



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



The role of alexithymia and perceived stress in mental health responses to COVID-19: A conditional process model

Ru Li^{a,b,*}, Jani Kajanoja^{a,b,c}, Jallu Lindblom^{b,d}, Riikka Korja^{b,h}, Linnea Karlsson^{a,b,e}, Hasse Karlsson^{a,b,e}, Saara Nolvi^{b,f,g,h}, Max Karukivi^{b,i}

^a Department of Psychiatry, University of Turku and Turku University Hospital, Turku, Finland

^b FinnBrain Birth Cohort Study, Department of Clinical Medicine, University of Turku, Turku, Finland

^c Department of Psychiatry, Satakunta Hospital District, Pori, Finland

^d Faculty of Social Sciences, Tampere University, Tampere, Finland

^e Centre for Population Health Research, University of Turku and Turku University Hospital, Turku, Finland

^f Turku Institute for Advanced Studies, University of Turku, Turku, Finland

^g Department of Medical Psychology, Charité Universitätsmedizin, Berlin, Germany

^h Department of Psychology and Speech-Language Pathology, University of Turku, Turku, Finland

ⁱ Department of Adolescent Psychiatry, University of Turku and Turku University Hospital, Turku, Finland

ARTICLE INFO

Keywords:

COVID-19

Alexithymia

Stress

Anxiety symptoms

Depressive symptoms

ABSTRACT

Background: Little is known about the psychological mechanisms underlying the mental health problems related to the COVID-19 pandemic. Hypothetically, perceived stress and alexithymia may be factors involved in the mental distress response to the pandemic; however, this remains largely unstudied. This study aims to explore the moderating role of alexithymia and the moderated mediation effects of perceived stress on the mental health change due to the pandemic.

Methods: The conditional process model was used to examine the moderated mediation. The sample consists of 659 parents from the FinnBrain Birth Cohort Study who completed the Toronto Alexithymia Scale (TAS-20) at 6 months after delivery, the Edinburgh Postnatal Depression Scale (EPDS) and the Symptom Checklist-90 (SCL-90) at 2 or 4 years postpartum between 2014 and 2019; and a questionnaire for pandemic events, a brief 4-item version of the Perceived Stress Scale (PSS-4) and the follow-up EPDS/SCL-90 in 2020 after 3 months from the outbreak of COVID-19 pandemic in Finland.

Results: Alexithymia moderated the perceived stress-mediated relations between the pandemic events and the changes of depressive and anxiety symptoms through enhancing the detrimental effect of perceived stress on mental health.

Limitations: This study was mainly limited by the causality and generalizability of the findings.

Conclusions: Our findings indicate the moderated mediation effects of alexithymia and perceived stress on the psychological symptoms, which has implications for understanding how and when stressful situations translate to mental health problems, identifying vulnerable individuals, and tailoring preventive and psychotherapeutic interventions.

1. Introduction

The outbreak of novel coronavirus disease (COVID-19) was declared by the WHO to be a public health emergency of international concern in early 2020 due to its rapid global spread (Mahase, 2020). It is suggested that mental health problems are related to trauma experiences including natural disasters (Blanc et al., 2015; Lowe et al., 2019) and severe

pandemics (Blakey et al., 2015; Mak et al., 2010; Sim et al., 2010; Xiang et al., 2020). Existing studies have shown that the COVID-19 pandemic may pose widespread influence on mental well-being in diverse populations such as students, medical personnel, and parents (Cox and Olatunji, 2020; Gunnell et al., 2020; Huang et al., 2020; Pierce et al., 2020; Romeo et al., 2021; Wang et al., 2020a, 2020b). Mental health in general population during the pandemic is found to have deteriorated

* Corresponding author at: FinnBrain Birth Cohort Study, Medisiina A, Kiinamylynkatu 8-10, Turun yliopisto, Finland.

E-mail address: ru.li@utu.fi (R. Li).

<https://doi.org/10.1016/j.jad.2022.03.024>

Received 8 October 2021; Received in revised form 6 January 2022; Accepted 10 March 2022

Available online 16 March 2022

0165-0327/© 2022 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

compared with the pre-pandemic period (Castellini et al., 2020; McGinty et al., 2020; Pierce et al., 2020). In a recent study, although there is no overall significant change in mental health, more profound mental distress was observed in a “high-stress” group (Schäfer et al., 2020).

Furthermore, it is reported that individuals experiencing more traumatic events perceive more stress (Norris, 1992). Distinguished from objective events and psychological symptoms, the perception of stress refers to subjectively evaluating one's situations as stressful, which is a cognitive appraisal process, and thus may be a key factor in mediating the relations between the pandemic events and mental health problems (Cohen et al., 1983). Previous research indicates significant associations of perceived stress with fears and financial losses due to a pandemic outbreak (Yu et al., 2005). Potential stressors relevant to the COVID-19 pandemic include health-related factors such as worries about personal physical health and fear of infecting family members, as well as restriction-related factors such as social isolation, changes in the economic situation, and changes in interpersonal relationships (Brooks et al., 2020; Cai et al., 2020; Douglas et al., 2020). Moreover, reviewed evidence shows that the lack of resources to cope with hardship and feelings of losing control in specific situations may induce higher perception of stress, in turn contributing to the negative mental health outcomes (Ehlers and Clark, 2000; Mineka and Kihlstrom, 1978; Spada et al., 2008).

Importantly, mental impacts of traumatic or stressful events may be moderated by individual characteristics (Carmassi et al., 2018; Engelhard et al., 2003; Suls and Martin, 2005; Xiong et al., 2020; Yan et al., 2021; Zhou et al., 2013). Alexithymia, a stable personality trait involving difficulties in identifying and expressing feelings, externally oriented style of thinking and a scarcity of imagination (Sifneos, 1973; Tolmunen et al., 2011), are reportedly associated with stress-related disorders. According to the stress-alexithymia hypothesis, the lacking emotional awareness leads to ineffective coping, which prolongs the exposure to stressors and predisposes to mental health problems (Martin and Pihl, 1985). In line with this, previous research has found significant associations between alexithymia and post-traumatic stress symptoms (PTSS), depression and anxiety symptoms (Frewen et al., 2008; Honkalampi et al., 2000; Marchesi et al., 2005; Tolmunen et al., 2010; Šago et al., 2020). More specifically, alexithymia has been found to moderate the association between number of traumatic experiences and PTSS (Park et al., 2015). A recent study on patients with myocardial infarction also reported the moderating effect of alexithymia on the relation between acute stress symptoms and PTSS (Ledermann et al., 2020). However, it remains unclear how alexithymia interacts with perceived stress, an appraisal process of stressors, to predict the mental health impacts of stressful events.

Research suggests that parents of young children may be vulnerable to the detrimental effects of the pandemic. For example, depressive and anxiety symptoms among Finnish parents were found to increase during the pandemic (Nolvi et al., 2021; Nolvi et al., 2020, English preprint available from: <https://doi.org/10.31234/osf.io/8htb4>). This is likely due to high demands of parenting tasks and limited opportunities for social support during the pandemic (e.g., homeschooling and social restrictions) (Gjerdingen et al., 1991; Gustafsson et al., 2021; Park et al., 2020; Pierce et al., 2020). Parental stress during the pandemic may have impacts on child mental health, and thus parental well-being is an especially important target for research (Spinelli et al., 2020). Yet, little is known about the personality traits as a potential psychological predisposition for risk for mental health problems among parents who are raising young children in the context of the COVID-19 pandemic. No previous study has determined how perceived stress together with alexithymia function in the mental health change, which makes it worthy of exploration. Therefore, the present study aimed to investigate the effects of perceived stress and alexithymia on the mental health problems due to the pandemic in parents of young children. We hypothesized that COVID-19 pandemic events have an effect on the change

in depressive and anxiety symptoms, mediated through perceived stress, and this indirect effect is moderated by alexithymia. Specifically, alexithymia was expected to emphasize the indirect effects of the pandemic on the mental health symptoms by interacting with perceived stress. Furthermore, we also exploratively tested the moderating effects of the alexithymia dimensions, including the difficulty identifying and describing feelings and externally oriented thinking.

