Amy L. Ai, PhD

Florida State University

2570 University Center Building-C

Tallahassee, FL 32306

(850) 644-3577

amyai8@gmail.com

June 20, 2024

Kathleen A. Kendall-Tackett, PhD

Editor-in-Chief

*Psychological Trauma: Theory, Research, Practice, and Policy* (PTTRPP)

Clinical Associate Professor of Pediatrics

Texas Tech University

Dear Dr. Kendall-Tackett,

Please find the manuscript, titled “*Association­­ of Posttraumatic Growth with Covid-19: A Meta-analytic Review,*” uploaded to the *PTTR* submission site. We hope that itbe considered for review by your editorial board. The article is not commissioned, nor does it respond to a call for special issues. No conflict of interest is involved in this study. None of parts in this manuscript was a ChatGPT product.

We assume that the finding will be of interest to the readers of *PTTR* because this interdisciplinary study provides information on an aggregated outcome on a trauma-related concept, PTG, in Covid-19, the deadliest pandemic that is traumatic event for all populations in the new century. It is the first meta-analysis for global findings on this topic.

To make the manuscript short, all subgroup analysis figures and tables are in the Appendix for provision upon request. We hope that the under-investigated positive side may have important implications for patient-centered trauma care and enhancing the role of psychological sciences in human health.

Thank you for your attention! Look forward to hearing your editorial decision*!*

Sincerely,

Amy L. Ai, PhD

FSU Distinguished Research Professor

**Association of Posttraumatic Growth with Covid-19:**

**A Meta-analytic Review**

Amy L. Ai, PhD1

Qizhou Duan, MS2

Marguerite Rwil, UROP RA3

Henry Carretta, PhD, MPH34

**(Running Head: Covid-19 and PTG)**

(03/20/2024, in Submission to PTTR

### 1. Corresponding author: Distinguished Research Professor, Colleges of Social Work, Medicine (Social Medicine and Behavioral Science), and Nursing, 2570 University Center Building C, Florida State University (FSU), Tallahassee, FL, 32306; amyai8@gmail.com

2. Department of Psychology, University of Notre Dame, qduan@nd.edu

3. Undergraduate Research Assistant, msr21b@fsu.edu

4. Colleges of Social Work, Medicine (Social Medicine and Behavioral Science), FSU, hjcarret@gmail.com

***Acknowledgement:*** All Authors have contributed to substantive development of this research and writing and agreed to be a co-author of this manuscript.

***Sources of Funding:*** None.

***Disclosures:*** None.

The authors have no conflicts of interest to declare. Amy L Ai served as lead for conceptualization, project administration, article review, and writing–review and editing. Qizhou Duan served in a role for methodology, article review, formal analysis, software, visualization, and writing–review and editing. Marguerite S Rwil contributed equally to [Data curation](http://159.203.176.220/contributor-roles/data-curation/), abstract review, and served in a supporting role for data curation, tables, and editing. Henry Carretta served in a supporting role for methodology, and writing–review and editing. Correspondence concerning this article should be addressed to Amy L Ai, Florida State University, 2570 University Center Building-C, Tallahassee, FL 32306. Email: amyai8@gmail.com

[Funding acquisition](http://159.203.176.220/contributor-roles/funding-acquisition/)—NA

[Investigation](http://159.203.176.220/contributor-roles/investigation/)—Ai, Q

[Methodology](http://159.203.176.220/contributor-roles/methodology/)—Q, Ai

[Project administration](http://159.203.176.220/contributor-roles/project-administration/)—M, Ai

[Resources](http://159.203.176.220/contributor-roles/resources/)—NA

[Software](http://159.203.176.220/contributor-roles/software/)—Q

[Supervision](http://159.203.176.220/contributor-roles/supervision/)—Ai, C

[Validation](http://159.203.176.220/contributor-roles/validation/)—Q, Ai

[Visualization](http://159.203.176.220/contributor-roles/visualization/)—Q

[Writing – original draft](http://159.203.176.220/contributor-roles/writing-original-draft/)—Ai, Q

[Writing – review & editing](http://159.203.176.220/contributor-roles/writing-review-editing/)—C, Ai, Q

**Association of Posttraumatic Growth with Covid-19 and Posttraumatic Stress:**

**A Meta-analytic Review**

**(Running Head: Covid-19 and PTG)**

(03/20/2024, in Submission to PTTR)

**Abstract: Background**. Emerging research suggests that posttraumatic growth (PTG), positive gains arising from the struggle with trauma, may occur among patients, health providers, and general populations affected by the deadly Covid-19. This is the first meta-analytic review of the association between PTG and Covid-19 using aggregated data from four continents. **Method.** PubMed (30), PsychINFO(6), Academic Search Complete (4), Ovid MEDLINE (20), electronic databases were systematically searched (05/23/2023—04/31/2024) to identify eligible studies reporting the targeted association by suing the predetermined Medical Subject Heading and psychological terms. Adjusted effect estimates were employed, and pooled analysis was conducted, using the Hartung-Knapp-Sidik-Jonkman random-effects model. Sensitivity and subgroup analyses were performed. The Meta-analysis-of-Observational-Studies-in-Epidemiology (MOOSE) reporting guideline was followed. **Results.** The final selection involved a composite of 71 studies, comprising 65,704 participants. COVID-19 was significantly associated with PTG as mostly determined by Posttraumatic Growth Inventory (PTGI)(*g*=2.033; 95%CI, 0.75-3.31; *p* = 0.002). **Conclusion.** The findings indicate that COVID-19 pandemic events could be associated with PTG as a positive population outcome. Prospective research and underlying bio-behavioral mechanisms are needed in in future investigation. **Policy implications**: Exploring the PTG phenomena may orient public health policy to positive changes in populations affected in catastrophic pandemics. (250 words + six words in subtitles).

***Keywords:*** Meta-analysis and systematic review, cardiovascular disease (COVID-19), post-traumatic growth (PTG), myocardial infarction, stroke, cardiac procedures

**Introduction**

Since the World Health Organization declared the 2019 novel coronavirus (Covid-19) as a global emergency (Sohrabi et al., 2020), the pandemic has created a sweeping impact on mortality and detrimental psychiatric consequences in three years (O’Connor et al., 2020; Wang et al., 2022). Unlike other severe diseases (e.g., cardiovascular diseases, cancer), Covid-19’s effect is pervasive and traumatic, influencing many sectors of populations (Krishnamoorthy et al., 2020) and at all levels (individual, family, community, nation, and the word). In medical settings, its highly contiguous nature also generated health and existential threats to both patients and health-care providers (Adjorlolo et al., 2022 ;Castiglioni et al. ,2023; Chen et al., 2021; Khattab et al., 2020; Lewis et al., 2022; Yeung et al., 2022; Zhang et al., 20210 Because of exposure to COVID-19, mental health problems, psychiatric distress, and alter human cognition (e.g., negative thoughts or views of the world) could rise as do following other traumas (Moreland et al., 2023).For instance, high prevalence of depression (47.10%), insomnia (36.2%), and suicidality (7.8%) was revealed from a Chinese national survey of mental health professionals who recovered from COVID-19.

Nevertheless, positive cognition, such as posttraumatic growth (PTG), can also emerge with struggles as trauma-related psychological gains (e.g., positive mindset changes in cognition and worldview)(Calhoun & Tedeschi, 2006).Most observed domains of PTG involved greater positive changes in personal strength, appreciation of life, and social relationships. PTG is also a kind of adaptive outcomes in patients with life-altering diseases (Ma et al., 2022; Pieta & Rzeszutek, 2022; Sawyer et al., 2010; Shand et al., 2015; Wang et al., 2022). A few meta-analyses have associated this phenomenon with low mortality in non-pandemic patients (Ma et al., 2022; Wan et al., 2023). A meta-analysis on individuals living with HIV/AIDS, a previously life-threatening pandemic, has shown the positive relationship between PTG and adjustment (Pieta & Rzeszutek, 2022). The paucity implies that meta-analyses will be desirable for this optimal outcome. Current pandemics, like the highly contentious COVID-19, have imposed more severe public health risks in a rapid and widely spread manner. Given the long-term and vast impact of Covid-19 (Kocatürk et al., 2021; Parums, 2021), it is necessary to examine if PTG, as a modifiable dimension of outcomes, could cooccur with this catastrophic pandemic in the United States and globally.

Emerging evidence has shown the promise. In 2021, a national representative study of US veterans reported moderate to greater levels of PTG resulting from the COVID-19 experience, especially among those suffering from posttraumatic stress symptoms (PTSD) linked with positive Covid-19 results (Pietrazk et al., 2021). A large-sample Swiss study found PTG emerged with sense of control and self-mastery two years since the onset of Covid-19 (Petrocchi et al., 2023). In Israel, researchers identified resilience, growth, and distress in participants belonging to the ultra-Orthodox society during the second wave of COVID-19 there (Levinsky et al., 2024). Yet, there has been no one pooled analysis on PTG across different types of people in various roles (e.g., general populations, health-care providers, and infected patients) throughout the traumatic pandemic around the world. Accordingly, we conducted this first meta-analytic review to examine the scope of this positive worldview-based mindset during and post COVID-19 in the United States and internationally.

By employing a systematic approach to synthesize empirical studies, we attempted to provide more reliable and robust conclusion on PTG. The aim was twofold: (1) Whether PTG could be observed under the existential threat of COVID-19 to mankind; and (2) whether the change in posttraumatic positive cognition were associated with certain moderators (e.g., risk and protective factors mostly examined in the literature). Based on the literature, we hypnotized a positive relationship of PTG to Covid-!9 across different sectors of global populations in a main analysis but did not expect directional links in subgroup analyses.

