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Harris Cooper, PhD, Editor-in-Chief

*American Psychologists*(AP)

Hugo L. Blomquist professor emeritus

Dartment of psychology and neuroscience

Duke University

Dear Dr. Cooper,

Please find the manuscript, titled “*Does a Deadly Global Pandemic Make Humankind Stronger?*” 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 *AP* because this interdisciplinary study provides information on an aggregated outcome on a trauma-related concept, posttraumatic growth (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, a subgroup analysis figures is 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. However, if you consider it to be unfit by glance, please inform us.

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

Sincerely,

Amy L. Ai, PhD

FSU Distinguished Research Professor

**Does a Deadly Global Pandemic Make Humankind Stronger?**

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

(03/20/2024, in Submission to PTTR

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**Does a Deadly Global Pandemic Make Humankind Stronger?**

**(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—05/31/2024) 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 75 studies, comprising 67,611 participants. COVID-19 was significantly associated with PTG as mostly determined by Posttraumatic Growth Inventory (PTGI) (*g*= 1.9813 ; 95%CI, 0.76-3.2; *p* = 0.0015). **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)

Consequently, 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).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 includes a posttraumatic outlook change in varied domains, or positive outlook, that could lead to optimal behavioral alternation. 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.”

threatenMeta-analyses have associated it with low mortality in non-pandemic patients (Ma et al., 2022; Wan et al., 2023). One meta-analysis on individuals living with HIV/AIDS, a previously life-changing pandemic, has shown a positive relationship between PTG and adjustment (Pieta & Rzeszutek, 2022). deadly eventsYet, there is a paucity of meta-analyses for this optimal outcome after this catastrophic pandemic in the United States and globally. Given the long-term and vast impact of Covid-19 (Kocatürk et al., 2021; Parums, 2021), it is necessary to examine if PTG could emerge. In his 1980 autobiography W*ill,* Friedrich Nietzsche said: What doesn’t kill me makes me stronger. We, thus, extended the statement to a population-based question: *Does a Deadly Global Pandemic Make Mankind Stronger*?

Emerging evidence has shown the promise answer. 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-analysis to examine the scope of this positive worldview-based mindset following COVID-19.

By synthesizing empirical studies, we attempted to provide more reliable and robust conclusion on PTG. The aim was to reveal whether PTG could be observed under the existential threat of COVID-19 to humankind. Based on the literature, we hypnotized a positive relationship of PTG to Covid-!9 across different sectors of global populations in a main analysis.

# **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 (Bovero et al., 2023; Hyun et al., 2021; Karbasi et al., 2024; 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.

# **Study Selection**

We followed the guidelines provided by Covidence for study selection. (Covidence, 2024). 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 gains did not all pertain to growth.

**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, Ottaviani et al.,2024; PTGI-X, Bai et al., 2024) 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 seen as evident.

We employed a random effect meta-analytical model for the 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. A post-hoc analysis was conducted with coping.

**Results**

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 (See Table 1).Of these 75 included in the analysis, all employed PTGI or its variants (e.g. PTGI-SF) to examine PTG. For the selected studies involving a total of 67,611 individuals, table 1 and table 3 present their overall characteristics, including study designs.

Table 1 contains the specifics of the demographic characteristics. Among the selected studies from developed countries, two were performed in Australia, four in Greece, seven in Italy, two in Poland, ten in the United States, and three in the United Kingdom. In addition, Canada, France, Norway, Switzerland, had one study each (See Table 1). Among those from developed countries, one was conducted in Ghana, seventeen in the Middle Eastern areas of Turkey, Pakistan, Iran, Saudi Arabia, Lebanon and Israel, and twenty-four in Asia (See Table 1).Included articles involved a variety of different types of people suchas patients and the general population, nurses and medical doctors, pregnant women, and studentsmost of which centered on the general population during COVID 19 (Table 1).

The 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 16 (Ulset & Soest, 2022) 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 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 showed a highly positive link between PTG and COVID-19: *I2* value 99.99% with high heterogeneity (Table 3).

Finally, the post-hoc analysis evaluated various types of coping strategies with PTG in 38 studies (*N=*23,386) (Table 3??) . The baseline effect size was *g*= 0.77, and the regression coefficient for coping was *B=2.42*; 95%CI [0.016, 4.82]; *p*=0.0485. Coping has a significant effect in the model baseline effect size. The for the model considering coping was 99.99%.