2. Materials and methods

2.1. Study participants

This study is a sub-study based on the FinnBrain Birth Cohort Study (www.finnbrain.fi), a prospective cohort study exploring the impacts of prenatal and early life stress on child brain development and health (Karlsson et al., 2018). Participants were recruited during a verified pregnancy at the first trimester ultrasound performed at 12 week's gestation between December 2011 and April 2015 from maternal welfare clinics in the South-Western Hospital District and the Åland Islands in Finland. The parents gave written informed consent on their own and on their child's behalf. After birth, the families have been followed up at 3- to 6-month intervals (the first 30 months) or 12- to 36-month intervals (from 36 months onwards) and the study is planned to continue for decades (more detailed information in Karlsson et al., 2018). All the participants in the cohort were invited to respond to the follow-up questionnaire during the pandemic. At this time, the children of the recruited parents were 5 to 8 years old, which indicates that most parents had children that normally attended to preschool or school and were staying at home due to the state of emergency and closing of schools. Overall, 856 parents responded to the COVID-19 follow-up questionnaire. Respondents were older ($t = -5.04, P < .001$), had higher level of education ($\chi^2 = 119.01, P < .001$) and higher economic satisfaction ($t = 4.01, P < .001$), and were more often female (78.2% vs. 56.3%, $\chi^2 = 146.90, P < .001$) compared to non-responders in the initial cohort sample. Among the respondents, 661 parents completed the questionnaire for alexithymia at 6 months postpartum (attrition analyses for those who did not return the cohort's 6-month questionnaire have been reported by Kajanoja et al. (2017)). Of these, two (0.3%) participants with missing data on the measurement of perceived stress and the symptoms were excluded. Thereby, the final sample of this study consists of 659 parents (520 mothers and 139 fathers) with age ranging from 24 to 55 years old.

2.2. Procedures

Due to the logistics of the birth cohort study that includes a variety of measures based on usability within a larger scale (www.finnbrain.fi), the background information regarding age, gender, education, and economic satisfaction was collected in the first trimester of pregnancy, and alexithymia was measured at 6 months postpartum (between 2012 and 2015). Baseline depressive and anxiety symptoms were measured at 2 or 4 years postpartum (between 2014 and 2019) (baseline). The measurements at 2 years postpartum were used only in case of unavailable 4-year data. Data on pandemic events, past-year life events, and the depressive and anxiety symptoms were obtained remotely between May 4 and June 2, 2020 (follow-up) through the Research Electronic Data Capture (REDCap) platform (Harris et al., 2009); that is, around 3 months after the first COVID-19 positive case was identified in Finland. All procedures in this study were performed in accordance with the ethical standards of the national and institutional research committee on human experimentation, and with the 1964 Helsinki Declaration as well as its later amendments. The Ethics Committee of the Hospital District of Southwest Finland approved the study protocol (ETMK #17/1802/2020).

2.3. Measures

2.3.1. COVID-19 pandemic events

The COVID-19 pandemic events were assessed employing a questionnaire modified according to the measurement for SARS-related stressors in the study by Main et al. (2011). In the present study, we used the questionnaire with a “yes” or “no” answer for each item based on experiences of the respondents, which covered following events: health events related to self, family members, friends, and relatives or acquaintances (e.g., showing COVID-like symptoms, receiving treatment with or without hospitalization because of the coronavirus); free time restrictions (e.g., living in an area that was isolated, having to give up important activities or hobbies due to the COVID-19); and economic influences (e.g., getting laid off from work, deterioration of personal or spouse's economic situation due to the pandemic). The total scores were calculated by summing together these events that the participants experienced during the COVID-19 pandemic.

2.3.2. Perceived stress

Perceived stress was assessed using the brief 4-item version of the Perceived Stress Scale (PSS-4) (Cohen et al., 1983). The Perceived Stress Scale is a validated and reliable self-report scale used for measuring global levels of psychological stress with acceptable psychometric properties worldwide in different language including Finnish (Dev Bhurtun et al., 2021; Lee, 2012). Given the similar psychometric properties in longer and shorter versions of the PSS, and a clear advantage of the brief version in terms of the time required to complete and the ease of use in remote measurement during the exceptional pandemic situation (Cohen et al., 1983; Leung et al., 2010; Vallejo et al., 2018), the PSS-4 was employed in this study. The PSS-4 consists of four items rated with a 5-point Likert scale (0 = never, 4 = very often) on following questions: in the last month, how often have you felt (1) that you were unable to control the important things in your life, (2) confident about your ability to handle your personal problem, (3) that things were going your way, and (4) difficulties were piling up so high that you could not overcome them. With reversing the scores of items 2 and 3, the PSS-4 total scores range from 0 to 16. The Cronbach's α was 0.69 in the current sample.

2.3.3. Alexithymia

Alexithymic features were measured by the Toronto Alexithymia Scale (TAS-20), which is one of the most widely used self-report scales measuring alexithymia (Bagby et al., 1994; Joukamaa et al., 2001; Taylor et al., 2003). It is divided into 3 subscales: difficulty identifying feelings (DIF), difficulty describing feelings (DDF) and externally oriented thinking (EOT). By summing the scores of 20 items rated on a 5-point Likert scale that ranges from 1 (Strongly disagree) to 5 (Strongly agree), a total score of the TAS-20 ranging from 20 to 100 is obtained. The Cronbach's α was 0.81 for the TAS-20 total scores in the current sample.

2.3.4. Depressive and anxiety symptoms

Depressive symptoms were measured by the Edinburgh Postnatal Depression Scale (EPDS), a widely used 10-item self-report questionnaire employed for screening postnatal depression to help for detecting postpartum depression among both mothers and fathers (Cox et al., 1987; Edmondson et al., 2010). Each question is scored from 0 to 3 and the total score ranges from 0 to 30 points. The Cronbach's α was 0.86 for the follow-up EPDS in the current sample.

To measure anxiety symptoms, the Symptom Checklist-90 (SCL-90) was employed (Derogatis et al., 1973; Holi et al., 1998). In this study, only the anxiety subscale was used for assessing the intensity of anxiety experienced in the previous month. The items are rated on a 5-point scale of 10 different anxious feelings ranging from 0 (not at all) to 4 (extremely). Respondents with higher scores were considered to have more anxiety symptoms. The Cronbach's α was 0.86 for the follow-up SCL-90 in the current sample.

2.3.5. Background and demographic information

For this study, the background and demographic information on the participants included age, gender (1 = Women; 2 = Men), education divided into three classes (1 = Low: High school or lower; 2 = Mid: Vocational tertiary degree; 3 = High: University degree), economic satisfaction ranging from 0 to 10 (0 = low satisfaction, 10 = high satisfaction). Since we are focusing on the pandemic event-specific mental health change, life events in the past year were also included as background information.

Life events including 18 experiences (e.g., a child starting school, moving into a new house, divorce, unemployment, and serious illness or death of a child's grandparent) that had happened during the past year. Additionally, the parents rated the events on a 5-point scale on each item, of which 1 or 2 indicated a perceived positive event, and 4 or 5 indicated a perceived negative event. The variables were categorized into two types according to whether the experienced event was considered positive or negative, with binary classes for each type (0 = had no experience; 1 = had experiences).

2.4. Statistics

Statistical analyses were conducted using IBM SPSS 25.0. Considering that the power of the model would be unnecessarily compromised by the reduction of the sample size due to omitting the participants only with missing covariate data, 22 (3.3%) missing values for economic satisfaction were imputed by the mean value, and 66 (10.0%) missing values for the baseline symptoms were imputed by using the hot deck imputation based on demographics including gender, education, and economic satisfaction (Andridge and Little, 2010; Myers, 2011). For descriptive analyses, normality of distribution within variables was examined visually and by the Shapiro-Wilk test. For the change of the symptoms, the differences in the EPDS and SCL-90 scores between the baseline and the follow-up were examined using the paired samples *t*-test. For quantifying the strength of the relations between the main variables, Spearman's correlation coefficient (ρ) was used.

A conditional process analysis, also known as moderated mediation analysis, combines simple mediation and moderation. It is used to determine how the strength of a mediation effect depends on or varies across situation, context, or individual differences, in order to explore the conditional nature (i.e., moderation effect) of mechanisms (Hayes and Rockwood, 2019; Preacher et al., 2007). To examine the alexithymia-moderated mediation effects of perceived stress on the associations between the COVID-19 pandemic events and the mental health problems, the conditional process analyses were conducted using the PROCESS 3.5 macro for SPSS (Hayes, 2017). Based on the correlation analysis between the background variables and symptom scores, gender, economic satisfaction, and past-year negative life events were controlled for in each path of the conditional process model. In addition, baseline symptoms were controlled for as covariates for the follow-up symptom scores, but not for perceived stress. Hence, we used a custom model based on the Model 14 (Hayes, 2017). The conceptual conditional process model is depicted in Fig. 1.

