotheses 5.2) models yielded no significant direct or indirect effects. When controlling for influential cases and alpha error cumulation, neither ELS nor dispositional mindfulness were significantly associated with change scores of perceived stress or psychopathological symptom severity.

A more detailed description of the results of hypotheses 3, 4, and 5 can be found in the supplementary material.

Secondary Findings

When exploratorily examining Pearson's and Spearman's (rank) correlation coefficients between ELS, dispositional mindfulness, perceived stress and psychopathological symptom severity at both assessments, we found a significant negative association between *ELS* and *dispositional mindfulness*, $r_{Spearman}(93) = -.28$, $p = .005$. Further, we found that higher ELS and lower dispositional mindfulness were significantly associated with higher levels of perceived stress, depression and anxiety at both timepoints. Neither somatization, nor the change scores that we had computed earlier were associated with ELS or dispositional mindfulness (all $p > .05$). The linear associations are depicted in Figure 2; the exact correlation coefficients are reported in the supplementary material.

Figure 2. Linear associations between (A) early life stress (ELS), or (B) dispositional mindfulness, and (i) perceived stress, (ii) depression, and (iii) anxiety at the first (green) and second (red) assessment. * indicates $p < .05$. Pearson correlation coefficients are reported. * indicated $p < .05$.

Discussion

In this longitudinal study, we investigated changes in perceived stress, psychopathological symptom severity and stress-related and emotional eating from an assessment prior to the Covid-19 pandemic (October to December 2019) to an assessment during the pandemic (April to June 2020). We found that perceived stress and depression increased, while anxiety decreased from first to second assessment (hypothesis 1). However, there was no change in eating behavior over time except for change in anxiety-related eating (hypothesis 2). We found no association of changes in perceived stress and psychopathological symptoms with changes in stress-related or emotional eating (hypothesis 3). ELS did not predict changes in perceived stress and psychopathological symptom severity (hypothesis 4). Dispositional

mindfulness neither served as mediator (hypothesis 5.1), nor moderator (hypothesis 5.2) in the relationship between the extent of ELS and increases in perceived stress and psychopathological symptoms. Thus, we were able to partially confirm hypothesis 1 and 2, but not hypothesis 3, 4 or 5.

In accordance with our first hypothesis, we found that levels of perceived stress and depression increased significantly from prior to during the Covid-19 pandemic. These results from our longitudinal study confirm preliminary evidence from cross-sectional studies that found higher psychological distress during the Covid-19 pandemic as compared to retrospectively reported pre-pandemic distress levels (e.g. Huang & Zhao, 2020; Petzold et al., 2020). In general, perceived stress is promoted by feelings of uncontrollability and helplessness, and the unpredictability of upcoming responsibilities (Cohen et al., 1983). At the onset of the Covid-19 pandemic, daily to weekly updates in governmental restrictions and health authority recommendations, together with the omnipresence of the negative health consequences of an infection in the media might have contributed to the elevated experience of perceived stress in a vast majority of the population. In line with previous studies, the increases in perceived stress were paralleled by increases in symptoms of depression (Hammen, 2005). Because learned helplessness under conditions of low subjective controllability (Seligman, 1972) fosters depressive symptoms, we assume that the experience of uncontrollability during the Covid-19 pandemic might have contributed to increases in both, perceived stress and depressive symptoms. Although the moderate to high levels of uncertainty strain and loneliness were associated with the observed increase in depression over time, these factors did not fully explain the increase in depression.

In contrast to the findings of perceived stress and depression, anxiety decreased significantly from first to second assessment. Similar to our findings, a longitudinal study focusing on the beef crisis in 1996 – when a high proportion of cattle had to be slaughtered for medical reasons, and financial compensation was uncertain – reported a decrease in anxiety of farmers, although mental health problems were expected. Comparing depression and anxiety scores from 1994 with data assessed during the crisis in 1996, a decrease in anxiety