**Discussion**

This study, the first meta-analysis on the association of PTG with Covid-19, was to determine if the deadly global pandemic could make humankind stronger. As we hypothesized, the synthesized result demonstrates a moderate level of growth in diverse populations internationally. The association is shown with a weighted mean PTGI score 59 involving 67,611 participants from 75 international studies (Tables 1 and 3). Indeed, 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 diversity of data sources across many different populations. Selected studies cover research being conducted in the United States and beyond, including countries from both high and low incomes in four most popularized continents. As such, the current review provides compelling evidence for Covid-19-related PTG 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 this wide-spread existentialchallenge, 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).

Moreover, selected samples involve different roles of participants during Covid-19 (e.g., patients, health care providers, students, veterans, and general populations). This implies that the overall sample have exposed to different degree of risk and included t diverse conditions, ranging from very sick to very healthy, while facing the same crisis of 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 shown in populations, settings, and designs of selected studies. Admittedly, subgroup analyses did not provide explanation for this heterogeneity (data not shown), which suggests the need for further investigation on the moderation of undetected factors.

Specifically, we found no significant association between PTG and risk/protective factors such as posttraumatic stress disorders (PTSD), except coping. This 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.

**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 (Wu 2024). 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. 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.

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**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.

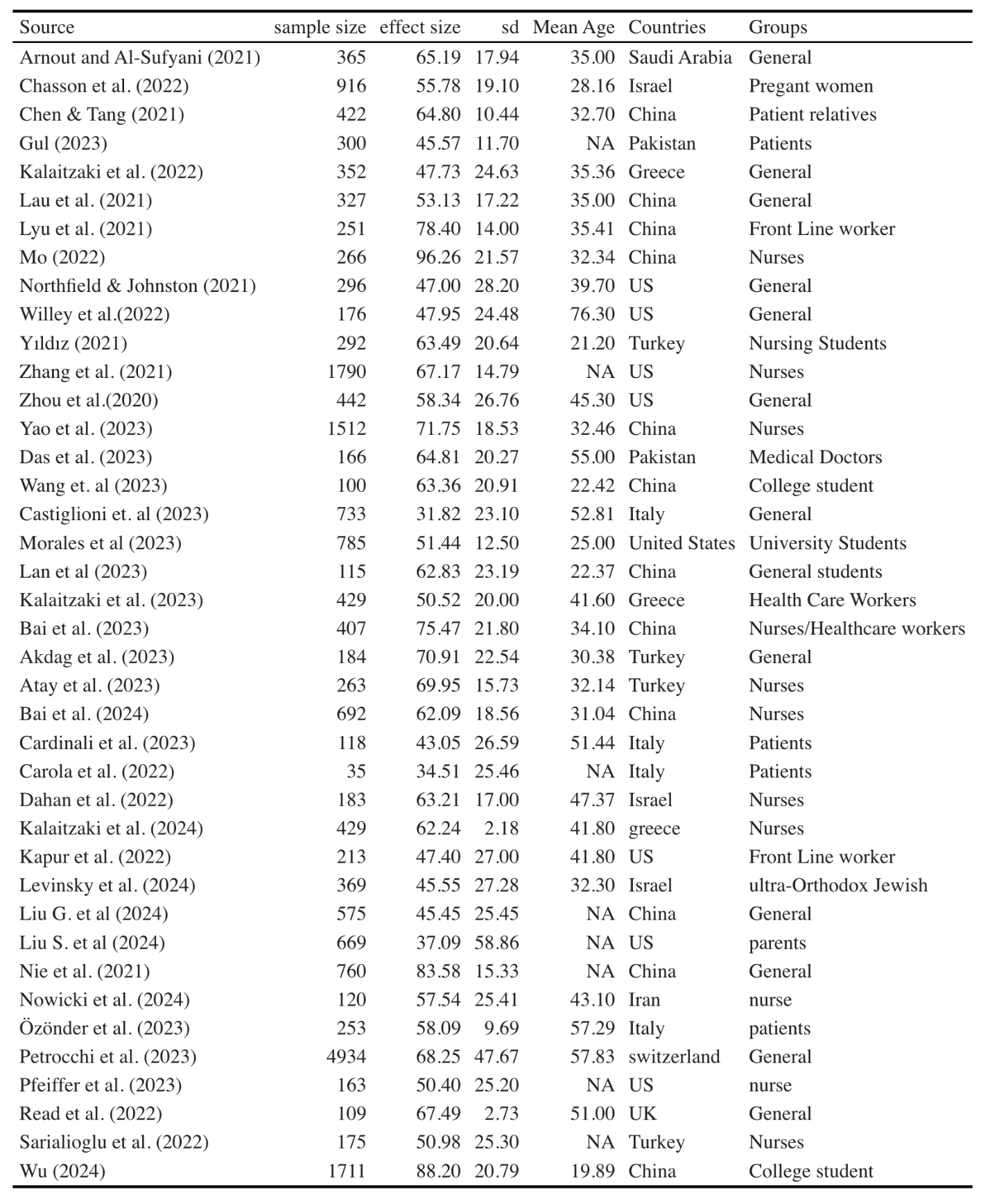
(n=35)