A simple slopes analysis was used for testing the moderating role of alexithymia in a single path. Conditional effects were analyzed at low, medium, and high levels of alexithymia, which was set to mean minus one standard deviation (SD), mean and mean plus SD, respectively. A bootstrap method with 5000 samples was adopted to compute 95% bootstrapped confidence intervals (CIs). The 95% CI that do not include zero indicate significant effects (Hayes and Rockwood, 2019).

3. Results

3.1. Descriptive statistics and correlation analyses

The sample consists of 520 mothers and 139 fathers. 19 (2.9%) of the participants with missing data on education were included because

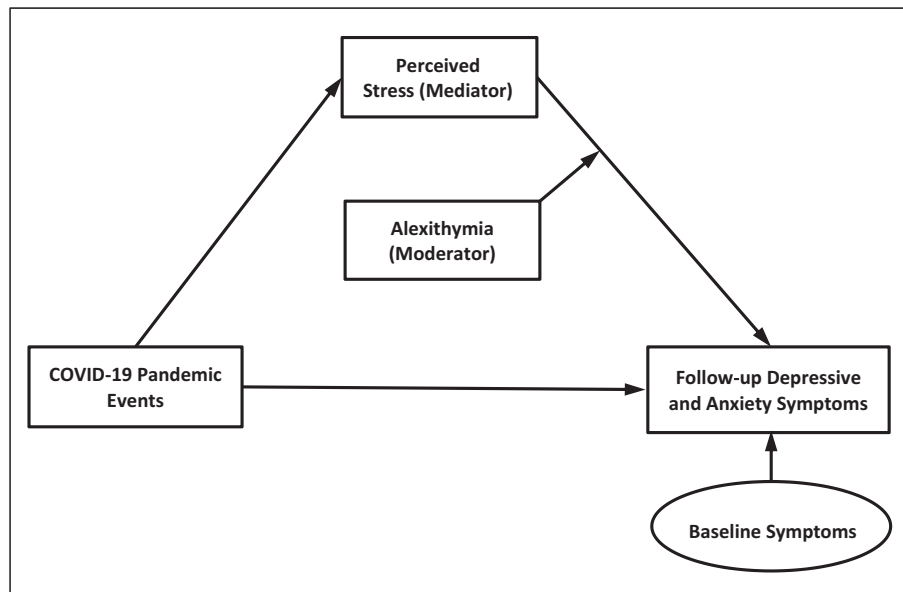


Fig. 1. The conceptual conditional process model.

education had no significant correlations with the outcome variables and thus it was not controlled for in the model. Nearly half of the sample (43.4%) had received “High” education, and 167 (25.3%) reported “Low” education and 187 (28.4%) “Mid” education. 101 (15.3%) and 198 (30.0%) of the participants reported experiences of past-year positive and negative life events, respectively.

The main study variables are shown in Table 1. Age, economic

satisfaction, pandemic events, the PSS-4 score, the TAS-20 score, the EPDS and the SCL-90 scores were presented as mean (SD) and range. The paired samples *t*-test showed significant differences (from baseline to follow-up) in the EPDS score, with a mean increase of 1.78 (5.02) ($P < .001$). A significant change in the SCL-90 scores with a mean increase of 1.25 (5.11) ($P < .001$) was also observed. This is in line with the prior study of the largely overlapping sample reporting a significant increase

Table 1
Descriptive statistics and Spearman's correlation.

	2	3	4	5	6	7	8	9	10	11	12	13
1. Gender	-0.12**	0.01	-0.01	0.14**	-0.02	-0.02	-0.05	0.14**	-0.08*	-0.06	-0.16**	-0.18**
2. Education		-0.07	0.00	0.13**	0.24**	-0.05	0.00	-0.19**	-0.08*	-0.06	-0.02	0.01
3. Positive life events			-0.04	-0.05	-0.01	0.02	0.04	-0.01	-0.01	0.00	0.03	-0.02
4. Negative life events				0.10*	-0.06	0.11**	0.13**	-0.02	0.03	-0.04	0.13**	0.10*
	<i>Mean (SD), range</i>											
5. Age					0.03	0.00	0.00	-0.01	-0.01	-0.03	-0.01	-0.06
6. Economic satisfaction						-0.20**	-0.03	-0.05	-0.20**	-0.12**	-0.14**	-0.12**
7. PSS-4							0.12**	0.14**	0.30**	0.25**	0.61**	0.46**
8. Pandemic events								-0.06	0.12**	0.11**	0.21**	0.27**
9. TAS-20									0.19**	0.16**	0.13**	0.16**
10. Baseline EPDS										0.60**	0.46**	0.37**
11. Baseline SCL-90											0.39**	0.47**
12. Follow-up EPDS												0.67**
13. Follow-up SCL-90												

Gender: 1 = Women; 2 = Men.

Education: 1 = Low: high school or lower; 2 = Mid: vocational tertiary degree; 3 = High: university degree. Positive/Negative Life events: 0 = had no experience; 1 = had experiences.

Economic satisfaction: from 0 to 10 (0 = low satisfaction, 10 = high satisfaction).

PSS-4 = 4-item Perceived Stress Scale; TAS-20 = 20-item Toronto Alexithymia Scale; EPDS = Edinburgh Postnatal Depression Scale; SCL-90 = Symptom Checklist-90 (anxiety subscale).

Baseline: 2 or 4 years postpartum (between 2014 and 2019); Follow-up: May 4 and June 2, 2020.

* $P < .05$.

** $P < .01$.

in parental depressive and anxiety symptoms from pre-pandemic to pandemic (Nolvi et al., 2021; Nolvi et al., 2020, English preprint available from: <https://doi.org/10.31234/osf.io/8htb4>).

Table 1 also shows the Spearman's correlation matrix for the background factors and follow-up EPDS and SCL-90 scores. The follow-up EPDS and SCL-90 scores had negative correlations with gender and economic satisfaction, and positive correlations with past-year negative life events, perceived stress, pandemic events, and TAS-20 score. Age, education, and positive life events were not significantly related to either perceived stress or the follow-up symptoms, and thus were excluded in further analyses.

3.2. Conditional process analyses

3.2.1. Parameters for the conditional process model

As presented in Table 2 (the upper part), after controlling for gender, economic satisfaction, and past-year negative life events, the pandemic events were positively related to perceived stress. After controlling for the same confounders as well as the baseline depressive and anxiety symptoms, perceived stress and the interactions between perceived stress and alexithymia were significantly related to the follow-up symptoms (the middle and lower part of Table 2), suggesting a mediating role of perceived stress and a moderating role of alexithymia. The model explained 52% of variance in the change in the depressive symptoms [$R^2 = 0.52$, $F(8, 650) = 87.99$, $P < .001$], and 43% in the anxiety symptoms [$R^2 = 0.43$, $F(8, 650) = 61.56$, $P < .001$].

Table 2
Conditional process models for testing moderated mediation effects.

	B	SE	95% CI		P
			LLCI	ULCI	
Outcome: perceived stress					
Constant	1.043	0.488	0.084	2.013	0.033
Gender	-0.092	0.260	-0.610	0.412	0.724
Economic satisfaction	-0.249	0.047	-0.352	-0.148	<0.001
Negative life events	0.514	0.233	0.050	0.982	0.028
Pandemic events	0.099	0.038	0.031	0.172	0.009
Outcome: follow-up depressive symptoms					
Constant	6.428	0.631	5.152	7.689	<0.001
Gender	-1.695	0.323	-2.272	-1.094	<0.001
Economic satisfaction	0.038	0.059	-0.077	0.156	0.516
Negative life events	0.573	0.286	0.008	1.166	0.045
Baseline symptoms	0.226	0.031	0.163	0.291	<0.001
Pandemic events	0.153	0.047	0.061	0.244	0.001
Perceived stress (M)	0.959	0.050	0.846	1.073	<0.001
Alexithymia (W)	0.026	0.014	-0.002	0.052	0.073
Interaction (M*W)	0.013	0.005	0.002	0.024	0.008
Outcome: follow-up anxiety symptoms					
Constant	5.002	0.702	3.620	6.383	<0.001
Gender	-1.852	0.370	-2.500	-1.184	<0.001
Economic satisfaction	-0.062	0.068	-0.199	0.073	0.359
Negative life events	0.020	0.330	-0.616	0.662	0.951
Baseline symptoms	0.327	0.035	0.245	0.425	<0.001
Pandemic events	0.250	0.055	0.136	0.364	<0.001
Perceived stress (M)	0.775	0.056	0.634	0.918	<0.001
Alexithymia (W)	0.053	0.016	0.022	0.084	0.001
Interaction (M*W)	0.018	0.006	0.005	0.032	0.001

N = 659; Bootstrapped sample size = 5000.