# **Methods**

# **Data Sources and Search Strategy**

This systematic meta-analytic review was conducted and presented following the recommendations of the Meta-analysis of Observational Studies in Epidemiology (MOOSE) reporting guideline (Stroup et al., 2000). A systematic literature search of Ovid MEDLINE, PsycINFO, Academic Search Complete, and PubMed was performed for research articles published from since the onset of Covid-19, January, 2000, to May, 2024. The following Medical and Psychological Subject Heading terms were used to identify studies that assessed PTG in patients with COVID-19: posttraumatic growth, stress-related growth, adverse growth, COVID-19 MI, positive effects, positive outcome, and self-growth. Furthermore, references from selected studies and relevant review articles were reviewed to identify additional publications (Cui et al., 2021; Feingold et al., 2022; Finstad et al., 2021; Hyun et al., 2021; Kowalski et al., 2021; Li et al., 2022; Van der Hallen & Godor et al., 2022) Additional search was conducted based on the information found from references of early identified publications. Several missing or incomplete effect size were obtained through outreach to authors. All results were compiled in EndNote and imported into Covidence systematic review software (Veritas Health Innovation, n.d.) for screening (see the online supplemental materials for full search criteria). We did not preregister the protocol for this review.

# **Study Selection**

Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org.

Covidence software was used for the study review and selection procedure. Selected articles were in English, though no language restriction was used to cover publications in both the United States and abroad. Two investigators (A.A., Q.D) independently reviewed the potential candidates for this review. Eligible studies were original empirical research articles that assessed posttraumatic and adulthood growth related terms in different types of people who had various with the global pandemic (e.g., patients, health providers, community dwellers, etc.). Studies on other pandemic only (e.g., Ebola, influenzas) or other disasters were excluded. Then, for the purpose of uniformity of measure, we decided to adopt PTGI(Posttraumatic Growth Inventory) (Tedeschi & Calhoun, 1996) as the standard scale for measuring PTG. Any standard variants of PTGI (e.g., PTGI-SF) that could be converted to its scoring style were included. Stated differently, only those with mean scores on PTG with standard deviation or correlates with PTG were included.

Studies using open-ended measures were excluded due to the lack of validation. Studies that did not employ an established and validated scale that specifically focused on PTG, or used other types of measures for gains were excluded. Measures such as Stress-related growth scales (e.g., SRGS; Park, Cohen, & Murch, 1996) that were derived from a different set of items, and accesses different aspects of PTG, were excluded. The latter type of exclusion also involved measures on such broader positive changes as Benefit Finding Scale (Mohr et al., 1999)and Perceived Benefit Scale (McMillen & Fisher., 1998),because certain gains did not pertain to adulthood growth.

**Abstract Review ??**

**Data Extraction and Quality Assessment**

According to pre-planned protocol and using a standardized form, an assistant investigator (M.R.) reviewed all abstracts first to identify potential studies for inclusion. Full text articles were obtained for all eligible studies and were independently reviewed by two investigators (A.A., Q.D.). Disagreement on the selected studies were then discussed for finalizing the sample. Next, the second reviewer (Q.D.) extracted data from the selected studies. The following data were extracted: study characteristics (e.g., author, year of publication, sample size, study design), patient characteristics (e.g., age, sex, COVID-19 diagnosis), PTG assessment tools, the measures (e.g. PTGI) of PTG, and the standard deviation of the measures for each study. The quality of the selected studies was assessed using Meta-analyses of Observational Studies in Epidemiology Checklist (Zuuren & Fedorowicz, 2016).

**Statistical Analysis**

R (version 4.3.1) was used to conduct the meta-analysis. The current study selected articles that reported the mean and standard deviation (SD) of PTG as assessed by the either PTGI (Tedeschi & Calhoun, 1996) or its variants. The PTG scale used in this study (PTGI) involved summing up ratings across 21 self-reported questions, resulting in a possible score range of 0 to 105. The weighted mean of PTGI was used to identify the level of PTG on COVID-19 patients. To categorize the level of PTG, a cutoff point was established: scores below 45 indicated none to low levels of PTG, while scores of 45 or above indicated medium to high levels of PTG. This cutoff point was chosen based on its frequent usage in existing literature (Mazor et al., 2016; Naghavi et al., 2020; Taher & Allan,2020; Wall et al., 2023).The PTG scale used in this study (PTGI) involved summing up ratings across 21 self-reported questions, resulting in a possible score range of 0 to 105.

Various forms of PTGI (e.g., PTGI-SF, PTGI-X,…. citations) can be converted to the equivalent scores to the original PTGI by using normalization techniques (Huang et. al, 2023). The weighted mean of PTGI was used to identify the level of PTG on COVID-19 patients. If the PTG measure collected from the studies were significantly higher than cut-off point of 45 Citation, then, the link of PTG with COVID-19 was considered to be present.

The main analysis used a random effect meta-analytical model for main analysis. Random effect model does not assume a single true effect size, but rather assumes a distribution of true effect sizes. This means ensures the flexibility to take the between-study variability/heterogeneity in effect sizes into account in the analysis. Subgroup analyses for moderators were conducted with PTSD, Anxiety, Depression, Social Support, Coping, religion.

**Results**

**Study Characteristics**

Figure 1 illustrates a flow diagram of the literature and related screening process. The search yielded 117 unique publications, of which 87 qualified for full-text review. In the end, 75 studies (Adjorlolo et al., 2022; Aggar et al., 2022; Akdag et al., 2023; Arnout & Al-Sufyani, 2021; Atay et al., 2023; Azman et al., 2023; Bai et al., 2023; Bai & Bai, 2024; Barnicot et al., 2023; Cardinali et al., 2024; Carola et al., 2022; Castiglioni et al., 2023; Chasson et al., 2022; Chen & Tang, 2021; Chen et al., 2020; Cui et al., 2021; Dahan et al., 2022; Das et al., 2023; Deitz, 2024; El-Khoury Malhame et al., 2023; Fino et al., 2023; Foster et al., 2024; Gaboardi et al., 2024; Gesi et al., 2024; Gul et al., 2023; Jiang et al., 2022; Kalaitzaki et al., 2021; Kalaitzaki et al., 2022; Kalaitzaki et al., 2023; Kalaitzaki et al., 2024; Kowalski et al., 2021; Lafuenti et al., 2023; Lan et al., 2023; Lau et al., 2021; Levinsky et al., 2024; Lewis et al., 2022; Li et al., 2021; Liu et al., 2024; Liu et al., 2024; Liu et al., 2021; Lyu et al., 2021; Mo et al., 2022; Morales et al., 2023; Moreno-Jimenez et al., 2021; Nie et al., 2021; Northfield & Johnston, 2021; Nowicki et al., 2024; Ottaviani et al., 2024; Ozonder et al., 2023; Paeizi et al., 2024; Peng et al., 2021; Petrocchi et al., 2023; Pfeiffer et al., 2023; Read et al., 2023; Sarialioglu et al., 2022; Song et al., 2024; Sun et al., 2022; Tu et al., 2023; Ulset & von Soest, 2022; Uziel et al., 2021; Vazquez et al., 2021; Veronese et al., 2022; Wang et al., 2023; Willey et al., 2022; Wu, 2024; Yao et al., 2023; Yeung et al., 2022; Yildiz, 2021; Yilmaz-Karaman et al., 2023; Yim & Kim, 2022; Zhang et al., 2021; Zhang et al., 2023; Zeng et al., 2023; Zhou et al., 2020; Zurko et al., 2022), met the inclusion criteria for the main analysis. 12 studies were selected for subgroup analyses on PTSD citations of them (Arnout & Al-Sufyani, 2021; Chen & Tang, 2021; Chen et al., 2020; Das et al., 2023; El-Khoury Malhame et al., 2023; Lan et al., 2023; Lau et al., 2021; Lewis et al., 2022; Mo et al., 2022; Vazquez et al., 2021; Wang et al., 2023; Zhang et al., 2021.)Of these 71 included in the analysis, all employed PTGI or its variants (e.g. PTGI-SF) to examine PTG. **UZ confirm my revision below!** For the selected studies involving a total of 65,704 individuals, table 1 and table 3 present their overall characteristics, including study designs.

Among the selected studies from developed countries, **UZ confirm my revision below!** two were performed in Australia (Aggar et al., 2022; Foster et al., 2024), four in Greece (Kalaitzaki et al., 2021; Kalaitzaki et al., 2022; Kalaitzaki et al., 2023; Kalaitzaki et al., 2024), seven in Italy (Cardinali et al., 2023; Carola et al., 2022; Castiglioni et al., 2023; Fino et al., 2023; Gaboardi et al., 2024; Gesi et al., 2024; Lafuenti et al., 2024; Ottavani et al., 2024), two in Poland (Nowicki et al., 2024; Zurko et al., 2022), two in Spain (Moreno-Jimenez et al., 2021; Vazquez et al., 2021), ten in the United States (Chen et al., 2021; Deitz, 2024; Liu et al., 2024; Morales et al., 2023; Northfield & Johnston, 2021; Pfeiffer et al., 2023; Tu et al., 2023; Willey et al., 2022; Zhang et al., 2021; Zhou et al., 2020), and three in the United Kingdom (Barnicot et al., 2023; Lewis et al., 2022; Read et al., 2023). In addition, Canada, France, Norway, Switzerland, had one study each (Uziel et al., 2021; Petrocchi et al., 2023; Ulset & von Soest, 2022; Uziel et al., 2021).

Among those from developed countries, one was conducted in Ghana (Adjorlolo et al., 2022), seventeen in the Middle Eastern areas of Turkey, Pakistan, Iran, Saudi Arabia, Lebanon and Israel (Akdag et al., 2023; Atay et al., 2023; Arnout & Al-Sufyani, 2021; Chasson et al., 2022; Das et al., 2023; Dahan et al., 2022; El-Khoury Malhame et al., 2023; Gul et al., 2023; Kowalski et al., 2021; Levinsky et al., 2024; Ozonder et al., 2023; Paeizi et al., 2024; Sarialioglu et al., 2022; Uziel et al., 2021; Veronese et al., 2022; Yildiz, 2021; Yilmaz-Karaman et al., 2023), and twenty-four in Asia (Azman et al., 2023; Bai et al., 2023; Bai et al., 2024; Chen & Tang, 2021; Cui et al., 2020; Jiang et al., 2022; Lan et al., 2023; Lau et al., 2021; Li et al., 2022; Liu et al., 2021; Liu et al., 2024; Lyu et al., 2021; Mo et al., 2022; Nie et al., 2021; Peng et al., 2021; Song et al., 2024; Sun et al., 2022; Wang et al., 2023; Wu, 2024; Yao et al., 2023; Yeung et al., 2022; Yim et al., 2022; Zeng et al., 2023; Zhang et al., 2023; ).

