The Benefit of Interventions to Reduce Posttraumatic Stress in Youth Exposed to Mass Trauma: A Review and Meta-Analysis

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Abbreviations:
CER: control event rate
NNT: number needed to treat
PTS: posttraumatic stress
PTSD: posttraumatic stress disorder
RCT: randomized controlled trial
REML: restricted maximum likelihood

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Abstract

Numerous interventions to address posttraumatic stress (PTS) in youth exposed to mass trauma have been delivered and evaluated. It remains unclear, however, which interventions work for whom and under what conditions. This report describes a meta-analysis of the effect of youth mass-trauma interventions on PTS to determine if interventions were superior to inactive controls and describes a moderator analysis to examine whether the type of event, population characteristics, or income level of the country where the intervention was delivered may have affected the observed effect sizes. A comprehensive literature search identified randomized controlled trials (RCTs) of youth mass-trauma interventions relative to inactive controls. The search identified 2,232 references, of which 25 RCTs examining 27 trials (N = 4,662 participants) were included in this meta-analysis. Intervention effects were computed as Hedge's *g* estimates and combined using a random effects model. Moderator analyses were conducted to explain the observed heterogeneity among effect sizes using the following independent variables: disaster type (political violence versus natural disaster); sample type (targeted versus non-targeted); and income level of the country where the intervention was delivered (high- versus middle- versus low-income). The correlation between the estimates of the intervention effects on PTS and on functional impairment was estimated. The overall treatment effect size was converted into a number needed to treat (NNT) for a practical interpretation. The overall intervention effect was statistically significant ($g = 0.57$; $P < .0001$), indicating that interventions had a medium beneficial effect on PTS. None of the hypothesized moderators explained the heterogeneity among the intervention effects. Estimates of the intervention effects on PTS and on functional impairment were positively correlated (Spearman's $r = 0.90$; $P < .0001$), indicating a concomitant improvement in both outcomes. These findings confirm that interventions can alleviate PTS and enhance functioning in children exposed to mass trauma. This study extends prior research by demonstrating improvement in PTS with interventions delivered to targeted and non-targeted populations, regardless of the country income level. Intervention populations and available resources should be considered when interpreting the results of intervention studies to inform recommendations for practice.

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Introduction

Mass trauma, in the form of political violence (eg, war, political conflict, or terrorism) and natural disasters (eg, earthquakes, hurricanes, or floods), has devastating human and economic effects.[1,2] Youth have been recognized as especially vulnerable to these adversities and a priority for intervention.[3–5] Posttraumatic stress (PTS), in the form of posttraumatic stress disorder (PTSD) and/or PTS symptoms or reactions, is the most commonly studied outcome and has been well-documented in youth exposed to mass trauma.[6,7] A meta-analysis of studies of children and adolescents from around the world revealed that 15.9% of those exposed to a traumatic event developed PTSD. The rate of PTSD was 25.2% for interpersonal trauma and 9.7% for non-interpersonal trauma.[8] Despite the complexities of providing services to address the psychological reactions of youth to mass trauma, an impressive array of interventions has been delivered and evaluated. Several methodological reviews[9–11] and meta-analyses[12–17] evaluating the evidence-base for these interventions have been published. Results of meta-analyses have varied from no intervention effect for PTS[17] to a small[13,16] or medium[12,14,15] effect.

Potential Moderators of Intervention Effect

Research findings cluster in three broad areas of potential moderators of mass-trauma outcomes in youth, including aspects of the traumatic event (eg, trauma type or morbidity and mortality rates); the youth (eg, demographics) and populations (eg, targeted or universal) receiving the intervention; and the context of intervention delivery (eg, geographic location or available resources).[18–20] Prior meta-analyses of youth mass-trauma intervention studies have examined type of trauma (eg, natural disaster or terrorist event);[12] characteristics of intervention recipients (eg, demographics);[12,15,16] geographic location where studies were conducted;[12,16] intervention approach (eg, eclectic, exposure, eye movement desensitization and reprocessing, or cognitive-behavioral);[12,15] and characteristics of intervention delivery (eg, timing, setting, or provider training).[12,15]

Type of Mass Trauma—Research has revealed contradictory findings regarding the influence of the type of mass trauma on outcomes.[20–22] In a review of PTSD in adult samples in 10 systematically-studied disasters, North and colleagues[21] concluded that there was no association between PTSD and type of disaster (natural disaster versus technological accident versus political violence). A meta-analysis of child disaster studies found no differences in PTS based on event type,[19] and a meta-analysis of child intervention studies found no significant moderator effect on PTS based on type of trauma.[12]

Intervention Recipients and Populations—Meta-analyses of youth mass-trauma interventions have examined the influence of various characteristics of intervention recipients.[12,15,16] For example, Purgato and colleagues[16] examined whether participants' demographics moderated the effect of psychosocial interventions. The interventions were effective for PTS across age group, gender, and geographic region, and in both displaced and non-displaced youth, with a larger effect size in adolescents aged 15 to 18 years compared to younger participants as well as in non-displaced youth compared to their displaced counterparts.[16] Newman and colleagues[15] also found a larger effect size for interventions delivered to older children compared to younger counterparts.