CI, confidence interval; LLCI, lower limit CI; ULCI, upper limit CI.

Gender: 1 = Women; 2 = Men. Negative Life events: 0 = had no experience; 1 = had experiences.

Baseline: 2 or 4 years postpartum (between 2014 and 2019); Follow-up: May 4 and June 2, 2020.

Bootstrapped 95% CI excluding zero indicates statistical significance.

The focal factors for the mediation and moderation are written in bold.

3.2.2. Moderating role of alexithymia in the single path between perceived stress and mental health change

The simple slopes analysis showed the moderating role of alexithymia in the relations between perceived stress and the mental health change. It should be noted that as the effects gradually increased with the levels of alexithymia, only the effect at low (Mean - 1SD) and high (Mean + 1SD) levels of alexithymia was shown. The effects of perceived stress on the mental symptoms at the low ($B = 0.838$ for depressive symptoms; $B = 0.605$ for anxiety symptoms) and high levels ($B = 1.079$ for depressive symptoms; $B = 0.946$ for anxiety symptoms) of alexithymia were all significant ($P < .001$ for all), but higher levels of alexithymia indicated stronger effects with steeper slopes (Fig. 2). This was observed more clearly in terms of the anxiety symptoms (Fig. 2 B). At the low level of perceived stress, no significant differences were found in the depressive ($P = .599$) and anxiety symptoms ($P = .926$) between low and high levels of alexithymia. However, at the high perceived stress level, significant differences were observed in the depressive ($P = .002$) and anxiety symptoms ($P < .001$).

3.2.3. Conditional indirect effects of pandemic events on mental health change depending on alexithymia

Moreover, with the bootstrapped 95% CI excluding zero, the indirect effects of the COVID-19 pandemic via perceived stress on the changes of depressive and anxiety symptoms were significant at both low and high alexithymia levels, which revealed a significant mediation role of perceived stress. In addition, the pairwise contrast of the indirect effects between low and high alexithymia is 0.024 for the depressive symptoms and 0.034 for the anxiety symptoms; bootstrapped 95% CI excluding zero indicated that the indirect effect of the pandemic events at high alexithymia levels was significantly stronger than the indirect effect at low alexithymia (Table 3). Accordingly, the indirect effects of the pandemic events on the mental health change were conditional on the level of alexithymia (as illustrated in Fig. 3). Taken together, these results further confirmed the significant alexithymia-moderated mediation effects of perceived stress on the associations between the COVID-19 pandemic events and mental health change.

To examine whether the indirect effects of the pandemic events mediated by perceived stress on the symptom changes conditionally depend on specific dimension of alexithymia, each TAS-20 subscale was treated as a moderator in the model. The results for the interaction terms of the subscales and perceived stress showed that the mediation was moderated by DIF ($B = 0.038$, $P < .001$ for depressive symptoms; $B = 0.058$, $P < .001$ for anxiety symptoms) and DDF ($B = 0.033$, $P = .003$ for depressive symptoms; $B = 0.028$, $P = .023$ for anxiety symptoms), but not EOT ($P = .402$ for depressive symptoms; $P = .736$ for anxiety symptoms). Table 3 also presents the indirect effects at both low and high levels of DIF, DDF and EOT. As the bootstrapped 95% CI included zero, no significant differences were observed in the indirect effects between low and high EOT levels, which suggested no moderating roles of EOT in the indirect effects of the pandemic events. However, the bootstrapped 95% CI excluding zero further confirmed that the indirect mental effects of the pandemic events were conditional, depending on DIF.

4. Discussion

The aim of this study was to explore the role of perceived stress and alexithymia, a personality trait related to difficulty of identifying and describing feelings, in the changes of mental health (depressive and anxiety) symptoms related to the COVID-19 pandemic. Our results demonstrated that alexithymia significantly moderated the mediation from the pandemic events to the changes in the mental health symptoms through perceived stress, indicating the stronger indirect effects of the pandemic on mental health problems in the individuals with higher alexithymia levels.

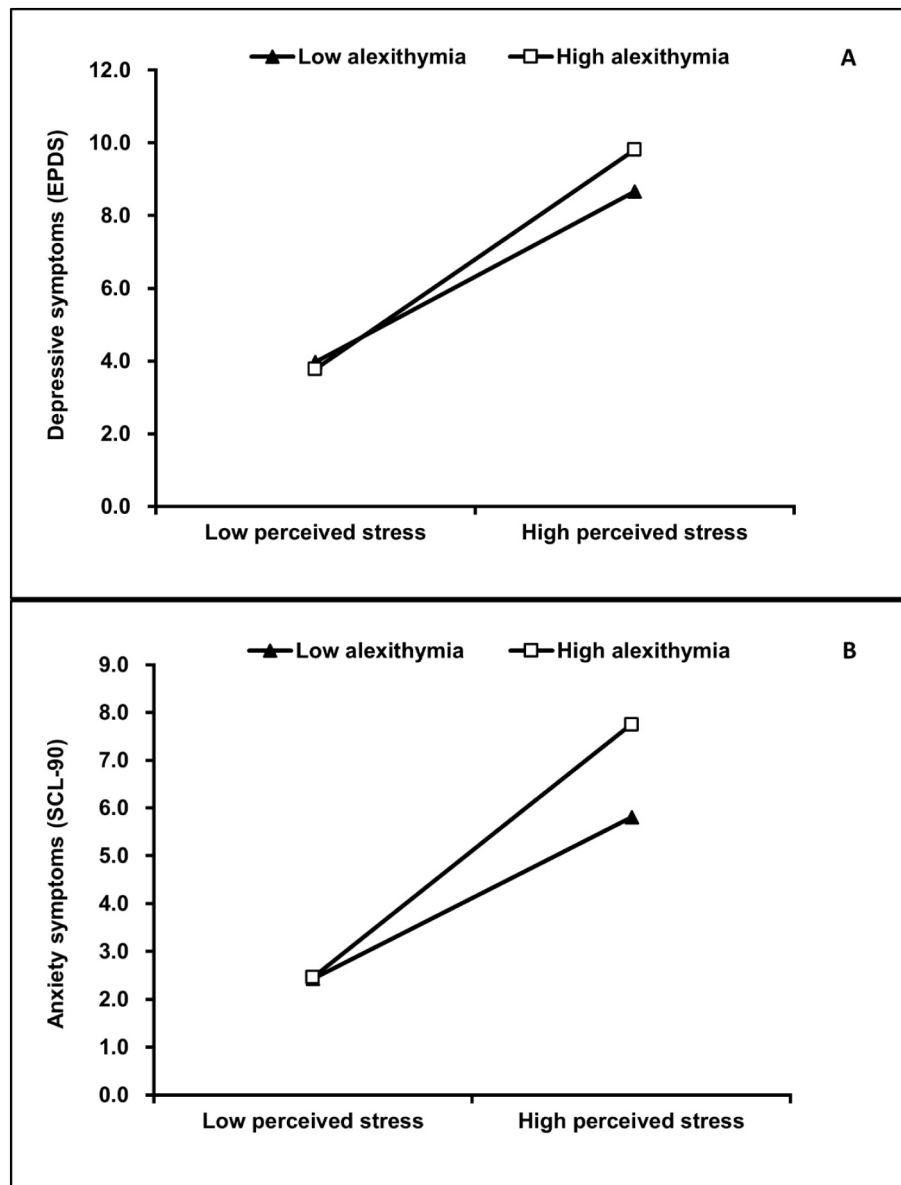


Fig. 2. Alexithymia as a moderator in the relations between perceived stress and the follow-up depressive (A) and anxiety (B) symptoms, controlling for the baseline symptoms.

EPDS, Edinburgh Postnatal Depression Scale; SCL-90, Symptom Checklist-90 (anxiety subscale).

4.1. Indirect mental impacts of the COVID-19 pandemic via perceived stress

It has been reported that the COVID-19 pandemic is related to mental health problems including insomnia, anxiety, and depression (Castellini et al., 2020; Cox and Olatunji, 2020; Gunnell et al., 2020; Huang et al., 2020; Wang et al., 2020a, 2020b). For further exploring the relationships, we intended to determine the possible indirect transition from the pandemic to depressive and anxiety symptoms. Generally, perceived stress refers to global stress levels based on one's subjective appraisal of nonspecific stressful events or situations, and thus to some degree, it may be more strongly associated with health-related outcomes than the actual number of stressful events (Cohen et al., 1983; Lee, 2012). Accordingly, we focused on whether perceived stress mediated the association between pandemic events and the change in mental health symptoms during the pandemic.