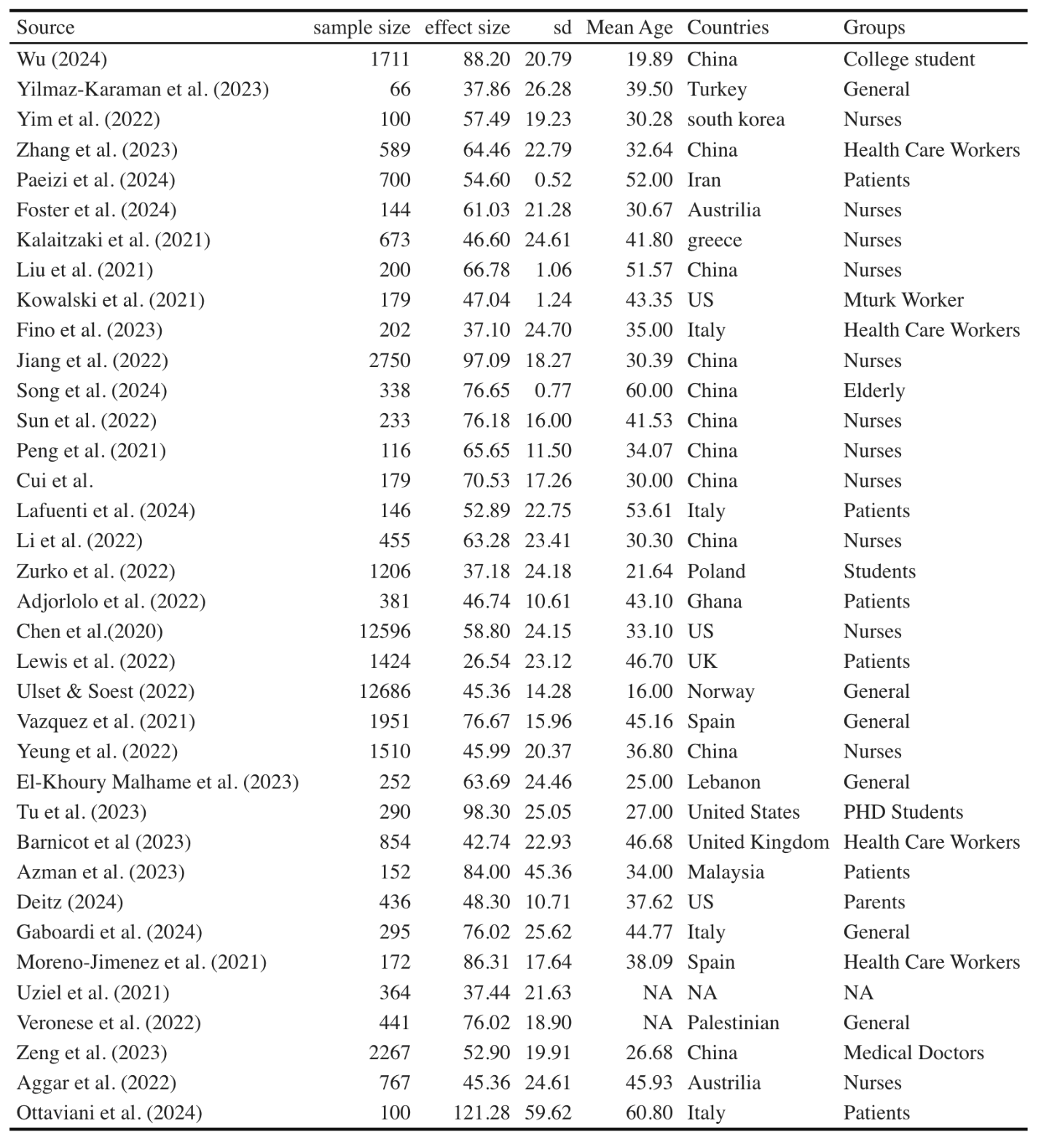
Studies included in review.