Included articles involved a variety of different types of people suchas patients and the general population (Adjorlolo et al., 2022; Arnout & Al-Sufyani, 2021; Castiglioni et al., 2023; Chen & Tang, 2021; Chen et al., 2020; El-Khoury Malhame et al., 2023; Gul et al., 2023; Kalaitzaki et al., 2022; Lau et al., 2021; Lewis et al., 2022; Northfield & Johnston, 2021; Ulset & von Soest, 2022;Vazquez et al., 2021;Willey et al., 2022; Zhou et al., 2020), nurses and medical doctors (Bai et al., 2023; Barnicot et al., 2023; Chen et al., 2020; Das et al., 2023; Kalaitzaki et al., 2023; Lyu et al., 2021; Mo et al., 2022; Yao et al., 2023; Yeung et al., 2022; Zhang et al., 2021), pregnant women (Chasson et al., 2022), and students (Lan et al., 2023; Morales et al., 2023; Tu et al., 2023; Wang et al., 2023; Yildiz, 2021)most of which centered on the general population during COVID 19.

**Main Analysis for Aim (1)**

The main analysis included 71 studies involving a total of 65,704 subjects. The sample size of these studies ranged from 35 Carola et al. (2022) to 12,586 individuals (Ulset & von Soest, 2022). Among the studies, different proportions of male participants were observed, with the percentage ranging from 3% (Liu et al., 2020)to 74% (Willey et al., 2022). Mean age of them ranged from age of 24.96 (Zhai et al., 2021) to age of 76.3 (Willey et al., 2022). The mean age of the participants varied with studies, with a few not providing explicit data, but indicating that the participants were adults above 18 years old (Arnout & Al-Sufyani, 2021; Gul et al., 2023; Morales et al., 2023).The mean PTG ranged from 26.54 to 98.30 with varying degrees of standard deviation, indicative of the range and spread of PTG scores in these studies. Table 1 presents overall characteristics of all studies.

The main analysis revealed a significant positive effect (M = 59.704) relative to the cutoff point of 45. The hedges’ g calculated to reflect the deviation from the 45 cutoff points was 2.034 with 95% CI [0.76, 3.31]. Based on the rule of thumb, 0.5 showed a medium effect and 0.8 or above presented a large effect (Taylor & Alanazi, 2023). These results indicated a highly positive relationship of PTG to COVID-19. *I2* value 99.99% in table 3 also showed high heterogeneity among selected studies.

**Subgroup Analyses for Aim (2)**

Table 4 shows the summary of subgroup analyses. The studies included in the study considered several factors in conjunction with PTG such as PTSD/PTSS, depression, anxiety, social support, coping, and spirituality.

***PTSD/PTSS***

Eighteen selected studies presented the association of PTSD with PTG with a total of 19,774 participants (Arnout & Al-Sufyani, 2021; Chen & Tang, 2021; Chen et al., 2020; Das et al., 2023; El-Khoury Malhame et al., 2023; Lan et al., 2023; Lau et al., 2021; Lewis et al., 2022; Mo et al., 2022; Vazquez et al., 2021; Wang et al., 2023; Zhang et al., 2021).The baseline effect size (the intercept term) was *g*=0.55, and whether the studies investigated PTSD yielded a higher effect with the regression coefficient associated with the PTSD term being *B=*0.49; 95%CI[-0.1, 1.08]; *p*=0.11. However, , there was no significant relationship between PTSD and PTG (*p*-value=0.11). Yet, the broad range of effect sizes indicated a considerable amount of uncertainty in the effect estimate (*SE*=0.30). An *I2* value of 99.60% showed substantial heterogeneity across the studies.

***Mental Health* (*Depression, Anxiety*)**

Seventeen selected studies presented the association of depression with PTG with a total of 17,064 participants (Adjorlolo et al., 2022; Arnout & Al-Sufyani, 2021; Barnicot et al., 2023; Castiglioni et al., 2023; Kalaitzaki et al., 2022; Morales et al., 2023; Tu et al., 2023; Ulset & Soest, 2021; Willey et al., 2022; Zhou et al., 2020).The baseline effect size was *g*=0.92, and the regression coefficient for depression is *B*=-0.52; 95%CI[-1.14, 0.09]; *p*=0.09, indicating no overall effect on PTG of depression on PTG. The broad range indicated considerable uncertainty in the effect estimate. A high *I2* value of 99.59% showed substantial heterogeneity across these studies.

With regards to Anxiety, there were 11 studies discussed and measured anxiety levels, spanning 7,245 participants. The baseline effect was *g*=0.84, with Anxiety having a regression coefficient of *B*=-0.24 with 95%CI [-0.86, 0.38]; *p*=0.44, indicating no effect of Anxiety on PTG. The heterogeneity after considering Anxiety as a moderator was also high indicate by an of 99.71%.

***Social Support***

Seventeen selected studies discussed social support concerning PTG with a total of 4231 participants (Gul et al., 2023; Kalaitzaki et al., 2022; Mo et al., 2022; Morales et al., 2023; Northfield & Johnston, 2021; Zhang et al., 2021; Zhou et al., 2020).The baseline effect was *g*=0.75, with Social Support having a regression coefficient of *B*=-0.03; 95%CI[-0.74, 0.69]; *p*=0.94. Overall, social support did not contribute much to `variability in PTG across studies. This can be seen from the high of 99.72% for the model that considered social support. Overall, social support did not contribute much to moderating the variability in PTG across studies.

***Coping***

Various types of coping strategies were investigated with PTG in 35 studies (Kalaitzaki et al., 2022; Kalaitzaki et al., 2023; Willey et al.,2022; Zhang et al.,2021; Zhou et al., 2020) with a total of 3,189 participants. The baseline effect size was *g*=0.80, and the regression coefficient for coping was *B*=-0.29; 95%CI[-1.10, 0.51]; *p*=0.47. Coping was not a significant effect in the model baseline effect size. . The for the model considering coping was 99.72%.

***Spirituality***

Finally, there were 25 studies that examined religion and spirituality with a total of 10,388 participants (Castiglioni et al., 2023; Das et al., 2023; El-Khoury Malhame et al., 2023; Kalaitzaki et al., 2022; Kalaitzaki et al., 2023; Morales et al., 2023; Tu et al., 2023; Vazquez et al., 2021; Willey et al., 2022;Yao et al., 2023; Yeung et al., 2022; Zhang et al., 2021; Zhou et al., 2020). The baseline effect size was *g*=0.74, and the regression estimate for spirituality was *B*=0.008; 95%CI[-0.60, 0.62]; *p*=0.98. Thus, there was no relation between spirituality and PTG. The for the model regarding spirituality was (99.71%).

**Discussion**

This study, first large scale comprehensive meta-analysis, was aimed to determine the extent to which PTG was related to the global traumatic pandemic of Covid-19. As we hypothesized, the synthesized result demonstrates a moderate level of growth in diverse populations. The association of Covid-19 and PTG is shown with a weighted mean PTGI score 59 involving 65,704 participants from 69 international studies (Adjorlolo et al., 2022; Arnout This was shown with a weighted mean PTGI score & Al-Sufyani, 2021; Bai et al., 2023; Barnicot et al., 2023; Castiglioni et al., 2023; Chasson et al., 2022; Chen & Tang, 2021; Chen et al.,2020; Das et al.,2023; El-Khoury Malhame et al., 2023; Gul et al., 2023; Kalaitzaki et al., 2022; Kalaitzaki et al., 2023; Lan et al., 2023; Lau et al., 2021; Lewis et al., 2022; Lyu et al., 2021; Morales et al., 2023; Mo et al., 2022; Northfield & Johnston, 2021; Tu et al., 2023; Ulset & von Soest, 2022; Vazquez et al., 2021; Wang et al., 2023; Willey et al., 2022; Yao et al., 2023; Yeung et al., 2022; Yildiz, 2021; Zhang et al., 2021; Zhou et al., 2020….).The finding from the main analysis indicates that a positive outcome could rise from the ashes of a catastrophic event that imposed existential crisis worldwide.

A strength in this meta-analysis lies in the global diversity of data sources. Selected studies cover research being conducted in the United States and beyond, including various populations from both high and low incomes in four most popularized continents. As such, the current review provides compelling evidence for Covid-19-assocated PTG over three years since late 2019, one that implies the resiliency of humankind as whole. In other words, through collective struggles the affected world’s populations could become stronger after experiencing the deadly challenge of a pandemic disease, as was shown in other chronic ailments with certain life risks (Ma et al., 2022; Pieta & Rzeszutek, 2022; Sawyer et al., 2010; Shand et al.,2015; Wang et al., 2022).

Furthermore, selected study samples involve their different roles during Covid-19 (e.g., patients, health care providers, students, veterans, and general populations). This implies that the overall sample have both very sick and very healthy people but all faced the same crisis, Covid-19. Different from those previously evident diseases, Covid-19 took lives of nurses and physicians who provided direct or indirect services of patients who were infected. Accordingly, the current finding may provide valuable information for trauma psychologists, public health workers, and health care providers with respect to pandemic-related risk-management and emergency care in the future. However, there was heterogeneity (*I* statistic of 99.72%), which may not be a surprise given the diversity reflected in populations, settings, and designs of selected studies. Also, subgroup analyses did not provide explanation for this heterogeneity. Thus, it remains unclear if individual characteristics (e.g., gender, age) and risk or protective factors may take a part.