Evidence has shown that the levels of psychological stress tend to be increased by unpredictable environmental factors such as natural

disasters and the outbreak of deadly epidemics (Han et al., 2021; Pickering, 2001; Yu et al., 2005). This is in line with our results emphasizing the significant relation between the pandemic events and the perceived stress. The observation that perceived stress was in turn significantly associated with the increase of the depressive and anxiety symptoms is supported by a number of studies reporting a relation between perceived stress and mental disorder symptoms including anxiety and depression (Dong et al., 2013; Spada et al., 2008). This link between stress and mental outcomes can be explained by the stress-vulnerability model (Zubin and Spring, 1977), which suggests that mental illnesses may manifest in individuals when stress exceeds their intrinsic threshold. In the present study applying the conditional process model, the relationship between pandemic events, perceived stress and the pandemic-related symptoms appeared to be significant independently of the moderator (alexithymia) levels. Taken together, our results that the COVID-19 pandemic events indirectly impact on the mental health change via perceived stress imply an explanatory mechanism underlying the mental influences of the pandemic.

Table 3
 Conditional indirect effects of pandemic events (X) via perceived stress (M) on the change of depressive (Y1) and anxiety symptoms (Y2) at low and high levels of the moderators (W) and the pairwise contrasts.

Process	Indirect effects of pandemic events (X)				
	Levels of W	Effect	SE	Bootstrapped 95% CI	
				LLCI	ULCI
X → M → Y1	Alexithymia (TAS-20 total)				
	Low	0.083	0.032	0.025	0.149
	High	0.107	0.040	0.032	0.189
	Contrast	0.024	0.014	0.002	0.055
	DIF				
	Low	0.081	0.032	0.021	0.147
	High	0.110	0.042	0.028	0.197
	Contrast	0.028	0.014	0.005	0.061
	DDF				
	Low	0.086	0.034	0.024	0.157
	High	0.106	0.040	0.029	0.187
	Contrast	0.020	0.012	0.001	0.047
	EOT				
	Low	0.092	0.037	0.023	0.168
	High	0.100	0.039	0.025	0.178
Contrast	0.008	0.012	-0.014	0.034	
X → M → Y2	Alexithymia (TAS-20 total)				
	Low	0.060	0.025	0.014	0.115
	High	0.094	0.036	0.026	0.168
	Contrast	0.034	0.017	0.006	0.072
	DIF				
	Low	0.052	0.023	0.012	0.102
	High	0.101	0.039	0.027	0.181
	Contrast	0.050	0.021	0.013	0.097
	DDF				
	Low	0.065	0.028	0.015	0.125
	High	0.091	0.035	0.024	0.163
	Contrast	0.026	0.016	-0.002	0.062
	EOT				
	Low	0.077	0.031	0.019	0.140
	High	0.081	0.033	0.020	0.149
Contrast	0.004	0.013	-0.023	0.032	

N = 659; Bootstrapped sample size = 5000.
 CI, confidence interval; LLCI, lower limit CI; ULCI, upper limit CI.
 TAS-20 = 20-item Toronto Alexithymia Scale; DDF = difficulty describing feelings; DIF = difficulty identifying feelings; EOT = externally oriented thinking.
 Contrast = Effect differences between low and high levels of the moderators (W).
 Bootstrapped 95% CI excluding zero indicates significant effects.

4.2. Moderating role of alexithymia in the indirect mental effects of the COVID-19 pandemic

As shown in previous research, alexithymia played a moderating role in the association acute stress with post-traumatic stress symptoms (Ledermann et al., 2020). Similarly, our results displayed significant moderation effects of alexithymia on the association between perceived stress and the change of depressive and anxiety symptoms in the context of the COVID-19 pandemic. In the individuals who perceived more stress, higher alexithymia levels indicated a larger symptom increase from pre-pandemic to the pandemic. The findings also echo the stress-alexithymia hypothesis that alexithymia may contribute to the development of stress-related disorders (Martin and Pihl, 1985). According to this hypothesis, alexithymic individuals would lack effective emotion regulation and coping due to their impaired emotional awareness and expression, and thus, experience prolonged stress-responses. Numerous studies have reported findings supporting the link of alexithymia to stress-related disorders; for example, it has been found to be associated with depression, anxiety, panic disorder, and cardiovascular disease (Honkalampi et al., 2000; Marchesi et al., 2005; Tolmunen et al., 2010; Šago et al., 2020). Our study provides further evidence of alexithymia as a factor moderating the mental health influences of an uncontrollable event and thus contributing to the cumulative stress load over time.

Furthermore, our findings indicated that the indirect mental effects of pandemic events via perceived stress were conditional on the levels of alexithymia. This further confirmed the moderation effects of alexithymia on the process extending from the pandemic events to the mental health problems. It has been suggested that personality traits could be involved in any process of exposure, appraisal, and negative mental outcomes to stressors (Suls and Martin, 2005). In a previous study, alexithymia was found to moderate the association between traumatic exposures and post-traumatic stress symptoms (Park et al., 2015). However, no moderating effect of alexithymia was observed on the direct path from the pandemic events to mental health problems in our study. The current findings showed that alexithymia only played a significant moderating role in the indirect path of the model, specifically, the path between perceived stress and the changes in depressive and anxiety symptoms, in turn moderating the indirect mental impacts of the COVID-19 pandemic events. In brief, alexithymia moderated the indirect mental health impacts of the pandemic events via interacting with perceived stress, which implies that the alexithymic feature was more relevant to the appraisal of subjective feelings instead of the objective events. Although the indirect relation between the pandemic events and the psychiatric symptoms was found significant regardless of alexithymia levels, this indirect effect of the pandemic intensified with the levels of alexithymia increasing. That is to say, the individuals with higher levels of alexithymia presented more depressive and anxiety symptoms due to perceiving more stress under the pandemic situation.

Finally, considering the dimensions of alexithymia, DIF and DDF, but not EOT, served as a significant moderator for the whole model. This may to a certain degree support the attention-appraisal model, which suggests that DIF and DDF refer to difficulties in emotion appraisal, whereas EOT reflects a deficiency in attending to emotions (Preece et al., 2017). Our findings are in line with the prior evidence that psychiatric symptoms have been found to be mainly associated with DIF and DDF but not EOT (Grabe et al., 2004; Kajanoja et al., 2017). However, on one hand, the EOT dimension is even speculated to act as a protective factor against emotional distress (Alkan Härtwig et al., 2014), but on the other hand, to possibly predispose to regulate emotions by problem behaviors such as substance use (Davydov et al., 2013; Kajanoja et al., 2018). The inconsistent effects between DIF/DDF and EOT could be especially crucial for the development of mental health problems when being exposed to same stressors. Thereby, further research would benefit from exploring the role of the different dimensions of alexithymia in the pandemic-related externalizing problems such as family violence and alcohol use, and in longitudinal symptom courses.

4.3. Implications and limitations

The current findings have implications for improving mental well-being during the COVID-19 pandemic. Even if the parents in our study represent a relatively “low-risk” and healthy population that may not suffer from mental disorders to marked extent, individuals with certain traits may expose themselves to prolonged stressors so that their negative emotional outcomes may be steadily exacerbated. Our finding that alexithymia played a significant moderating role in this perceived stress-symptoms path may indicate alexithymic features as a noteworthy predictor for identifying the vulnerable individuals under stressful situations such as pandemic exposure. Additionally, unlike many previous studies testing moderated mediation effects in cross-sectional settings, this study conducted the conditional process model with using longitudinal data, which may also add to the current understanding for the mechanism underlying the development of mental health problems due to the pandemic.