and depression scores for farmers and non-farmers alike was observed (Eisner, Neal, & Scaife, 1999). The authors assumed that a longer observation period might be required to determine the psychological impact of the crisis. Changes in anxiety may be more transient and fluctuating in nature in comparison to depressive symptoms. This is also reflected in the diagnostic criteria of anxiety and depression: while anxiety symptoms have to be present for typically at least six months, depressive episodes are defined by a period of at least two weeks (American Psychiatric Association, 2013). In our study, the second assessment took place just a few weeks after Covid-19 related restrictions were introduced by the government. Hence, to draw comprehensive conclusions about mid- or long-term effects of pandemic-related changes on anxiety, longer observation periods could be required. Nevertheless, the significant decrease in anxiety after the onset of the Covid-19 pandemic was unexpected. Here, the operationalization of anxiety symptom severity used in this study might explain the observed result. On the BSI, anxiety is primarily assessed by questions on hyperarousal, a diagnostic criterium of panic and other anxiety disorders (American Psychiatric Association, 2013). Many people might have been less frequently confronted with anxiogenic situations that people with anxiety problems usually try to avoid, especially large crowds or other potential stressors, due to governmental restrictions and the “safe” environment at home. Furthermore, social isolation at home might have decelerated the pace of everyday life for many people (Huang & Zhao, 2020) and thus hyperarousal could have been reduced. However, it might have added to the feelings of loneliness and depressiveness in turn (Erzen & Çikrikci, 2018). Yet, these considerations act on the assumption of a safe home environment, which was not assessed in the current study. Thus, it is possible that different results might emerge when taking into account if individuals were victims of domestic violence. In addition to reduced hyperarousal, talking about a shared fear (a “common enemy”), supporting each other, having a sense of community, and confidence in governmental policies and measures could have further contributed to a decrease in anxiety levels. Overall, our results did not indicate that stress-related and emotional eating changed from prior to, to shortly after the onset of the Covid-19 pandemic.

Moreover, neither changes in perceived stress, nor in psychopathological symptom severity had an influence on stress-related and emotional eating. This suggests that eating patterns were rather weakly influenced by external circumstances, at least in this relatively healthy sample. As such, the results suggest that stress-related and emotional eating tendencies are traits, rather than states.

In contrast to our expectations, levels of ELS did not influence the strength of the increase in perceived stress and depression in this sample, and this relationship was neither mediated, not moderated by dispositional mindfulness. Accordingly, our results cannot support the mediating role of mindfulness proposed (Brett et al., 2018).

However, we found that higher levels of ELS predicted higher levels of perceived stress, depression and anxiety at both assessment times and higher levels of dispositional mindfulness predicted lower levels of perceived stress, depression and anxiety at both assessment times respectively. This secondary observation is in line with a number of studies identifying ELS as a risk factor for increased mental health problems (e.g. Lima et al., 2010) and reduced dispositional mindfulness (e.g. Brown & Ryan, 2003). The results suggest that while ELS and mindfulness contrarily impact psychological well-being, their effect is not potentiated by an acute crisis such as the Covid-19 pandemic. Thus, the effect of the Covid-19 pandemic is independent of the impact of ELS and mindfulness, and is thus affecting everyone regardless of their predisposition. Another potential explanation and drawback regards our sample (mostly University students) with overall good health, generally low levels of ELS, high education, and beneficial stress coping skills. A broader sample of adults that would include those with lower socio-economic status, and higher levels of ELS may have revealed a different pattern of results. Finally, the observation period might not have been long enough to see an effect of ELS or mindfulness on changes in perceived stress and psychopathological symptom severity. With the second assessment taking place four weeks after governmental restrictions were installed, we might not have been able to see long-term effects of potential risk or protective factors. In addition, our results strengthen the negative association between ELS and dispositional mindfulness. In this regard, mindfulness

interventions could be a promising approach to mitigate the negative effect of ELS on mental health outcomes later in life (Ortiz & Sibinga, 2017). What is more, the psychological impact of Covid-19 could be discussed as a new type of ELS in future generations with its negative impact on stress and depressiveness itself and by potentially enhancing negative effects of neglectful or abusive childhood environments during the pandemic (Cuartas, 2020).