As noted, we found no significant association between PTG and risk/protective factors (Anxiety, Depression, Coping, Social Support, and Spirituality). This surprise result suggests that more concise analysis should be done to identify these relationships across diverse populations or roles during the pandemic to facilitate better intervention and prevention in the future. Twenty-two of the selected studies demonstrated the mental health damage of Covid 19 in this analysis (Adjorlolo et al., 2022; Arnout & Al‐Sufyani, 2021; Barnicot et al, 2023; Castiglioni et. al, 2023; Chasson et al., 2022; Chen & Tang, 2021; Chen et al., 2020; Das et al., 2023; El-Khoury Malhame et al., 2023; Kalaitzaki et al., 2022; Lan et al, 2023; Lau et al., 2021; Lewis et al. ,2022; Mo ,2022; Morales et al, 2023; Tu et al., 2023; Ulset & Soest ,2022; Vazquez et al., 2021; Wang et. al, 2023; Willey et al., 2022; Zhang et al., 2021; Zhou et al., 2020).Observed PTG indicates the renewal of worldview, including restoration of meaning and purpose. Individuals high in growth could possess other unrevealed psychosocial strengths or traits, motivationally, behaviorally, and affectively. This negative finding does not end but calls for a new level of clinical awareness and investigation after the Covid-19 survival.

**Clinical Significance**

The pooled international evidence on Covid-based PTG points to three potential directions for future pandemic health care and investigation. First, this systematic review involves considerable variability in study samples, global locations, age range, and cultural diversity. The consistent growth phenomenon, however, suggest that the PTGI may be a suitable instrument for assessing the positive outcome following Covid-19 and similar pandemics. Further longitudinal research might provide more information for its application as a tool (e.g., its short form) in clinical settings.

Second, Covid-19 and similar deadly pandemics may cause catastrophe in public health and long-term health damage in certain proportions of large populations (e.g., long-Covid). Whether PTG will be related to the better prognosis of pathological process and a survival benefit for victims of long Covid-19 remains unknown. However, meta-analyses showed its association with low mortality in non-pandemic patients (Ma et al., 2022; Wan et al., 2023).If this is the case for people affected by pandemics, the development of PTG-enhancing interventions may benefit patients and high-risk care providers.

Finally, PTG and pathology (e.g., depression, PTSD) belong to two different paradigms in posttraumatic human wellbeing, *hedonic* versus *eudaemonic well-*being (Ai et al., 2013; 2021), while PTG and PTSD are both related to struggle as two sides for one coin, trauma. Beyond PTG-related psycho-behavioral theories, a new study also suggested the complicated mechanisms involving many domains (e.g., physiological, biochemical, immunological, neuronal, and genetic alteration (Dell’Osso et al., 2023). More interdisciplinary studies are warranted in this regard to better inform clinical medicine for both sides.

**Mechanisms**

The literature suggests certain overlapping areas between the emerging research on the scientific mechanism of PTG and the more established one on that of PTSD. Because PTSD, and other psychiatric disorders (e.g., depression) have been related to the poor prognosis of CVD, more interdisciplinary research on the mechanism PTG may assist better clinical CVD care through enhancement on CVD-related PTG in the future.Most studies in this meta-analysis did not involve basic science investigation, but evidence has emerged in the past decade. In the neuroendocrine and immunological area, research has assorted higher levels of PTG with low levels of cortisol in patients suffering from PTSD and women with breast c­­ancer, respectively (Smyth et al., 2008; Diaz et al., 2014). In studies on brain function and structures, PTG was linked with the frontocentral EEG alpha asymmetry in survivors of motor vehicle accidents, controlling for trait positive affect (Rabe et al., 2006) and was negatively correlated with grey matter volume in left dorsolateral prefrontal cortex during Covid-19 (Lan et al., 2023). However, PTSS was positively associated with grey matter volume in medial prefrontal cortex/dorsal anterior singular cortex in structured magnetic resonance imaging data acquired before the pandemic (Lan et al., 2023).

A pioneer work in the genomic area found a relation of PTG to the gene-environment (GxE) interaction study using a New Orleans sample of low-income non-Hispanic Black individuals who exposed to Hurricane Katrina (Dunn et al., 2014). Among the identified ten common variants in seven genes, the presence of homozygotes rs4606 variants of RGS2 gene was strongly associated with greater PTG after multiple testing, which appeared to be driven by a GxE interaction. Finally, due to the emergent pandemic, studies in this meta-analysis were published in a narrow period (2020-2022) with a few conducted using a prospective design. Accordingly, basic science research of PTG in Covid-19 may assist better understanding of its medical implications.

**Limitations**

The limitations of this meta-analysis should be acknowledged. First, methodological heterogeneousness exists across studies and contributed to divergent findings of studies included. The diverse populations, concerning age, race, cultural, geographic location, and roles in the pandemic (e.g., patients, health providers, general populations), may also lead to heterogeneous findings. This divergence suggests the need for further subgroup analysis (e.g., roles). The link between Covid-19 and PTG was nevertheless evident through these studies. Second, to be conceptually sound, we excluded studies with scales without specific foci on growth and those with only invalidated, single-item measures. This decision could exclude potentially valuable information or deflate the effect size.

Third, important medical indices are missing in most studies; thus, we could not systematically assess their associations with PTG. Fourth, covariates included in studies vary wildly, which may account for the heterogeneity in our subgroup analysis. Fifth, most studies employed convenient samples that compromise the representativeness of them. QZ, please add at least one sample for the opposite if you can find one! Finally, due to the emergent pandemic, studies in this meta-analysis were published in a close period (2020-2024) with few were conducted in a prospective design. Many studies are cross-sectional, which does not allow conclusions on causality. The increased overtime growth has been observed by a new Covid-19 (Kalaitzaki et al., 2023) and a few non-Covid (Ai et al.,2021; Hu et al., 2020; Kelly et al., 2018) studies, a fact underscoring the need to follow-up post-pandemic PTG.

**Conclusions**

Over the past two decades, burgeoning research has shown PTG as a promising endpoint after trauma and disasters. The findings from this first meta-analysis suggest that the optimal outcome could occur among patients, health care providers, and general populations who were all exposed to the Covid-19 threat globally. PTG includes a posttraumatic outlook change in varied domains, or positive outlook, that could lead to optimal behavioral changes. The worldview-based gain is consistent with psychiatrist Frankl’s (2004; p. XIII)survival tenon: “when we are no longer able to change a situation, we are challenged to change ourselves.” Based on the finding, social science related health care policies may encourage the population under threat of deadly pandemics to seek such positive changes cognitively and behaviorally as part of emergency and crisis management. Investigations should also address important medical questions (e.g., What could be behavioral and salutogenic bio-psycho-behavioral mechanism to inform clinical practices). Finally, trauma psychologists may help distressed clients under the pandemic related existential threat to prioritize their goals and strategies with openness to positive changes and other potentials for optimal survival.

Reference

Adjorlolo, S., Adjorlolo, P., Andoh-Arthur, J., Ahiable, E. K., Kretchy, I. A., & Osafo, J. (2022). Post-traumatic growth and resilience among hospitalized Covid-19 survivors: A gendered analysis. *International Journal of Environmental Research and Public Health, 19(16)*, 10014. <https://doi.org/10.3390/ijerph191610014>

Ai, A. L., Hall, D., Pargament, K., & Tice, T. N. (2013). Posttraumatic growth in patients who survived cardiac surgery: the predictive and mediating roles of faith-based factors. *Journal of behavioral medicine, 36(2)*, 186–198. https://doi.org/10.1007/s10865-012-9412-6

Ai, A. L., Raney, A., & Huang, B. (2023). Well-being following Hurricane Michael: Complex pathways involving substance use and character strengths. *Applied Research in Quality of Life, 18(1)*, 435-453. DOI: 10.1007/s11482-022-10083-7

Arnout, B. A., & Al‐Sufyani, H. H. (2021). Quantifying the impact of Covid‐19 on the individuals in the kingdom of Saudi Arabia: A cross‐sectional descriptive study of the posttraumatic growth. *Journal of Public Affairs, 21(4)*. https://doi.org/10.1002/pa.2659

Bai, C., Ma, J., Bai, B., & Zhu, S. (2023). How does strength use relate to posttraumatic growth in health care workers during the COVID-19 pandemic? The mediating role of self-efficacy and optimism. *Psychological trauma: theory, research, practice and policy,* 10.1037/tra0001626. <https://doi.org/10.1037/tra0001626>

Barnicot, K., McCabe, R., Bogosian, A., Papadopoulos, R., Crawford, M., Aitken, P., Christensen, T., Wilson, J., Teague, B., Rana, R., Willis, D., Barclay, R., Chung, A., & Rohricht, F. (2023). Predictors of post-traumatic growth in a sample of United Kingdom mental and community healthcare workers during the COVID-19 pandemic. *International journal of environmental research and public health, 20(4)*, 3539. <https://doi.org/10.3390/ijerph20043539>

Calhoun, L. G., & Tedeschi, R. G. (2006). The Foundations of Posttraumatic Growth: An Expanded Framework. In L. G. Calhoun & R. G. Tedeschi (Eds.), Handbook of posttraumatic growth: *Research & practice,* 3–23. Lawrence Erlbaum Associates Publishers.