One possible limitation of this study is that our assessments were based on self-report measures. Second, negative life events measured in this study did not cover the whole interval between the baseline and follow-up time points, and thus there may be other factors than the pandemic events interacting with the changes in the psychological

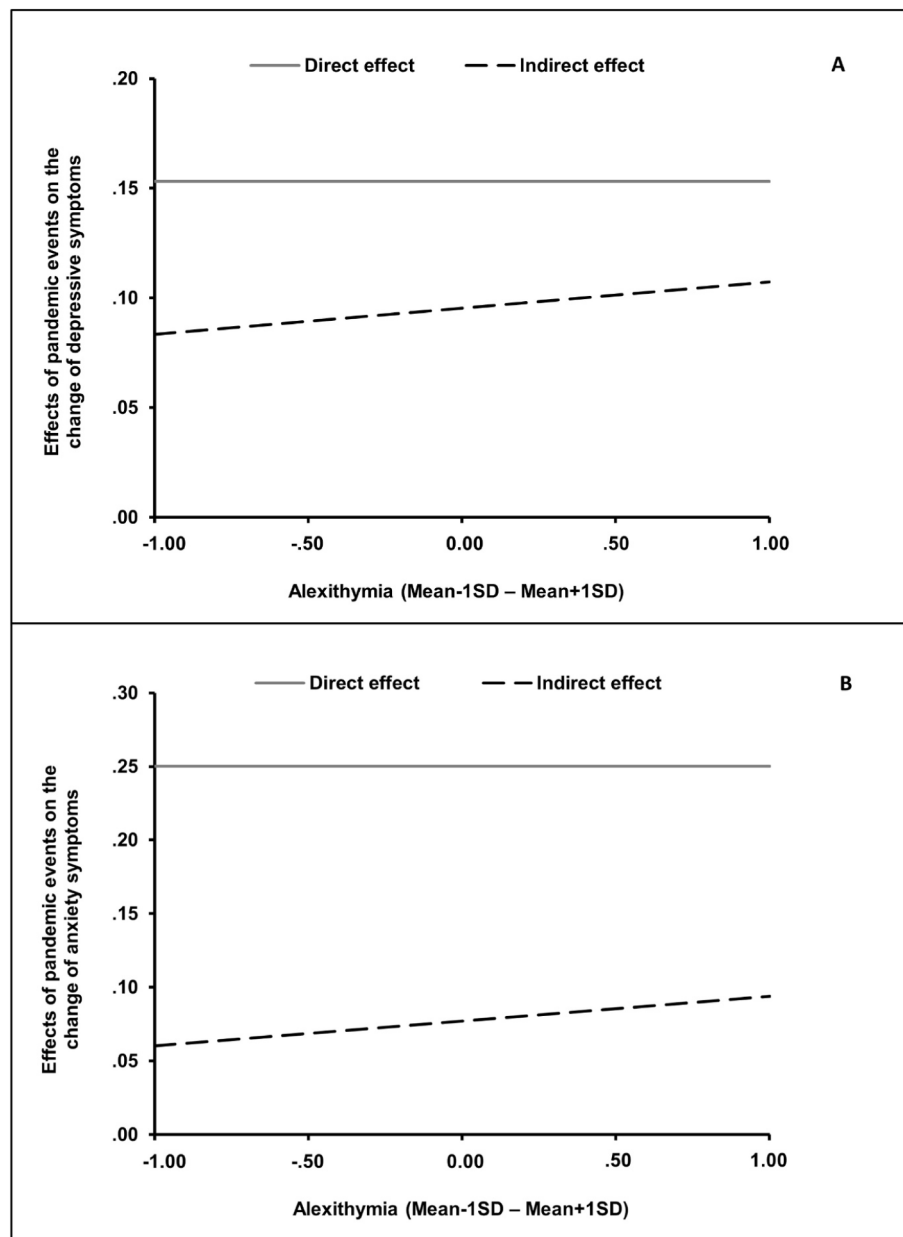


Fig. 3. Alexithymia as a moderator for the indirect effects of pandemic events via perceived stress on the change of the depressive (A) and anxiety (B) symptoms.

symptoms, which should be considered when interpreting the findings. This would benefit from further follow-up investigation of the mental health changes over time during the pandemic. Third, although the significant moderated mediation effects found in this study provide a mechanistic explanation, the pandemic events, perceived stress, and the follow-up symptoms were measured at the same time and thus causal inferences cannot be made. For example, we need to consider the possibility that mental health symptoms could also contribute to perceived stress levels. However, their associations were not moderated by alexithymia, supporting our theoretical moderated mediation. Fourth, alexithymia was measured at 6-month postpartum, which is several years earlier than the pandemic. Nevertheless, alexithymia is a personality feature with high stability, even over 11 years in the adult general population (Hiironen et al., 2017; Karukivi et al., 2014; Tolmunen et al., 2011) and in the perinatal period (Le et al., 2007). Fifth, it should be noted that the present findings may not be generalized to entire general population due to the measurement that has been carried out in the postpartum period. The generalizability of the findings to all

populations and other countries may also be limited by the relatively high education and socioeconomic status of the parents in the current study, even compared to the samples in the initial FinnBrain cohort (Karlsson et al., 2018). However, considering that the effects of the pandemic, perceived stress, and alexithymia on mental health change were found to be significant among the apparently “low-risk” parents forming the sample in the present study, it is reasonable to believe that these findings would apply also to other populations with higher risk. Lastly, the majority of the participants are females in the current study, which should be considered as a limitation as well.

5. Conclusions

In this study, we found that individuals with higher alexithymia levels showed stronger indirect path from COVID-19 pandemic events to an increase in depressive and anxiety symptoms from pre-pandemic to pandemic period via perceived stress, highlighting the significance of moderated mediation effects of alexithymia and perceived stress on the

pandemic-related mental health problems. Specifically, the current study provide evidence that alexithymia increases the risk for mental health symptom response to major pandemic stressor when the individual is experiencing high levels of stress, which suggests relevant implications for identifying vulnerable individuals, as well as tailoring preventive and psychotherapeutic interventions. Similar effects of alexithymia and perceived stress may be involved in other mental health issues related to the pandemic, such as sleep disturbances and substance use, so further research on alexithymia as one psychological mechanism underlying mental health problems in the face of stressors is strongly recommended. Furthermore, the possible long-term influences related to the COVID-19 pandemic on mental health are also worthy of future research.

Funding sources

The work was supported by the Signe and Ane Gyllenberg Foundation and the Academy of Finland.

CRediT authorship contribution statement

Ru Li: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Jani Kajanoja:** Supervision, Methodology, Writing – review & editing. **Jallu Lindblom:** Data curation, Writing – review & editing. **Riikka Korja:** Writing – review & editing. **Linnea Karlsson:** Writing – review & editing, Project administration, Resources, Funding acquisition. **Hasse Karlsson:** Writing – review & editing, Project administration, Resources, Funding acquisition. **Saara Nolvi:** Data curation, Writing – review & editing, Project administration. **Max Karukivi:** Supervision, Methodology, Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors declare no conflicts of interest.

Acknowledgments

We are grateful to the FinnBrain Birth Cohort study participants and the staff and assisting personnel for their work in managing the logistics in the study.