(n=30)

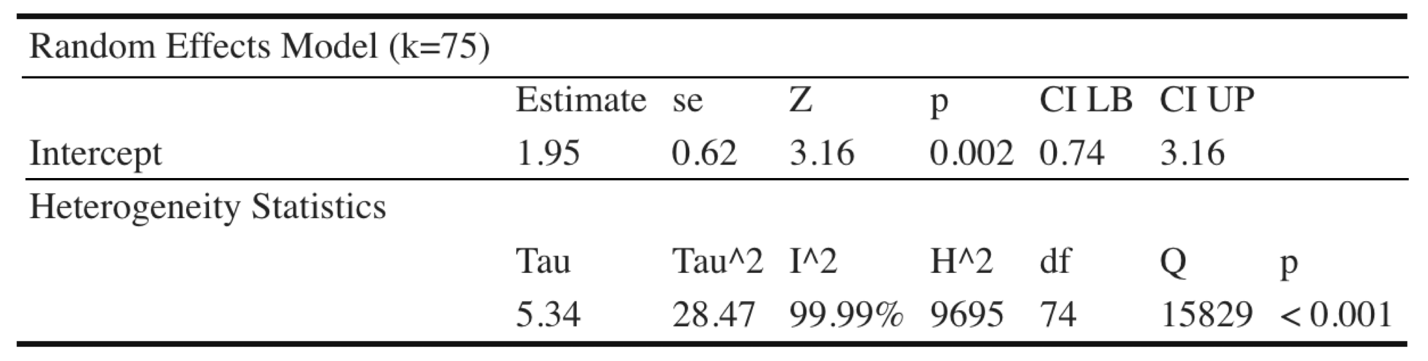
**Included**

**Table 1: Overview of the selected studies (k=75) for main analysis**

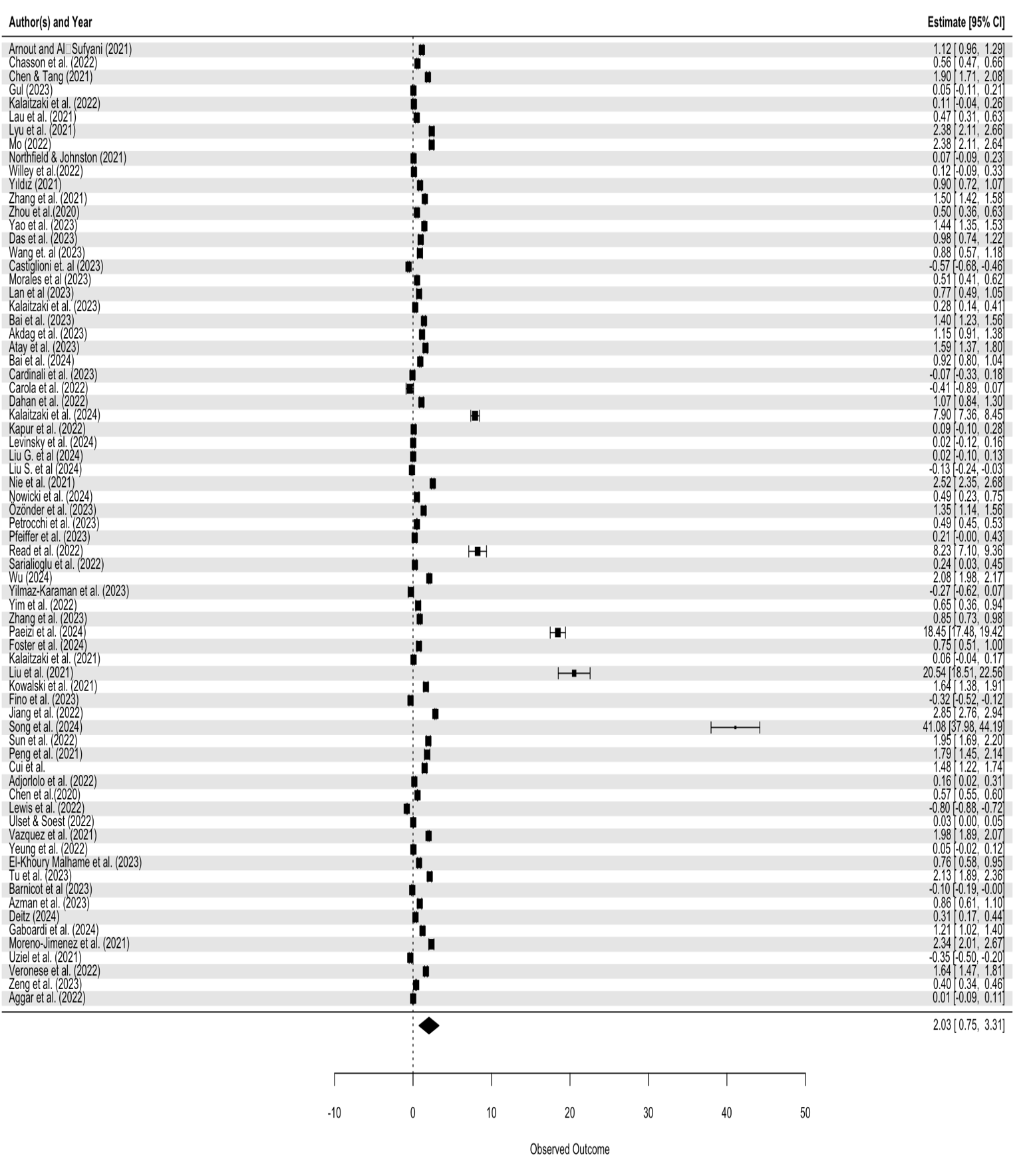


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**Table 2: Statistical result of Main Analysis**

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

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**Appendix**

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

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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. (Taiwan)

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.

Subgroup analyses for moderators were conducted with PTSD, Anxiety, Depression, Social Support, Coping, religion.

**Study Characteristics**

**Main Analysis for Aim (1)**

**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 (Table 3).

***PTSD/PTSS***

Nineteen selected studies presented the association of PTSD with PTG with a total of 24,033 participants (Table 3). The baseline effect size (the intercept term) was *g* = 2.32, and whether the studies investigated PTSD yielded a lower effect with the regression coefficient associated with the PTSD term being *B=*-1.31; 95%CI [-0.412, 1.49]; *p*=0.36. However, there was no significant relationship between PTSD and PTG (*p*-value=0.36). Yet, the broad range of effect sizes indicated a considerable amount of uncertainty in the effect estimate (*SE*=1.43). An *I2* value of 99.99% showed substantial heterogeneity across the studies.

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

Eighteen selected studies presented the association of depression with PTG with a total of 21,802 participants (Table 3). The baseline effect size was *g*=2.49, and the regression coefficient for depression is *B*=-2.10; 95%CI [0.15, -4.93]; *p*=0.14, 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 99.99% showed substantial heterogeneity across these studies.