Castiglioni, M., Caldiroli, C. L., Procaccia, R., Conte, F., Neimeyer, R. A., Zamin, C., Paladino, A., & Negri, A. (2023). The up-side of the COVID-19 pandemic: Are core belief violation and meaning making associated with post-traumatic growth?. *International journal of environmental research and public health, 20(11)*, 5991. <https://doi.org/10.3390/ijerph20115991>

Chasson, M., Orit, T., Ben, A., & Salam, A.S. (2022). Posttraumatic growtma, h in the wake of COVID-19 among Jewish and Arab pregnant women in Israel. *Psychological trauma: theory, research, practice and policy, 14(8)*, 1324-1332. doi:10.1037/tra0001189

Chen, C., & Tang, S. (2021). Profiles of grief, post-traumatic stress, and post-traumatic growth among people bereaved due to Covid-19. *European journal of psychotraumatology, 12(1)*, 1947563. doi:10.1080/20008198.2021.1947563

Chen, R., Sun, C., Chen, J. J., Jen, H. J., Kang, X. L., Kao, C. C., & Chou, K. R. (2021). A large-scale survey on trauma, burnout, and posttraumatic growth among nurses during the COVID-19 pandemic. *International journal of mental health nursing, 30(1)*, 102-116. doi:10.1111/inm.12796

Cui, P. P., Wang, P. P., Wang, K., Ping, Z., Wang, P., & Chen, C. (2021). Post-traumatic growth and influencing factors among frontline nurses fighting against COVID-19. *Occupational and environmental medicine, 78(2)*, 129–135. https://doi.org/10.1136/oemed-2020-106540

Das, K., Qureshi, S., Haider, A., Tarique, M., & Bhatija, R. R. (2023). Post-traumatic growth among frontline doctors fighting against COVID-19 at a tertiary care public hospital in Karachi, Pakistan. *The Journal of the Pakistan Medical Association, 73(8)*, 1653–1657. <https://doi.org/10.47391/JPMA.7813>

Dell'Osso, L., Carpita, B., Nardi, B., Bonelli, C., Calvaruso, M., & Cremone, I. M. (2023). Biological correlates of post-traumatic growth (PTG): A literature review. *Brain Sciences, 13(2)*, 305. <https://doi.org/10.3390/brainsci13020305>

Diaz, M., Aldridge-Gerry, A., & Spiegel, D. (2014). Posttraumatic growth and diurnal cortisol slope among women with metastatic breast cancer. *Psychoneuroendocrinology, 44*, 83-87. <https://doi.org/10.1016/j.psyneuen.2014.03.001>

Dunn, E. C., Solovieff, N., Lowe, S. R., Gallagher, P. J., Chaponis, J., Rosand, J., Koenen, K. C., Waters, M. C., Rhodes, J. E., & Smoller, J. W. (2014). Interaction between genetic variants and exposure to Hurricane Katrina on post-traumatic stress and post-traumatic growth: a prospective analysis of low income adults. *Journal of affective disorders,* 152-154, 243–249. <https://doi.org/10.1016/j.jad.2013.09.018>

El Khoury-Malhame, M., Sfeir, M., Hallit, S., & Sawma, T. (2023). Factors associated with posttraumatic growth: Gratitude, PTSD and distress; one year into the COVID-19 pandemic in Lebanon. *Current psychology (New Brunswick, N.J.)*, 1–10. <https://doi.org/10.1007/s12144-022-04159-8>

Feingold, J. H., Hurtado, A., Feder, A., Peccoralo, L., Southwick, S. M., Ripp, J., & Pietrzak, R. H. (2022). Posttraumatic growth among health care workers on the frontlines of the COVID-19 pandemic. *Journal of affective disorders, 296*, 35–40. https://doi.org/10.1016/j.jad.2021.09.032

Finstad, G. L., Giorgi, G., Lulli, L. G., Pandolfi, C., Foti, G., León-Perez, J. M., Cantero-Sánchez, F. J., & Mucci, N. (2021). Resilience, coping strategies and posttraumatic growth in the workplace following COVID-19: A narrative review on the positive aspects of trauma. *International Journal of Environmental Research and Public Health, 18(18)*, 9453. <https://doi.org/10.3390/ijerph18189453>

Gul, H., Ehsan, N., Iqbal, N., & Hassan, B. (2023). Illness perception, social isolation, psychological distress, and posttraumatic growth in the aftermath of Covid-19. Pakistan *Journal of Psychological Research, 38(2)*, 309–327. <https://doi.org/10.33824/pjpr.2023.38.2.19>

Hu, R., Wang, X., Liu, Z., Hou, J., Liu, Y., Tu, J., Jia, M., Liu, Y., & Zhou, H. (2022). Stigma, depression, and post-traumatic growth among Chinese stroke survivors: A longitudinal study examining patterns and correlations. *Topics in stroke rehabilitation, 29(1),* 16–29. https://doi.org/10.1080/10749357.2020.1864965

Hyun, S., Wong, G. T. F., Levy-Carrick, N. C., Charmaraman, L., Cozier, Y., Yip, T., Hahm, H. C., & Liu, C. H. (2021). Psychosocial correlates of posttraumatic growth among U.S. young adults during the COVID-19 pandemic. *Psychiatry research, 302*, 114035. <https://doi.org/10.1016/j.psychres.2021.114035>

Kalaitzaki, A., Tsouvelas, G., & Tamiolaki, A. (2022). Perceived posttraumatic growth and its psychosocial predictors during two consecutive Covid-19 lockdowns. *International Journal of Stress Management*. https://doi.org/10.1037/str0000273

Kalaitzaki, A. E., Tamiolaki, A., Tsouvelas, G., Theodoratou, M., & Konstantakopoulos, G. (2023). Gain from pain: Exploring vicarious posttraumatic growth and its facilitators among health care workers across two consecutive lockdowns during the COVID-19 pandemic. *International Journal of Stress Management*. <https://doi.org/10.1037/str0000314>

Kelly, G., Morris, R., & Shetty, H. (2018). Predictors of post-traumatic growth in stroke survivors. *Disability and rehabilitation, 40(24)*, 2916–2924. https://doi.org/10.1080/09638288.2017.1363300

Khattab, M. F., Kannan, T. M. A., Morsi, A., Al-Sabbagh, Q., Hadidi, F., Al-Sabbagh, M. Q., M Taha, M., Bourghli, A., & Obeid, I. (2020) The short-term impact of COVID-19 pandemic on spine surgeons: A cross-sectional global study. *European Spine Journal, 29(8)*, 1806–1812. <https://doi.org/10.1007/s00586-020-06517-1>.

Krishnamoorthy, Y., Nagarajan, R., Saya, G. K., & Menon, V. (2020). Prevalence of psychological morbidities among general population, healthcare workers and COVID-19 patients amidst the COVID-19 pandemic: A systematic review and meta-analysis. *Psychiatry research, 293*, 113382. https://doi.org/10.1016/j.psychres.2020.113382

Kocatürk, E., Salman, A., Cherrez-Ojeda, I., Criado, P. R., Peter, J., Comert-Ozer, E., Abuzakouk, M., Agondi, R. C., Al-Ahmad, M., Altrichter, S., Arnaout, R., Arruda, L. K., Asero, R., Bauer, A., Ben-Shoshan, M., Bernstein, J. A., Bizjak, M., Boccon-Gibod, I., Bonnekoh, H., Bouillet, L., Maurer, M. (2021). The global impact of the COVID-19 pandemic on the management and course of chronic Urticaria. *Allergy, 76(3)*, 816–830, <https://doi.org/10.1111/all.14687>.

Kowalski, R. M., Carroll, H., & Britt, J. (2022). Finding the silver lining in the COVID-19 crisis. *Journal of health psychology, 27(6)*, 1507–1514. https://doi.org/10.1177/1359105321999088

Lan, H., Suo, X., Zuo, C., Pan, N., Zhang, X., Kemp, G. J., Gong, Q., & Wang, S. (2023). Distinct pre-COVID brain structural signatures in COVID-19-related post-traumatic stress symptoms and post-traumatic growth. *Cerebral cortex (New York, N.Y. : 1991), 33(23),* 11373–11383. <https://doi.org/10.1093/cercor/bhad372>

Lau, B. H. P., Chan, C. L. W., & Ng, S. M. (2021). Post-traumatic growth in the first Covid outbreak in Hong Kong. *Frontiers in psychology, 12*, 675132. <https://doi.org/10.3389/fpsyg.2021.675132>

Lewis, C., Lewis, K., Edwards, B., Evison, C., John, A., Pearce, H., Raisanen, L., Richards, N., Roberts, A., Jones, I., & Bisson, J. I. (2022). Posttraumatic growth related to the Covid-19 pandemic among individuals with lived experience of psychiatric disorder. *Journal of traumatic stress, 35(6)*, 1756–1768. <https://doi.org/10.1002/jts.22884>

Li, L., Mao, M., Wang, S., Yin, R., Yan, H., Jin, Y., & Cheng, Y. (2022). Posttraumatic growth in Chinese nurses and general public during the COVID-19 outbreak. *Psychology, health & medicine, 27(2),* 301–311. https://doi.org/10.1080/13548506.2021.1897148

Lyu, Y., Yu, Y., Chen, S., Lu, S., & Ni, S. (2021). Positive functioning at work during Covid‐19: Posttraumatic growth, resilience, and emotional exhaustion in Chinese frontline healthcare workers. *Applied Psychology: Health and Well-Being.* <https://doi.org/10.1111/aphw.12276>

Ma X, Wan X, Chen C. (2022). The correlation between posttraumatic growth and social support in people with breast cancer: A meta-analysis. *Front Psychol, 13*,1060150. doi:10.3389/fpsyg.2022.1060150

Mazor, Y., Gelkopf, M., Mueser, K. T., & Roe, D. (2016). Posttraumatic Growth in Psychosis. *Frontiers in psychiatry, 7,* 202. https://doi.org/10.3389/fpsyt.2016.00202

McMillen, J. C., & Fisher, R. H. (1998). The Perceived Benefit Scales: Measuring perceived positive life changes after negative events. *Social Work Research, 22(3)*, 173–186. <https://doi.org/10.1093/swr/22.3.173>

Mo, Y.,Tao, P., Liu, G., Chen, L., Li, G., Lu, S., Zhang, G., Liang, R., & Huang, H. (2022). Post-traumatic growth of nurses who faced the Covid-19 epidemic and its correlation with professional self-identity and social support. *Frontiers in psychiatry, 12,* 562938. <https://doi.org/10.3389/fpsyt.2021.562938>

Mohr D. C., Dick L. P., Russo D., Pinn J., Boudewyn A. C., Likosky W., Goodkin D. E. (1999). The psychosocial impact of multiple sclerosis: Exploring the patient’s perspective. *Health Psychology, 18(4)*, 376–382.