This longitudinal study represents among the first evidence for changes in perceived stress and psychopathological symptoms after the onset of the Covid-19 pandemic. Yet, the following limitations have to be considered when interpreting the results. First of all, as the majority of this sample are students our results are not representative for the general population. Nevertheless, this longitudinal study provides important insights into the psychological impact of the Covid-19 pandemic in a young, and well-educated sample. Other studies should determine the effect of the pandemic in other subsamples, e.g. immigrants, children, health care workers, disabled, or people at-risk for Covid-19 related complications. Second, although we have assessed longitudinal data, we are not able to determine to which extent the pandemic has contributed to the changes in our outcome variables as compared to other major life-events (e.g., the loss of a beloved one, marriage, divorce, or severe accidents). Statistically controlling for self-reported experience of those events did however, not change the results. Hence, we think it is plausible that the pandemic-related changes have triggered the observed changes. Third, the period between assessments might have been too short to observe the effect of ELS or mindfulness on the mental health consequences of the Covid-19 pandemic. We are planning further follow-up studies to determine mid- to long-term effects of the Covid-19 pandemic on perceived stress and psychopathological symptom severity. Last, the assessment of biological markers of stress-sensitive systems like the hypothalamic-pituitary-adrenal axis and the autonomic nervous system could further inform how changes in perceived stress and psychopathological symptom severity contribute to modulations of neurobiological stress mechanisms.

In summary, the current findings show that perceived stress and depression increased, while anxiety decreased after the onset of the Covid-19 pandemic. This is in addition to previous

findings showing that uncontrollable, unpredictable, and novel situations trigger stress (Dickerson & Kemeny, 2004). Thus, the aim of political and health decision-makers during exceptional situations like pandemics should be to try and minimize uncertainty and increase transparency in respect to public recommendations and decisions. Furthermore, we think that the introduction of governmental restrictions comparable to a common depressive state (e.g. social isolation, and withdrawal from common public activities (American Psychiatric Association, 2013) should be carefully reflected upon and the awareness of risks and supporting measures to cope with the situation should be raised in concordance.

Data availability statement

The dataset generated and analyzed during the current study is available online at the Open Science Project associated with this work (<https://osf.io/h5tjx/>).

Supplementary Information

Supplementary information is available online at <https://osf.io/h5tjx/>. A preregistration of the main analyses has been published online together with the Open Science Project associated with this work (<https://osf.io/h5tjx/>) on April 29, 2020 (registration DOI: 10.17605/OSF.IO/PXZT3).

Competing interest statement

The authors declare no competing interests.

Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Konstanz, Germany and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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CRediT author contribution

ABEB & MM: *Conceptualization, Methodology, Formal analysis, Data Curation, Writing - Original Draft, Visualization*; UUB, SJD, & BFD: *Writing - Review & Editing*; JCP: *Conceptualization, Funding acquisition, Resources, Writing - Review & Editing*; EU: *Conceptualization, Methodology, Formal analysis, Data Curation, Writing - Original Draft, Supervision, Project administration*.