Typologies used to classify interventions recognize the importance of event exposures, experiences, and/or reactions of the youth receiving the intervention, but these population characteristics have not been examined in prior meta-analyses of intervention studies. Intervention typologies have focused on universal, selective, and indicated populations, or alternatively on universal and targeted populations.[23–26] Universal populations include all individuals regardless of their event exposures, experiences, or reactions.[24,27] Targeted populations are selective (including exposed children, at-risk children, and/or children with distress reactions or dysfunction) and indicated (including those with marked distress, early PTS, other comorbid symptoms, or other risk factors for adverse outcome).[23] Targeted populations may be identified through a screening process to determine symptom thresholds and/or risk for psychopathology.[27]

Context—A host of contextual factors, including economic resources and social support, may influence mass-trauma outcomes.[18,20] Economically impoverished and under-developed areas lack the infrastructure and resources for preparedness and response, and changes in support networks following mass trauma may result in inadequate social support and impede recovery.[18] Mass-trauma events generate an increase in the need for services at a time when service infrastructures may be damaged. Meta-analyses of child mass-trauma intervention studies have found no difference in PTS outcomes based on geographic region (Africa and other low-resource regions)[16] or continent[12] where the study was conducted. Purgato and colleagues[16] did not explain the rationale for comparing Africa and other regions and did not discuss their failure to find regional differences in the intervention studies included in their meta-analysis, all of which were delivered in low-resource areas. Brown and colleagues[12] did not specify their results in terms of the area's economic resources or capacity for development, which arguably have the potential to influence mass-trauma and intervention outcomes. These contextual factors may be reflected, for example, in data published by the World Bank Data Help Desk (Washington, DC USA)[28] on the gross national income per capita of member countries of the World Bank. The gross national income is calculated through the Atlas method, which adjusts for inflation in exchange rates and is correlated with quality of life indices such as life expectancy, child mortality, and school enrollment.[28]

The Current Review

This meta-analytic review of randomized controlled trials (RCTs) was conducted to determine if mass-trauma interventions were superior to inactive controls in addressing PTS. This study addresses methodological limitations of prior meta-analyses in two ways. First, meta-analyses by Fu and Underwood[13] and by Newman and colleagues[15] included trials using non-randomized controls, which may have inflated effects.[29] Second, meta-analyses by Brown and colleagues[12] and by Newman and colleagues[15] included trials using active (other interventions) as well as in-active (waitlist, no-treatment) controls, which render the summary effect sizes difficult to interpret for clinicians selecting interventions. The current analysis also augments prior meta-analytic studies by: (1) including more studies than prior meta-analyses;[13,16,17] (2) investigating the effectiveness of interventions administered in the aftermath of natural disasters as well as mass violence;[14,16] and (3) broadening the type of interventions (eg, focused psychosocial support),[16] the settings (eg, schools),[13] or the context where the interventions were delivered (eg, low-resource environments).[14,16] The moderator analysis conducted for this report addressed unsettled issues that are likely to influence service delivery decisions, including the type of trauma, the populations receiving the intervention, and the context of the study. The relationship between the estimates of the intervention effects on PTS and on functional impairment was also assessed. Finally, to guide service decisions about intervention applications, this paper offers an approach to weigh potential benefit and cost-effectiveness using intervention effect estimates.

Report: Search Methodology and Statistical Approach

The inclusion criteria, literature search, and results of the search; coding of included studies; statistical approach to the meta-analysis; and other analyses are described below.

Inclusion Criteria and Literature Search

The RCTs included in this study were selected based on the Population-Intervention-Comparison-Outcome (PICO) paradigm proposed by the Cochrane Collaboration (London, United Kingdom).[30] Studies meeting the following criteria were selected:

RCTs of (1) psychological and behavioral interventions with no pharmacological component; (2) addressing PTS; (3) in youth, 18 years of age or younger, exposed to mass trauma; and (4) compared against waitlist or no-treatment control conditions.