Morales, D. X., Grineski, S. E., & Collins, T. W. (2023). The silver lining of the COVID-19 pandemic: Undergraduate research experiences, mentorship, and posttraumatic growth. *Research in Higher Education.* <https://doi.org/10.1007/s11162-023-09763-6>

Moreland, M. L., Rickman, S. R. M., & Yalch, M. M. (2023). Influence of trauma and personality on posttraumatic cognitions in military veterans. *Traumatology*. <https://doi.org/10.1037/trm0000469>

Naghavi, A., Teismann, T., Asgari, Z., Mohebbian, M. R., Mansourian, M., & Mañanas, M. Á. (2020). Accurate Diagnosis of Suicide Ideation/Behavior Using Robust Ensemble Machine Learning: A University Student Population in the Middle East and North Africa (MENA) Region. *Diagnostics (Basel, Switzerland)*, *10(11)*, 956. https://doi.org/10.3390/diagnostics10110956

Northfield, E.-L., & Johnston, K. L. (2022). I get by with a little help from my friends: Posttraumatic growth in the Covid-19 pandemic. *Traumatology, 28(1)*, 195–201.

O'Connor, R. C., Wetherall, K., Cleare, S., McClelland, H., Melson, A. J., Niedzwiedz, C. L., O'Carroll, R. E., O'Connor, D. B., Platt, S., Scowcroft, E., Watson, B., Zortea, T., Ferguson, E., & Robb, K. A. (2021). Mental health and well-being during the COVID-19 pandemic: longitudinal analyses of adults in the UK COVID-19 mental health & wellbeing study. *The British journal of psychiatry: the journal of mental science, 218(6),* 326–333. <https://doi.org/10.1192/bjp.2020.212>

Park, C. L., Cohen, L. H., & Murch, R. L. (1996). Stress related growth scale (SRGS). *APA PsycTests*. https://doi.org/10.1037/t17236-000

Paums, Dinah V. (2021). Editorial: Long COVID, or Post-COVID syndrome, and the global impact on health care. *Medical Science Monitor, 27.* <https://doi.org/10.12659/msm.933446>.

Pięta M, Rzeszutek M. (2022). Posttraumatic growth and well-being among people living with HIV: A systematic review and meta-analysis in recognition of 40 years of HIV/AIDS. *Qual Life Res, 31(5)*,1269-1288. doi:10.1007/s11136-021-02990-3

Pietrzak, R. H., Tsai, J., & Southwick, S. M. (2021). Association of symptoms of posttraumatic stress disorder with posttraumatic psychological growth among US veterans during the COVID-19 pandemic. *JAMA network open, 4(4)*, e214972. https://doi.org/10.1001/jamanetworkopen.2021.4972

Rabe, S., Zoellner, T., Maercker, A., & Karl, A. (2006). Neural correlates of posttraumatic growth after severe motor vehicle accidents. J*ournal of Consulting and Clinical Psychology, 74(5)*, 880–886. <https://doi.org/10.1037/0022-006X.74.5.880>

Sawyer A, Ayers S, Field AP. (2010). Posttraumatic growth and adjustment among individuals with cancer or HIV/AIDS: a meta-analysis. *Clin Psychol Rev, 30(4),* 436-447. doi:10.1016/j.cpr.2010.02.004

Shand LK, Cowlishaw S, Brooker JE, Burney S, Ricciardelli LA. (2015). Correlates of post-traumatic stress symptoms and growth in cancer patients: a systematic review and meta-analysis. P*sychooncology, 24(6)*, 624-634. doi:10.1002/pon.3719

Smyth, J. M., Hockemeyer, J. R., & Tulloch, H. (2008). Expressive writing and post-traumatic stress disorder: Effects on trauma symptoms, mood states, and cortisol reactivity. *British Journal of Health Psychology, 13(1)*, 85–93. <https://doi.org/10.1348/135910707X250866>

Sohrabi, C., Alsafi, Z., O'neill, N., Khan, M., Kerwan, A., Al-Jabir, A., Iosifidis, C., & Agha, R. (2020). World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). *International Journal of Surgery, 76*, 71-76. <https://doi.org/10.1016/j.ijsu.2020.02.034>

Sun, H. L., Chen, P., Bai, W., Zhang, L., Feng, Y., Su, Z., Cheung, T., Ungvari, G. S., Cui, X. L., Ng, C. H., An, F. R., & Xiang, Y. T. (2024). Prevalence and network structure of depression, insomnia and suicidality among mental health professionals who recovered from COVID-19: a national survey in China. Translational psychiatry, 14(1), 227. https://doi.org/10.1038/s41398-024-02918-8

Stroup, D. F., Berlin, J. A., Morton, S. C., Olkin, I., Williamson, G. D., Rennie, D., Moher, D., Becker, B. J., Sipe, T. A., & Thacker, S. B. (2000). Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis of observational studies in epidemiology (MOOSE) group. *JAMA, 283(15),* 2008–2012. <https://doi.org/10.1001/jama.283.15.2008>

Taher R., Allan T. (2020). Posttraumatic growth in displaced Syrians in the UK: A mixed-methods approach. *Journal of Loss & Trauma, 25*(4), 333–347. https://doi.org/10.1080/15325024.2019.1688022

Taylor, J. M., & Alanazi, S. (2023). Cohen's and Hedges' g. The Journal of nursing education, 62(5), 316–317. https://doi.org/10.3928/01484834-20230415-02

Tedeschi RG, Calhoun LG. The Posttraumatic Growth Inventory: Measuring the positive legacy of trauma. *Journal of Traumatic Stress*. 1996;9(3):455-472.

Tu, A. K., Restivo Haney, J., O'Neill, K., Swaminathan, A., Choi, K. W., Lee, H., Smoller, J. W., Patel, V., Barreira, P. J., Liu, C. H., & Naslund, J. A. (2023). Post-traumatic growth in PhD students during the COVID-19 pandemic. *Psychiatry research communications, 3(1)*, 100104. <https://doi.org/10.1016/j.psycom.2023.100104>

Ulset, V. S., & von Soest, T. (2022). Posttraumatic growth during the Covid-19 lockdown: A large-scale population-based study among Norwegian adolescents. *Journal of traumatic stress, 35(3),* 941-954. doi:10.1002/jts.22801

Van der Hallen, R., & Godor, B. P. (2022). COVID-19 pandemic-related posttraumatic growth in a small cohort of university students: A 1-year longitudinal study. *Psychiatry research, 312*, 114541.https://doi.org/10.1016/j.psychres.2022.114541

Van Zuuren, E. J., and Z. Fedorowicz. (2016). Moose on the loose: checklist for meta‐analyses of observational studies. *British Journal of Dermatology, 175.5*, 853-854.

Vazquez, C., Valiente, C., García, F. E., Contreras, A., Peinado, V., Trucharte, A., & Bentall, R. P. (2021). Post-traumatic growth and stress-related responses during the Covid-19 pandemic in a national representative sample: The role of positive core beliefs about the world and others. *Journal of Happiness Studies*. <https://doi.org/10.1007/s10902-020-00352-3>

Wall, C. L., Carson, J., Brown, G. (2023). COVID-19 Relates to Both PTSD and PTG in a Non-clinical Population, Why? *Journal of Loss and Trauma, 28:1*, 61-73, DOI: 10.1080/15325024.2022.2068264

Wan, X., Huang, H., Peng, Q., Yu, N. X., Zhang, Y., Ding, Y., Wu, H., Hao, J., Lu, G., & Chen, C. (2023). A meta-analysis on the relationship between posttraumatic growth and resilience in people with breast cancer. *Nurs Open, 10(5)*,734-2745. doi:10.1002/nop2.1540

Wang, S., Quan, L., Chavarro, J. E., Slopen, N., Kubzansky, L. D., Koenen, K. C., Kang, J. H., Weisskopf, M. G., Branch-Elliman, W., & Roberts, A. L. (2022). Associations of depression, anxiety, worry, perceived stress, and loneliness prior to infection with risk of post-COVID-19 conditions. *JAMA psychiatry, 79(11)*, 1081–1091. <https://doi.org/10.1001/jamapsychiatry.2022.2640>

Wang, S., Zhao, Y., & Li, J. (2023). True grit and brain: Trait grit mediates the connection of DLPFC functional connectivity density to posttraumatic growth following COVID-19. *Journal of affective disorders, 325*, 313–320. <https://doi.org/10.1016/j.jad.2023.01.022>

Willey, B., Mimmack, K., Gagliardi, G., Dossett, M. L., Wang, S., Udeogu, O. J., Donovan, N. J., Gatchel, J. R., Quiroz, Y. T., Amariglio, R., Liu, C. H., Hyun, S., ElTohamy, A., Rentz, D., Sperling, R. A., Marshall, G. A., & Vannini, P. (2022). Racial and socioeconomic status differences in stress, posttraumatic growth, and mental health in an older adult cohort during the Covid-19 pandemic. *EclinicalMedicine, (45),* 101343. <https://doi.org/10.1016/j.eclinm.2022.101343>.

Yao, X., Wang, J., Yang, Y., & Zhang, H. (2023). Factors influencing nurses' post-traumatic growth during the COVID-19 pandemic: Bayesian network analysis. *Frontiers in psychiatry, 14*, 1163956. <https://doi.org/10.3389/fpsyt.2023.1163956>

Yeung, N. C. Y., Wong, E. L.-Y., Cheung, A. W.-L., Leung, C. S.-Y., Yeoh, E.-K., & Wong, S. Y.-S. (2022). Finding the positives from the Covid-19 pandemic: factors associated with posttraumatic growth among nurses in Hong Kong. European Journal of *Psychotraumatology, 13(1).* <https://doi.org/10.1080/20008198.2021.2005346>

Yıldız, E. (2021). Posttraumatic growth and positive determinants in nursing students after Covid‐19 alarm status: A descriptive cross‐sectional study. *Perspectives in Psychiatric Care*. <https://doi.org/10.1111/ppc.12761>

Zhai, H. K., Li, Q., Hu, Y. X., Cui, Y. X., Wei, X. W., & Zhou, X. (2021). Emotional creativity improves posttraumatic growth and mental health during the COVID-19 pandemic. *Frontiers in psychology, 12,* 600798. https://doi.org/10.3389/fpsyg.2021.600798

Zhang, X. T., Shi, S. S., Qin Ren, Y., & Wang, L. (2021). The Traumatic Experience of Clinical Nurses During the COVID-19 Pandemic: Which Factors are Related to Post-Traumatic Growth?. *Risk management and healthcare policy,14*,2145–2151. https://doi.org/10.2147/RMHP.S307294.