525 **References**

- 526 American Psychiatric Association. (2013). Diagnostic and statistical manual of mental
527 disorders, fifth edition (DSM-5). Washington, D.C.: American Psychiatric Publishing.
- 528 Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using Self-Report
529 Assessment Methods to Explore Facets of Mindfulness. *Assessment*, 13(1), 27–45.
530 <http://doi.org/10.1177/1073191105283504>
- 531 Bernstein, D. P., Stein, J. A., Newcomb, M. D., Walker, E., Pogge, D., Ahluvalia, T., et al.
532 (2003). Development and validation of a brief screening version of the Childhood Trauma
533 Questionnaire. *Child Abuse & Neglect*, 27(2), 169–190. [http://doi.org/10.1016/S0145-](http://doi.org/10.1016/S0145-2134(02)00541-0)
534 2134(02)00541-0
- 535 Brett, E. I., Espeleta, H. C., Lopez, S. V., Leavens, E. E. S., & Leffingwell, T. R. (2018).
536 Mindfulness as a mediator of the association between adverse childhood experiences
537 and alcohol use and consequences. *Addictive Behaviors*, 84, 92–98.
538 <http://doi.org/https://doi.org/10.1016/j.addbeh.2018.04.002>
- 539 Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role
540 in psychological well-being. *Journal of Personality and Social Psychology*, 84(4), 822–
541 848. <http://doi.org/10.1037/0022-3514.84.4.822>
- 542 Brown, K. W., Goodman, R. J., & Inzlicht, M. (2012). Dispositional mindfulness and the
543 attenuation of neural responses to emotional stimuli. *Social Cognitive and Affective*
544 *Neuroscience*, 8(1), 93–99. <http://doi.org/10.1093/scan/nss004>
- 545 Buecker, S., Horstmann, K. T., Terwiel, S., Krasko, J., Kritzler, S., Kaiser, T., & Luhmann, M.
546 (2020). Psychological Item Pool for Corona Outbreak (PIPCO). Retrieved from
547 osf.io/62dmf
- 548 Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress.
549 *Journal of Health and Social Behavior*, 24(3), 385–396.
- 550 Cuartas, J. (2020). Heightened risk of child maltreatment amid the COVID-19 pandemic can
551 exacerbate mental health problems for the next generation. *Psychological Trauma:*
552 *Theory, Research, Practice, and Policy*, 12(S1), S195–S196.
553 <http://doi.org/10.1037/tra0000597>
- 554 Derogatis, L. R. (2000). BSI-18. Brief Symptom Inventory-18. Administration, Scoring, and
555 Procedures Manual. Minneapolis: NCS Pearson, INC.
- 556 Dickerson, S. S., & Kemeny, M. E. (2004). Acute Stressors and Cortisol Responses: A
557 Theoretical Integration and Synthesis of Laboratory Research. *Psychological Bulletin*,
558 130(3), 355–391. <http://doi.org/10.1037/0033-2909.130.3.355>
- 559 Duffy, K. A., McLaughlin, K. A., & Green, P. A. (2018). Early life adversity and health-risk
560 behaviors: proposed psychological and neural mechanisms. *Annals of the New York*
561 *Academy of Sciences*, 1428(1), 151–169. <http://doi.org/10.1111/nyas.13928>
- 562 Eisner, C. S., Neal, R. D., & Scaife, B. (1999). The effect of the 1996 “beef crisis” on
563 depression and anxiety in farmers and non-farming controls. *British Journal of General*
564 *Practice*, 49, 385–386.
- 565 Erzen, E., & Çikrikci, Ö. (2018). The effect of loneliness on depression: A meta-analysis.
566 *International Journal of Social Psychiatry*, 64(5), 427–435.
567 <http://doi.org/10.1177/0020764018776349>
- 568 Gromer, D. (2020). apa: Format Outputs of Statistical Tests According to APA Guidelines. R
569 package version 0.3.3. <https://CRAN.R-project.org/package=apa>.
- 570 Hammen, C. (2005). Stress and Depression. *Annual Review of Clinical Psychology*, 1(1),
571 293–319. <http://doi.org/10.1146/annurev.clinpsy.1.102803.143938>