References

- Alkan Härtwig, E., Crayen, C., Heuser, I., Eid, M., 2014. It's in the mix: psychological distress differs between combinations of alexithymic facets. *Front. Psychol.* 5, 1259.
- Andridge, R.R., Little, R.J., 2010. A review of hot deck imputation for survey non-response. *Int. Stat. Rev.* 78, 40–64.
- Bagby, R.M., Parker, J.D., Taylor, G.J., 1994. The twenty-item Toronto Alexithymia Scale-I. Item selection and cross-validation of the factor structure. *J. Psychosom. Res.* 38: 23–32.
- Blakey, S.M., Reuman, L., Jacoby, R.J., Abramowitz, J.S., 2015. Tracing “Fearbola”: psychological predictors of anxious responding to the threat of Ebola. *Cognit Ther Res.* 39, 816–825.
- Blanc, J., Bui, E., Mouchenik, Y., Derivois, D., Birmes, P., 2015. Prevalence of post-traumatic stress disorder and depression in two groups of children one year after the January 2010 earthquake in Haiti. *J. Affect. Disord.* 172, 121–126.
- Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., Rubin, G.J., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet.* 395, 912–920.
- Cai, H., Tu, B., Ma, J., Chen, L., Fu, L., Jiang, Y., Zhuang, Q., 2020. Psychological impact and coping strategies of frontline medical staff in Hunan between January and march 2020 during the outbreak of coronavirus disease 2019 (COVID-19) in Hubei. *China. Med Sci Monit.* 26, e924171.
- Carmassi, C., Gesi, C., Corsi, M., Cremone, I.M., Bertelloni, C.A., Massimetti, E., Olivieri, M.C., Conversano, C., Santini, M., Dell’Osso, L., 2018. Exploring PTSD in emergency operators of a major University Hospital in Italy: a preliminary report on the role of gender, age, and education. *Ann. General Psychiatry* 17, 17.
- Castellini, G., Rossi, E., Cassioli, E., Sanfilippo, G., Innocenti, M., Gironi, V., Silvestri, C., Voller, F., Ricca, V., 2020. A longitudinal observation of general psychopathology before the COVID-19 outbreak and during lockdown in Italy. *J. Psychosom. Res.* 141, 110328.
- Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. *J. Health Soc. Behav.* 24, 385–396.
- Cox, J.L., Holden, J.M., Sagovsky, R., 1987. Detection of postnatal depression. Development of the 10-item Edinburgh postnatal depression scale. *Br. J. Psychiatry* 150, 782–786.
- Cox, R.C., Olatunji, B.O., 2020. Linking insomnia and OCD symptoms during the coronavirus pandemic: examination of prospective associations. *J. Anxiety Disord.* 77, 102341.
- Davydov, D.M., Luminet, O., Zech, E., 2013. An externally oriented style of thinking as a moderator of responses to affective films in women. *Int. J. Psychophysiol.* 87, 152–164.
- Derogatis, L.R., Lipman, R.S., Covi, L., 1973. SCL-90: an outpatient psychiatric rating scale—preliminary report. *Psychopharmacol. Bull.* 9, 13–28.
- Dev Bhurtun, H., Saaranen, T., Turunen, H., Estola, M., 2021. The psychometric properties of the perceived stress scale when used to measure stress levels of Finnish nursing undergraduate students. *J. Nurs. Meas.* 29, E78–E94.
- Dong, X., Qu, Z., Liu, F., Jiang, X., Wang, Y., Chui, C., Wang, X., Tian, D., Zhang, X., 2013. Depression and its risk factors among pregnant women in 2008 Sichuan earthquake area and non-earthquake struck area in China. *J. Affect. Disord.* 151, 566–572.
- Douglas, M., Katikireddi, S.V., Taulbut, M., McKee, M., McCartney, G., 2020. Mitigating the wider health effects of covid-19 pandemic response. *BMJ.* 369, m1557.
- Edmondson, O.J., Psychogiou, L., Vlachos, H., Netsi, E., Ramchandani, P.G., 2010. Depression in fathers in the postnatal period: assessment of the Edinburgh postnatal depression scale as a screening measure. *J. Affect. Disord.* 125, 365–368.
- Ehlers, A., Clark, D.M., 2000. A cognitive model of posttraumatic stress disorder. *Behav. Res. Ther.* 38, 319–345.
- Engelhard, I.M., van den Hout, M.A., Kindt, M., 2003. The relationship between neuroticism, pre-traumatic stress, and post-traumatic stress: a prospective study. *Pers Individ Dif.* 35, 381–388.
- Frewen, P.A., Dozois, D.J., Neufeld, R.W., Lanius, R.A., 2008. Meta-analysis of alexithymia in posttraumatic stress disorder. *J. Trauma. Stress.* 21, 243–246.
- Gjerdingen, D.K., Froberg, D.G., Fontaine, P., 1991. The effects of social support on women's health during pregnancy, labor and delivery, and the postpartum period. *Fam. Med.* 23, 370–375.
- Grabe, H.J., Spitzer, C., Freyberger, H.J., 2004. Alexithymia and personality in relation to dimensions of psychopathology. *Am. J. Psychiatry* 161, 1299–1301.
- Gunnell, D., Appleby, L., Arensman, E., Hawton, K., John, A., Kapur, N., Khan, M., O'Connor, R.C., Pirkis, J., 2020. Suicide risk and prevention during the COVID-19 pandemic. *Lancet Psychiatry* 7, 468–471.
- Gustafsson, H.C., Young, A.S., Doyle, O., Nagel, B.J., Mackiewicz Seghete, K., Nigg, J.T., Sullivan, E.L., Graham, A.M., 2021. Trajectories of perinatal depressive symptoms in the context of the COVID-19 pandemic. *Child Dev.* 92, e749–e763.
- Han, Y.R., Jeong, Y.W., Kim, S.K., Jeong, H.S., 2021. Changes in the levels of stress perception, experiencing depressive symptoms and health-related quality of life of residents after the 2016 Gyeongju earthquake. *Int. J. Environ. Res. Public Health* 18, 540.
- Harris, P.A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., Conde, J.G., 2009. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J. Biomed. Inform.* 42: 377–81.
- Hayes, A.F., 2017. Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition: A Regression-Based Approach. Guilford Publications, New York, UNITED STATES.
- Hayes, A.F., Rockwood, N.J., 2019. Conditional process analysis: concepts, computation, and advances in the modeling of the contingencies of mechanisms. *Am. Behav. Sci.* 64, 19.
- Hiirola, A., Pirkola, S., Karukivi, M., Markkula, N., Bagby, R.M., Joukamaa, M., Jula, A., Kronholm, E., Saarijärvi, S., Salminen, J.K., Suvisaari, J., Taylor, G., Mattila, A.K., 2017. An evaluation of the absolute and relative stability of alexithymia over 11 years in a Finnish general population. *J. Psychosom. Res.* 95, 81–87.
- Holi, M.M., Sammallahti, P.R., Aalberg, V.A., 1998. A Finnish validation study of the SCL-90. *Acta Psychiatr. Scand.* 97, 42–46.
- Honkalampi, K., Hintikka, J., Tanskanen, A., Lehtonen, J., Viinamäki, H., 2000. Depression is strongly associated with alexithymia in the general population. *J. Psychosom. Res.* 48, 99–104.
- Huang, L., Lei, W., Xu, F., Liu, H., Yu, L., 2020. Emotional responses and coping strategies in nurses and nursing students during Covid-19 outbreak: a comparative study. *PLoS One* 15, e0237303.
- Joukamaa, M., Miettinen, J., Kokkonen, P., Koskinen, M., Julkunen, J., Kauhanen, J., Jokelainen, J., Veijola, J., Läksy, K., Järvelin, M.R., 2001. Psychometric properties of the Finnish 20-item Toronto alexithymia scale. *Nord J Psychiatry.* 55, 123–127.
- Kajanoja, J., Scheinin, N.M., Karlsson, L., Karlsson, H., Karukivi, M., 2017. Illuminating the clinical significance of alexithymia subtypes: a cluster analysis of alexithymic traits and psychiatric symptoms. *J. Psychosom. Res.* 97, 111–117.
- Kajanoja, J., Scheinin, N.M., Karukivi, M., Karlsson, L., Karlsson, H., 2018. Alcohol and tobacco use in men: the role of alexithymia and externally oriented thinking style. *Am J Drug Alcohol Abuse.* 1–9.
- Karlsson, L., Tolvanen, M., Scheinin, N.M., Uusitupa, H.M., Korja, R., Ekholm, E., Tuulari, J.J., Pajulo, M., Huotilainen, M., Paunio, T., Karlsson, H., 2018. Cohort profile: the FinnBrain birth cohort study (FinnBrain). *Int. J. Epidemiol.* 47, 15–16j.
- Karukivi, M., Pölonen, T., Vahlberg, T., Saikkonen, S., Saarijärvi, S., 2014. Stability of alexithymia in late adolescence: results of a 4-year follow-up study. *Psychiatry Res.* 219, 386–390.
- Le, H.N., Ramos, M.A., Muñoz, R.F., 2007. The relationship between alexithymia and perinatal depressive symptomatology. *J. Psychosom. Res.* 62, 215–222.