Zhou, Y., MacGeorge, E. L., & Myrick, J. G. (2020). Mental health and its predictors during the early months of the Covid-19 pandemic experience in the United States. *International Journal of Environmental Research and Public Health, 17(17)*, 6315. <https://doi.org/10.3390/ijerph17176315>

Frankl, V. (1946). Man’s search for meaning. Beacon Press.

Huang, L., Qin, J., Zhou, Y., Zhu, F., Liu, L., & Shao, L. (2023). Normalization techniques in training dnns: Methodology, analysis and application. *IEEE transactions on pattern analysis and machine intelligence*, *45*(8), 10173-10196.

53-854.QZ ??

**Figure 1: Flowchart of Study Selection**

Studies from databases/registers (n=60)

**Identification**

Duplicates removed. (n=10)

Records screened.

(n=42)

Records excluded\*\*

(n=30)

Reports not retrieved.

(n =0)

Reports sought for retrieval.

(n=35)

**Screening**

Reports excluded:

(n=30)

Wrong scale: (n= 10)

Reports assessed for eligibility.

(n=35)

Studies included in review.

(n=30)

**Included**

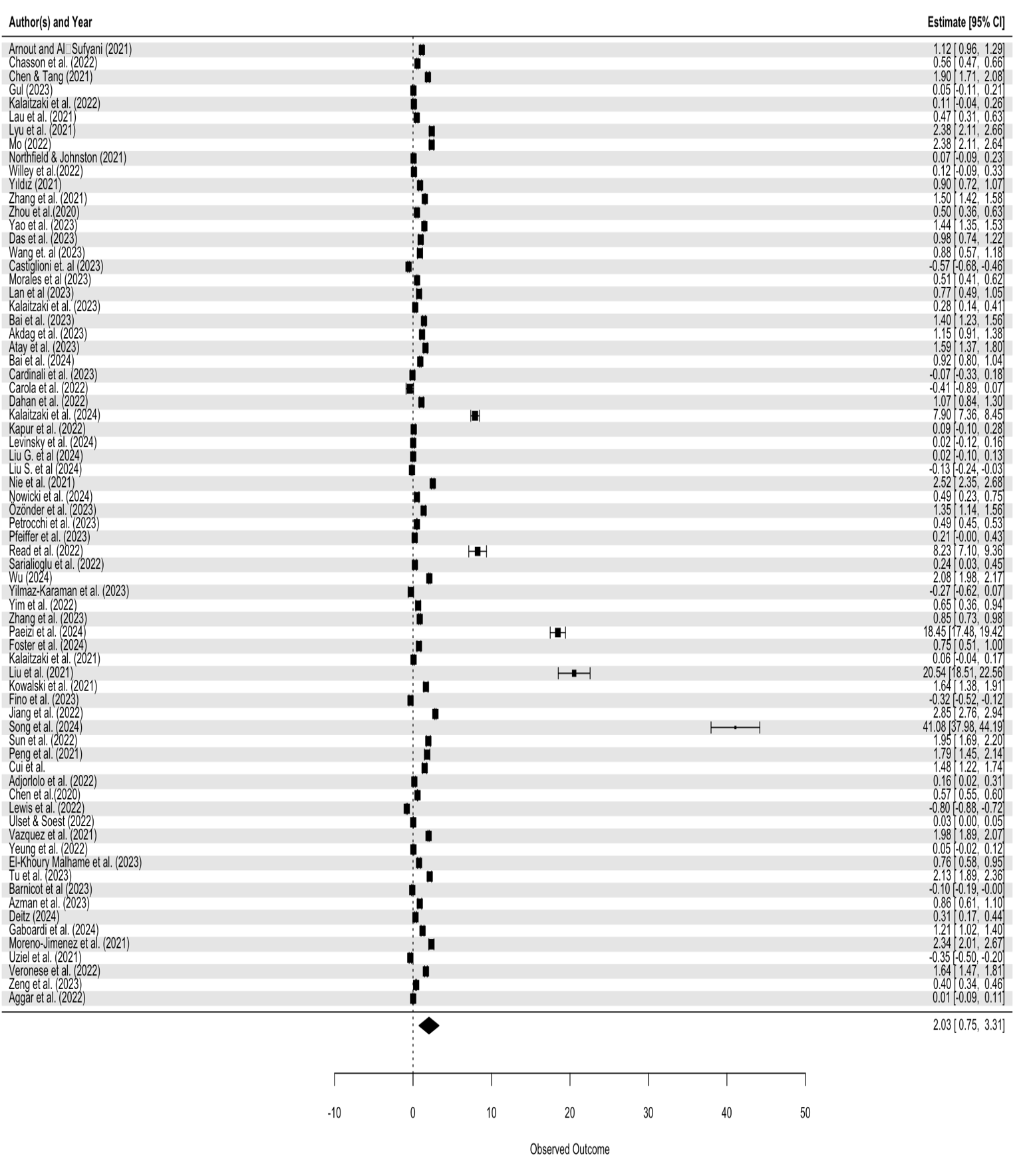
**Table 1: Overview of the selected studies (k=30) for main analysis**

| Source | sample size | effect size | sd |
| --- | --- | --- | --- |
| Arnout and Al‐Sufyani (2021) | 365 | 65.19 | 17.94 |
| Chasson et al. (2022) | 916 | 55.78 | 19.10 |
| Chen & Tang (2021) | 422 | 64.80 | 10.44 |
| Gul (2023) | 300 | 45.57 | 11.70 |
| Kalaitzaki et al. (2022) | 352 | 47.73 | 24.63 |
| Lau et al. (2021) | 327 | 53.13 | 17.22 |
| Lyu et al. (2021) | 251 | 78.40 | 14.00 |
| Mo (2022) | 266 | 96.26 | 21.57 |
| Northfield & Johnston (2021) | 296 | 47.00 | 28.20 |
| Willey et al.(2022) | 176 | 47.95 | 24.48 |
| Yıldız (2021) | 292 | 63.49 | 20.64 |
| Zhang et al. (2021) | 1790 | 67.17 | 14.79 |
| Zhou et al.(2020) | 442 | 58.34 | 26.76 |
| Yao et al. (2023) | 1512 | 71.75 | 18.53 |
| Das et al. (2023) | 166 | 64.81 | 20.27 |
| Wang et. al (2023) | 100 | 63.36 | 20.91 |
| Castiglioni et. al (2023) | 733 | 31.82 | 23.10 |
| Morales et al (2023) | 785 | 51.44 | 12.50 |
| Lan et al (2023) | 115 | 62.83 | 23.19 |
| Kalaitzaki et al. (2023) | 429 | 50.52 | 20.00 |
| Bai et al. (2023) | 407 | 75.47 | 21.80 |
| Akdag et al. (2023) | 184 | 70.91 | 22.54 |
| Atay et al. (2023) | 263 | 69.95 | 15.73 |
| Bai et al. (2024) | 692 | 62.09 | 18.56 |
| Cardinali et al. (2023) | 118 | 43.05 | 26.59 |
| Carola et al. (2022) | 35 | 34.51 | 25.46 |
| Dahan et al. (2022) | 183 | 63.21 | 17.00 |
| Kalaitzaki et al. (2024) | 429 | 62.24 | 2.18 |
| Kapur et al. (2022) | 213 | 47.40 | 27.00 |
| Levinsky et al. (2024) | 369 | 45.55 | 27.28 |
| Liu G. et al (2024) | 575 | 45.45 | 25.45 |
| Liu S. et al (2024) | 669 | 37.09 | 58.86 |
| Nie et al. (2021) | 760 | 83.58 | 15.33 |
| Nowicki et al. (2024) | 120 | 57.54 | 25.41 |
| Özönder et al. (2023) | 253 | 58.09 | 9.69 |
| Petrocchi et al. (2023) | 4934 | 68.25 | 47.67 |
| Pfeiffer et al. (2023) | 163 | 50.40 | 25.20 |
| Read et al. (2022) | 109 | 67.49 | 2.73 |
| Sarialioglu et al. (2022) | 175 | 50.98 | 25.30 |
| Wu (2024) | 1711 | 88.20 | 20.79 |
| Yilmaz-Karaman et al. (2023) | 66 | 37.86 | 26.28 |
| Yim et al. (2022) | 100 | 57.49 | 19.23 |
| Zhang et al. (2023) | 589 | 64.46 | 22.79 |
| Paeizi et al. (2024) | 700 | 54.60 | 0.52 |
| Foster et al. (2024) | 144 | 61.03 | 21.28 |
| Kalaitzaki et al. (2021) | 673 | 46.60 | 24.61 |
| Liu et al. (2021) | 200 | 66.78 | 1.06 |
| Kowalski et al. (2021) | 179 | 47.04 | 1.24 |
| Fino et al. (2023) | 202 | 37.10 | 24.70 |
| Jiang et al. (2022) | 2750 | 97.09 | 18.27 |
| Song et al. (2024) | 338 | 76.65 | 0.77 |
| Sun et al. (2022) | 233 | 76.18 | 16.00 |
| Peng et al. (2021) | 116 | 65.65 | 11.50 |
| Cui et al. | 179 | 70.53 | 17.26 |
| Adjorlolo et al. (2022) | 381 | 46.74 | 10.61 |
| Chen et al.(2020) | 12596 | 58.80 | 24.15 |
| Lewis et al. (2022) | 1424 | 26.54 | 23.12 |
| Ulset & Soest (2022) | 12686 | 45.36 | 14.28 |
| Vazquez et al. (2021) | 1951 | 76.67 | 15.96 |
| Yeung et al. (2022) | 1510 | 45.99 | 20.37 |
| El-Khoury Malhame et al. (2023) | 252 | 63.69 | 24.46 |
| Tu et al. (2023) | 290 | 98.30 | 25.05 |
| Barnicot et al (2023) | 854 | 42.74 | 22.93 |
| Azman et al. (2023) | 152 | 84.00 | 45.36 |
| Deitz (2024) | 436 | 48.30 | 10.71 |
| Gaboardi et al. (2024) | 295 | 76.02 | 25.62 |
| Moreno-Jimenez et al. (2021) | 172 | 86.31 | 17.64 |
| Uziel et al. (2021) | 364 | 37.44 | 21.63 |
| Veronese et al. (2022) | 441 | 76.02 | 18.90 |
| Zeng et al. (2023) | 2267 | 52.90 | 19.91 |
| Aggar et al. (2022) | 767 | 45.36 | 24.61 |