- Huang, Y., & Zhao, N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 epidemic in China: a web-based cross-sectional survey, 1–19. <http://doi.org/10.1101/2020.02.19.20025395>
- Kabat-Zinn, J. (2003). Mindfulness-Based Interventions in Context: Past, Present, and Future. *Clinical Psychology: Science and Practice*, 10(2), 144–156. <http://doi.org/10.1093/clipsy/bpg016>
- Koss, K. J., & Gunnar, M. R. (2018). Annual Research Review: Early adversity, the hypothalamic-pituitary-adrenocortical axis, and child psychopathology. *Journal of Child Psychology and Psychiatry*, 59(4), 327–346. <http://doi.org/10.1111/jcpp.12784>
- Lawrence, M. A. (2016). ez: Easy Analysis and Visualization of Factorial Experiments. R package version 4.4-0. <https://CRAN.R-project.org/package=ez>.
- Lima, A. R., Mello, M. F., & Mari, J. de J. (2010). The role of early parental bonding in the development of psychiatric symptoms in adulthood. *Current Opinion in Psychiatry*, 23(4), 383–387. <http://doi.org/10.1097/YCO.0b013e32833a51ce>
- Meule, A., Reichenberger, J., & Blechert, J. (2018a). Development and Preliminary Validation of the Salzburg Emotional Eating Scale. *Frontiers in Psychology*, 9, 318–10. <http://doi.org/10.3389/fpsyg.2018.00088>
- Meule, A., Reichenberger, J., & Blechert, J. (2018b). Development and preliminary validation of the Salzburg Stress Eating Scale. *Appetite*, 120, 442–448. <http://doi.org/10.1016/j.appet.2017.10.003>
- Ortiz, R., & Sibinga, E. (2017). The Role of Mindfulness in Reducing the Adverse Effects of Childhood Stress and Trauma. *Children*, 4(3), 16–19. <http://doi.org/10.3390/children4030016>
- Parker, G., Tupling, H., & Brown, L. B. (1979). A Parental Bonding Instrument. *British Journal of Medical Psychology*, 52(1), 1–10. <http://doi.org/10.1111/j.2044-8341.1979.tb02487.x>
- Pedersen, T. L. (2020). patchwork: The Composer of Plots. R package version 1.0.1. <https://CRAN.R-project.org/package=patchwork>.
- Petzold, M. B., Bendau, A., Plag, J., Pyrkosch, L., Mascarell Maricic, L., Betzler, F., et al. (2020). Risk, resilience, psychological distress, and anxiety at the beginning of the COVID-19 pandemic in Germany. *Brain and Behavior*, 49(3), 155–10. <http://doi.org/10.1002/brb3.1745>
- R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.
- Revelle, W. (2018) psych: Procedures for Personality and Psychological Research, Northwestern University, Evanston, Illinois, USA, <https://CRAN.R-project.org/package=psych> Version = 1.8.12.
- Santarelli, S., Zimmermann, C., Kalideris, G., Lesuis, S. L., Arloth, J., Uribe, A., et al. (2017). An adverse early life environment can enhance stress resilience in adulthood. *Psychoneuroendocrinology*, 78, 213–221. <http://doi.org/10.1016/j.psyneuen.2017.01.021>
- Satow, L. (2012). *Stress- und Coping-Inventar (SCI): Vollständige Test- und Skaldokumentation*. Retrieved July 28, 2020, from <http://www.drsatow.de/tests/stress-und-coping-inventar/>
- Seligman, M. E. P. (1972). Learned helplessness. *Annual Review of Medicine*, 23, 407–412. <http://doi.org/https://doi.org/10.1146/annurev.me.23.020172.002203>
- Steinmetz, H., Batzdorfer, V., & Bosnjak, M. (2020). The ZPID Lockdown Measures Dataset for Germany. <http://doi.org/10.23668/psycharchives.3130>
- Sønderskov, K. M., Dinesen, P. T., Santini, Z. I., & Østergaard, S. D. (2020). The depressive state of Denmark during the COVID-19 pandemic. *Acta Neuropsychiatrica*, 1–3. <http://doi.org/10.1017/neu.2020.15>

- Tingley, D., Yamamoto, T., Hirose, K., Keele, L., Imai, K. (2014). mediation: R Package for Causal Mediation Analysis. *Journal of Statistical Software*, 59(5), 1-38. URL <http://www.jstatsoft.org/v59/i05/>.
- Torales, J., O'Higgins, M., Castaldelli-Maia, J. M., & Ventriglio, A. (2020). The outbreak of COVID-19 coronavirus and its impact on global mental health. *International Journal of Social Psychiatry*, 66(4), 317–320. <http://doi.org/10.1177/0020764020915212>
- Whitaker, R. C., Dearth-Wesley, T., Gooze, R. A., Becker, B. D., Gallagher, K. C., & McEwen, B. S. (2014). Adverse childhood experiences, dispositional mindfulness, and adult health. *Preventive Medicine*, 67(C), 147–153. <http://doi.org/10.1016/j.ypmed.2014.07.029>
- Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York.
- World Health Organization. (2020). Coronavirus disease (COVID-19) Pandemic. Retrieved July 28, 2020, from <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>