- Ledermann, K., von Känel, R., Barth, J., Schnyder, U., Znoj, H., Schmid, J.P., Meister Langraff, R.E., Princip, M., 2020. Myocardial infarction-induced acute stress and post-traumatic stress symptoms: the moderating role of an alexithymia trait - difficulties identifying feelings. *Eur. J. Psychotraumatol.* 11, 1804119.
- Lee, E.H., 2012. Review of the psychometric evidence of the perceived stress scale. *Asian Nurs Res (Korean Soc Nurs Sci)*. 6, 121–127.
- Leung, D.Y., Lam, T.H., Chan, S.S., 2010. Three versions of perceived stress scale: validation in a sample of Chinese cardiac patients who smoke. *BMC Public Health* 10, 513.
- Lowe, S.R., Bonumwezi, J.L., Valdespino-Hayden, Z., Galea, S., 2019. Posttraumatic stress and depression in the aftermath of environmental disasters: a review of quantitative studies published in 2018. *Curr Environ Health Rep.* 6, 344–360.
- Mahase, E., 2020. China coronavirus: WHO declares international emergency as death toll exceeds 200. *BMJ*. 368, m408.
- Main, A., Zhou, Q., Ma, Y., Lueken, L.J., Liu, X., 2011. Relations of SARS-related stressors and coping to Chinese college students' psychological adjustment during the 2003 Beijing SARS epidemic. *J. Couns. Psychol.* 58, 410–423.
- Mak, I.W., Chu, C.M., Pan, P.C., Yiu, M.G., Ho, S.C., Chan, V.L., 2010. Risk factors for chronic post-traumatic stress disorder (PTSD) in SARS survivors. *Gen. Hosp. Psychiatry* 32, 590–598.
- Marchesi, C., Fontò, S., Balista, C., Cimmino, C., Maggini, C., 2005. Relationship between alexithymia and panic disorder: a longitudinal study to answer an open question. *Psychother. Psychosom.* 74, 56–60.
- Martin, J.B., Pihl, R.O., 1985. The stress-alexithymia hypothesis: theoretical and empirical considerations. *Psychother. Psychosom.* 43, 169–176.
- McGinty, E.E., Presskreischer, R., Han, H., Barry, C.L., 2020. Psychological distress and loneliness reported by US adults in 2018 and April 2020. *JAMA*. 324, 93–94.
- Mineka, S., Kihlstrom, J.F., 1978. Unpredictable and uncontrollable events: a new perspective on experimental neurosis. *J. Abnorm. Psychol.* 87, 256–271.
- Myers, T., 2011. Goodbye, Listwise deletion: presenting hot deck imputation as an easy and effective tool for handling missing data. *Commun. Methods Meas.* 5, 297.
- Nolvi, S., Karukivi, M., Korja, R., Lindblom, J., Karlsson, L., Karlsson, H., 2020. Parental depressive and anxiety symptoms as a response to the COVID-19 pandemic: a birth cohort follow-up study. Preprint available from: <https://doi.org/10.31234/osf.io/8h4b4>.
- Nolvi, S., Karukivi, M., Korja, R., Lindblom, J., Karlsson, L., Karlsson, H., 2021. Vanhempien masennus- ja ahdistusoireet lisääntyivät COVID-19-pandemian alkuvaiheessa - FinnBrain-syntymäkohorttitutkimus [symptoms of depression and anxiety among parents increased in the early stages of the COVID-19 pandemic – FinnBrain birth cohort study]. *Duodecim; Lääketieteellinen Aikakauskirja*. 137.
- Norris, F.H., 1992. Epidemiology of trauma: frequency and impact of different potentially traumatic events on different demographic groups. *J. Consult. Clin. Psychol.* 60, 409–418.
- Park, C.L., Russell, B.S., Fendrich, M., Finkelstein-Fox, L., Hutchison, M., Becker, J., 2020. Americans' COVID-19 stress, coping, and adherence to CDC guidelines. *J. Gen. Intern. Med.* 35, 2296–2303.
- Park, J., Jun, J.Y., Lee, Y.J., Kim, S., Lee, S.H., Yoo, S.Y., Kim, S.J., 2015. The association between alexithymia and posttraumatic stress symptoms following multiple exposures to traumatic events in north Korean refugees. *J. Psychosom. Res.* 78, 77–81.
- Pickering, T.G., 2001. Mental stress as a causal factor in the development of hypertension and cardiovascular disease. *Curr. Hypertens. Rep.* 3, 249–254.
- Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., McManus, S., Abel, K.M., 2020. Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. *Lancet Psychiatry* 7, 883–892.
- Preacher, K.J., Rucker, D.D., Hayes, A.F., 2007. Addressing moderated mediation hypotheses: theory, methods, and prescriptions. *Multivariate Behav. Res.* 42, 185–227.
- Preece, D., Becerra, R., Allan, A., Robinson, K., Dandy, J., 2017. Establishing the theoretical components of alexithymia via factor analysis: introduction and validation of the attention-appraisal model of alexithymia. *Pers Individ Dif.* 119, 341–352.
- Romeo, A., Benfante, A., Castelli, L., Di Tella, M., 2021. Psychological distress among Italian university students compared to general workers during the COVID-19 pandemic. *Int. J. Environ. Res. Public Health* 18, 2503.
- Šago, D., Babić, G., Bajić, Ž., Filipčić, I., 2020. Panic disorder as unthinkable emotions: alexithymia in panic disorder, a Croatian cross-sectional study. *Front Psychiatry*. 11, 466.
- Schäfer, S.K., Sopp, M.R., Schanz, C.G., Staginnus, M., Göritz, A.S., Michael, T., 2020. Impact of COVID-19 on public mental health and the buffering effect of a sense of coherence. *Psychother. Psychosom.* 89, 386–392.
- Sifneos, P.E., 1973. The prevalence of 'alexithymic' characteristics in psychosomatic patients. *Psychother. Psychosom.* 22, 255–262.
- Sim, K., Huak Chan, Y., Chong, P.N., Chua, H.C., Wen Soon, S., 2010. Psychosocial and coping responses within the community health care setting towards a national outbreak of an infectious disease. *J. Psychosom. Res.* 68, 195–202.
- Spada, M.M., Nikčević, A.V., Moneta, G.B., Wells, A., 2008. Metacognition, perceived stress, and negative emotion. *Pers Individ Dif.* 44, 1172–1181.
- Spinelli, M., Lionetti, F., Pastore, M., Fasolo, M., 2020. Parents' stress and Children's psychological problems in families facing the COVID-19 outbreak in Italy. *Front. Psychol.* 11, 1713.
- Suls, J., Martin, R., 2005. The daily life of the garden-variety neurotic: reactivity, stressor exposure, mood spillover, and maladaptive coping. *J. Pers.* 73, 1485–1509.
- Taylor, G.J., Bagby, R.M., Parker, J.D., 2003. The 20-item Toronto alexithymia scale. IV. Reliability and factorial validity in different languages and cultures. *J. Psychosom. Res.* 55, 277–283.
- Tolmunen, T., Lehto, S.M., Heliste, M., Kurl, S., Kauhanen, J., 2010. Alexithymia is associated with increased cardiovascular mortality in middle-aged Finnish men. *Psychosom. Med.* 72, 187–191.
- Tolmunen, T., Heliste, M., Lehto, S.M., Hintikka, J., Honkalampi, K., Kauhanen, J., 2011. Stability of alexithymia in the general population: an 11-year follow-up. *Compr. Psychiatry* 52, 536–541.
- Vallejo, M.A., Vallejo-Slocker, L., Fernández-Abascal, E.G., Mañanes, G., 2018. Determining factors for stress perception assessed with the perceived stress scale (PSS-4) in Spanish and other European samples. *Front. Psychol.* 9, 37.
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C.S., Ho, R.C., 2020a. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int. J. Environ. Res. Public Health* 17, 1729.
- Wang, Y., Ma, S., Yang, C., Cai, Z., Hu, S., Zhang, B., Tang, S., Bai, H., Guo, X., Wu, J., Du, H., Kang, L., Tan, H., Li, R., Yao, L., Wang, G., Liu, Z., 2020b. Acute psychological effects of coronavirus disease 2019 outbreak among healthcare workers in China: a cross-sectional study. *Transl. Psychiatry* 10, 348.
- Xiang, Y.T., Yang, Y., Li, W., Zhang, L., Zhang, Q., Cheung, T., Ng, C.H., 2020. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *Lancet Psychiatry* 7, 228–229.
- Xiong, J., Lipsitz, O., Nasri, F., Lui, L., Gill, H., Phan, L., Chen-Li, D., Iacobucci, M., Ho, R., Majeed, A., McIntyre, R.S., 2020. Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J. Affect. Disord.* 277, 55–64.
- Yan, L., Gan, Y., Ding, X., Wu, J., Duan, H., 2021. The relationship between perceived stress and emotional distress during the COVID-19 outbreak: effects of boredom proneness and coping style. *J. Anxiety Disord.* 77, 102328.
- Yu, H.Y.R., Ho, S.C., So, K.F.E., Lo, Y.L., 2005. The psychological burden experienced by Hong Kong midlife women during the SARS epidemic. *Stress and HealthStress and Health*. 21, 177–184.
- Zhou, X., Kang, L., Sun, X., Song, H., Mao, W., Huang, X., Zhang, Y., Li, J., 2013. Risk factors of mental illness among adult survivors after the Wenchuan earthquake. *Soc. Psychiatry Psychiatr. Epidemiol.* 48, 907–915.
- Zubin, J., Spring, B., 1977. Vulnerability: a new view of schizophrenia. *J. Abnorm. Psychol.* 86, 103–126.