**Table 2: Statistical result of Main Analysis**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Random Effects Model (k=30)** | |  |  |  |  |  |  |
|  | Estimate | se | Z | p | CI Lower Bound | CI Upper Bound |  |
| Intercept | 0.75 | 0.15 | 4.92 | <.0001 | 0.45 | 1.05 |  |
| Heterogeneity Statistics | |  |  |  |  |  |  |
|  | Tau | Tau^2 | I^2 | H^2 | df | Q | p |
|  | 0.83 | 0.69 | 99.72% | 352.96 | 29 | 6174.90 | <.0001 |

**Figure 2: Forest Plot of Main Analysis**

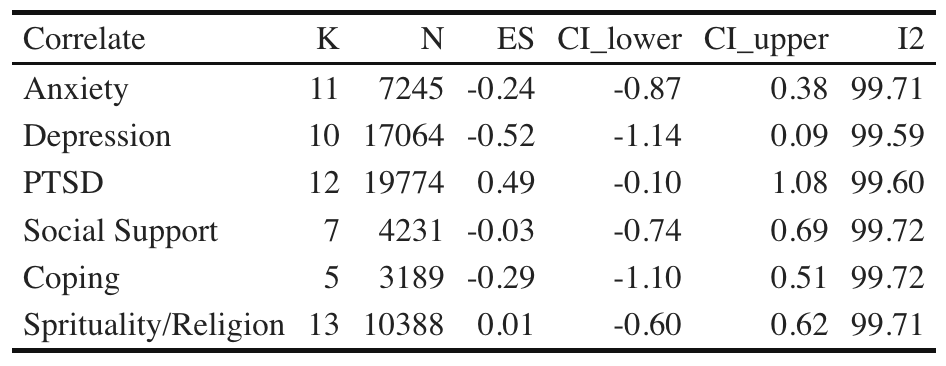
****

**Appendix**

**Table 3:** Overview of the selected studies for subgroup analysis

| Source | sample size | PTSD | Anxiety | Depression | Social Support | Coping | Sprituality/Religion |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Arnout and Al‐Sufyani (2021) | 365 | 1 | 1 | 1 | 0 | 0 | 0 |
| Chasson et al. (2022) | 916 | 0 | 1 | 0 | 0 | 0 | 0 |
| Chen & Tang (2021) | 422 | 1 | 0 | 0 | 0 | 0 | 0 |
| Gul (2023) | 300 | 0 | 0 | 0 | 1 | 0 | 0 |
| Kalaitzaki et al. (2022) | 352 | 0 | 1 | 1 | 1 | 1 | 1 |
| Lau et al. (2021) | 327 | 1 | 0 | 0 | 0 | 0 | 0 |
| Lyu et al. (2021) | 251 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mo (2022) | 266 | 1 | 0 | 0 | 1 | 0 | 0 |
| Northfield & Johnston (2021) | 296 | 0 | 0 | 0 | 1 | 0 | 0 |
| Willey et al.(2022) | 176 | 0 | 1 | 1 | 0 | 1 | 1 |
| Yıldız (2021) | 292 | 0 | 0 | 0 | 0 | 0 | 0 |
| Zhang et al. (2021) | 1790 | 1 | 0 | 0 | 1 | 1 | 1 |
| Zhou et al.(2020) | 442 | 0 | 1 | 1 | 1 | 1 | 1 |
| Yao et al. (2023) | 1512 | 0 | 0 | 0 | 0 | 0 | 1 |
| Das et al. (2023) | 166 | 1 | 0 | 0 | 0 | 0 | 1 |
| Wang et. al (2023) | 100 | 1 | 0 | 0 | 0 | 0 | 1 |
| Castiglioni et. al (2023) | 733 | 0 | 1 | 1 | 0 | 0 | 1 |
| Morales et al (2023) | 785 | 0 | 1 | 1 | 1 | 0 | 1 |
| Lan et al (2023) | 115 | 1 | 0 | 0 | 0 | 0 | 1 |
| Kalaitzaki et al. (2023) | 429 | 0 | 0 | 0 | 0 | 1 | 1 |
| Bai et al. (2023) | 407 | 0 | 0 | 0 | 0 | 0 | 1 |
| Akdag et al. (2023) | 184 | 1 | 0 | 0 | 1 | 0 | 0 |
| Atay et al. (2023) | 263 | 0 | 0 | 0 | 0 | 1 | 0 |
| Bai et al. (2024) | 692 | 0 | 0 | 0 | 0 | 1 | 0 |
| Cardinali et al. (2023) | 118 | 0 | 0 | 0 | 0 | 1 | 0 |
| Carola et al. (2022) | 35 | 0 | 1 | 0 | 0 | 0 | 0 |
| Dahan et al. (2022) | 183 | 0 | 1 | 0 | 0 | 1 | 0 |
| Kalaitzaki et al. (2024) | 429 | 0 | 0 | 0 | 0 | 1 | 0 |
| Kapur et al. (2022) | 213 | 0 | 0 | 0 | 0 | 1 | 0 |
| Levinsky et al. (2024) | 369 | 0 | 1 | 1 | 0 | 0 | 0 |
| Liu G. et al (2024) | 575 | 0 | 1 | 1 | 0 | 0 | 0 |
| Liu S. et al (2024) | 669 | 0 | 1 | 0 | 0 | 1 | 0 |
| Nie et al. (2021) | 760 | 0 | 0 | 0 | 0 | 1 | 0 |
| Nowicki et al. (2024) | 120 | 0 | 0 | 0 | 0 | 0 | 1 |
| Özönder et al. (2023) | 253 | 0 | 0 | 0 | 0 | 1 | 1 |
| Petrocchi et al. (2023) | 4934 | 0 | 1 | 0 | 0 | 1 | 0 |
| Pfeiffer et al. (2023) | 163 | 0 | 0 | 0 | 0 | 0 | 0 |
| Read et al. (2022) | 109 | 0 | 0 | 0 | 0 | 1 | 0 |
| Sarialioglu et al. (2022) | 175 | 0 | 0 | 0 | 0 | 1 | 0 |
| Wu (2024) | 1711 | 0 | 0 | 0 | 1 | 1 | 1 |
| Yilmaz-Karaman et al. (2023) | 66 | 0 | 1 | 0 | 0 | 1 | 0 |
| Yim et al. (2022) | 100 | 1 | 0 | 0 | 1 | 0 | 1 |
| Zhang et al. (2023) | 589 | 0 | 1 | 0 | 0 | 1 | 0 |
| Paeizi et al. (2024) | 700 | 0 | 0 | 0 | 0 | 1 | 1 |
| Foster et al. (2024) | 144 | 0 | 1 | 1 | 0 | 1 | 0 |
| Kalaitzaki et al. (2021) | 673 | 0 | 0 | 0 | 1 | 1 | 1 |
| Liu et al. (2021) | 200 | 0 | 0 | 0 | 0 | 1 | 0 |
| Kowalski et al. (2021) | 179 | 0 | 0 | 0 | 0 | 1 | 1 |
| Fino et al. (2023) | 202 | 1 | 0 | 0 | 1 | 1 | 0 |
| Jiang et al. (2022) | 2750 | 1 | 0 | 0 | 0 | 0 | 0 |
| Song et al. (2024) | 338 | 0 | 0 | 0 | 1 | 1 | 1 |
| Sun et al. (2022) | 233 | 0 | 0 | 0 | 0 | 1 | 0 |
| Peng et al. (2021) | 116 | 0 | 0 | 0 | 1 | 0 | 0 |
| Cui et al. | 179 | 0 | 0 | 0 | 0 | 1 | 1 |
| Adjorlolo et al. (2022) | 381 | 0 | 1 | 1 | 1 | 0 | 0 |
| Chen et al.(2020) | 12596 | 1 | 0 | 0 | 0 | 0 | 0 |
| Lewis et al. (2022) | 1424 | 1 | 0 | 0 | 0 | 0 | 0 |
| Ulset & Soest (2022) | 12686 | 0 | 0 | 1 | 1 | 0 | 0 |
| Vazquez et al. (2021) | 1951 | 1 | 1 | 0 | 0 | 0 | 1 |
| Yeung et al. (2022) | 1510 | 0 | 0 | 0 | 0 | 0 | 1 |
| El-Khoury Malhame et al. (2023) | 252 | 1 | 0 | 0 | 0 | 0 | 1 |
| Tu et al. (2023) | 290 | 0 | 1 | 1 | 1 | 0 | 1 |
| Barnicot et al (2023) | 854 | 0 | 1 | 1 | 0 | 0 | 0 |
| Azman et al. (2023) | 152 | 0 | 1 | 1 | 0 | 0 | 0 |
| Deitz (2024) | 436 | 1 | 1 | 0 | 0 | 1 | 0 |
| Gaboardi et al. (2024) | 295 | 0 | 0 | 0 | 0 | 1 | 0 |
| Moreno-Jimenez et al. (2021) | 172 | 0 | 1 | 0 | 0 | 1 | 0 |
| Uziel et al. (2021) | 364 | 0 | 1 | 1 | 0 | 0 | 0 |
| Veronese et al. (2022) | 441 | 1 | 0 | 0 | 0 | 1 | 0 |
| Zeng et al. (2023) | 2267 | 0 | 1 | 1 | 0 | 1 | 0 |
| Aggar et al. (2022) | 767 | 0 | 1 | 1 | 0 | 1 | 0 |

**Table 4: Results Summary of subgroup analysis**



**Figure 3: Forest plot for Depression related PTG among COVID-19 people**

A graph with numbers and a line

Description automatically generated