With regards to Anxiety, there were 28 studies discussed and measured anxiety levels, spanning 19,522 participants. The baseline effect was *g*=2.87, with Anxiety having a regression coefficient of *B*=-2.35 with 95%CI [-4.83, 0.13]; *p*=0.06, indicating almost significant effect of Anxiety on PTG. The heterogeneity after considering Anxiety as a moderator was also high indicate by an of 99.99%.

***Social Support***

Seventeen selected studies discussed social support concerning PTG with a total of 20,912 participants (Table 3). The baseline effect was *g*= 1.6806 , with Social Support having a regression coefficient of *B*= 1.3138 ; 95%CI[-1.61, 4.24]; *p*=0.37. Overall, social support did not contribute much to `variability in PTG across studies. This can be seen from the high of 99.99% for the model that considered social support. Overall, social support did not contribute much to moderating the variability in PTG across studies.

***Spirituality***

Finally, there were 25 studies that examined religion and spirituality with a total of 15,263 participants (Table 3). The baseline effect size was *g*= 1.42 , and the regression estimate for spirituality was *B*= 1.66; 95%CI -0.93 , 4.24]; *p*= 0.21. Thus, there was no relation between spirituality and PTG. The for the model regarding spirituality was (99.99%).

Also, subgroup analyses did not provide explanation for this heterogeneity. The high heterogeneity is likely to be caused by the extensive span of the number of articles we reviewed and the variety of corresponding sample sizes in each of the articles. However, based on the subgroup analysis, it remains unclear if individual characteristics (e.g., gender, age) and risk or protective factors may take a part.

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.

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