A literature search was conducted in December 2016 to identify studies of psychological and behavioral interventions for children and adolescents exposed to disasters, natural disasters, terrorism, terrorist events, threat of terrorism, political conflict, war, and/or other mass-casualty events using the following databases: EBM Reviews (Ovid Technologies; New York, New York USA); EMBASE (Elsevier; Amsterdam, Netherlands); ERIC (US Department of Education; Washington, DC USA); Medline (US National Library of Medicine, National Institutes of Health; Bethesda, Maryland USA); PILOTS (ProQuest; Ann Arbor, Michigan USA); PsycINFO (American Psychological Association; Washington DC, USA); PubMed (National Center for Biotechnology Information, National Institutes of Health; Bethesda, Maryland USA); and Social Work Abstracts (EBSCO Information Services; Ipswich, Massachusetts USA). No time limit was placed on date of publication and the search was confined to published research and English language sources. A total of 2,232 unduplicated publications were identified. After reviewing titles and removing 2,060 irrelevant publications (eg, publications on disaster reactions, services, or other sources of trauma), abstracts of the remaining 172 sources were examined. Review of these 172 abstracts resulted in the elimination of 123 publications, including 52 descriptive papers on interventions and services, 31 reporting non -controlled trials, 15 describing intervention reviews, nine on services and service delivery issues, six describing intervention trials using active control conditions, five on interventions used with adults, four on interventions for other types of trauma, and one on intervention development. This left 49 papers that were reviewed in full. Of these 49 papers, 35 were excluded, including 11 describing non-randomized trials, seven that did not assess PTS as an outcome, four reporting studies captured in another publication that was included in the current analysis, three that did not evaluate an intervention, two studying heterogeneous types of trauma, two describing non-controlled trials, two reporting studies with an active control, two with insufficient information to compute the intervention effect (multiple unsuccessful attempts were made by telephone and/or email to contact the authors for additional information), one describing an intervention delivered to parents, and one describing a web-based intervention. One trial that included participants aged 15 to 24 years[31] was retained because the average age of participants was 18.0 years (SD = 2.4 years). Thus, the search identified 14 RCTs with inactive controls that assessed PTS. The reference sections of these publications and review articles uncovered six additional qualifying studies which were included along with another four studies known to the authors. An updated search in December 2018 identified one additional study meeting the inclusion criteria.[32] Thus, 25 empirical research studies using randomized controlled design with inactive control groups to assess PTS were identified. Two of the research studies described two interventions[33,34] for a total of 27 intervention trials from 25 studies (Figure 1; Table 1[31-55]).

Coding of Selected Studies

The outcome variable examined in this review was PTS. The moderator analysis examined the nature of the traumatic experience as political violence or a natural disaster; the population receiving the intervention as either targeted or non-targeted (universal); and the location of the event in a low-, middle-, or high-income country. Targeted populations included children with severe exposure (eg, child soldiers) and/or those who screened positive for specific psychological symptoms; non-targeted populations included children without regard for their trauma exposure or reactions. Income level of the country where the event occurred or where the trial was implemented[49,52] was used to represent contextual factors such as economic resources and support networks which were not consistently measured or reported in the studies included in this analysis. Location was classified as low-, middle-, or high-income based on information from the World Bank Data Help Desk[28] on the income level of the country during the year the intervention was administered. Two authors independently coded populations with discrepancies settled through consensus of three authors. Table 1 shows a listing and description of the studies.

Statistical Analytic Strategy

For all the statistical tests, Type I error probability (α) was set to 0.05 and all the reported P values are two-tailed.

Meta-Analysis—In studies that reported several post-intervention assessments, only the first assessment was selected for the computation of the intervention effect size to minimize bias due to attrition in subsequent follow-up assessments. Standardized mean difference Hedge's *g* was used as the effect size statistic because it corrects for bias in studies with relatively small sample sizes.[56] For cluster randomized studies, intervention effect size was corrected for the clustering by multiplying the variance of the effect size by the design effect D: $D = (1 + (M-1)*ICC)$, where M is the average cluster size and ICC is the intra-cluster correlation of the study outcome. An ICC of 0.1 was used for the cluster-randomized trials that did not provide the ICC for the study sample.

A random effects model using restricted maximum likelihood (REML) was fitted to estimate the meta-analysis parameters and the summary effect of the interventions. For each hypothesized moderator, the size of the intervention effect was computed for each level of the moderator (political violence versus natural disasters, targeted versus non-targeted population, and low- versus middle- versus high-income), and a mixed effects model fitted with REML estimated the difference between these effect sizes. The summary effect sizes, their 95% confidence interval (95% CI; which reflects the precision of the overall estimate), and 80% prediction interval (80% PI; which reflects the range of the true intervention effect) are reported. The 95% confidence intervals for these effect sizes were adjusted with the method proposed by Hartung and Knapp,[57] a method shown to have a better coverage probability for the summary effect than alternative techniques, especially when heterogeneity is high and/or sample sizes are small.[58]

As many included studies were conducted by the same research team, a multi-level random effects model (Level 1 = research team; Level 2 = individual studies) was fitted to compute the intra-class correlation and to determine whether the intervention effects were clustered within research teams. Since effect sizes that have not been corrected for measurement errors can be biased downward, a sensitivity analysis was conducted to determine whether adjusting the effect sizes for the instrument reliability would yield different findings. The method developed by Schmidt and Hunter[59] was used to account for these measurement errors in PTS. Internal consistency (measured with Cronbach's alpha) was the most commonly reported reliability statistic from the studies included in this review. Internal consistency only accounts for random response error and specific factor error, however. It fails to account for

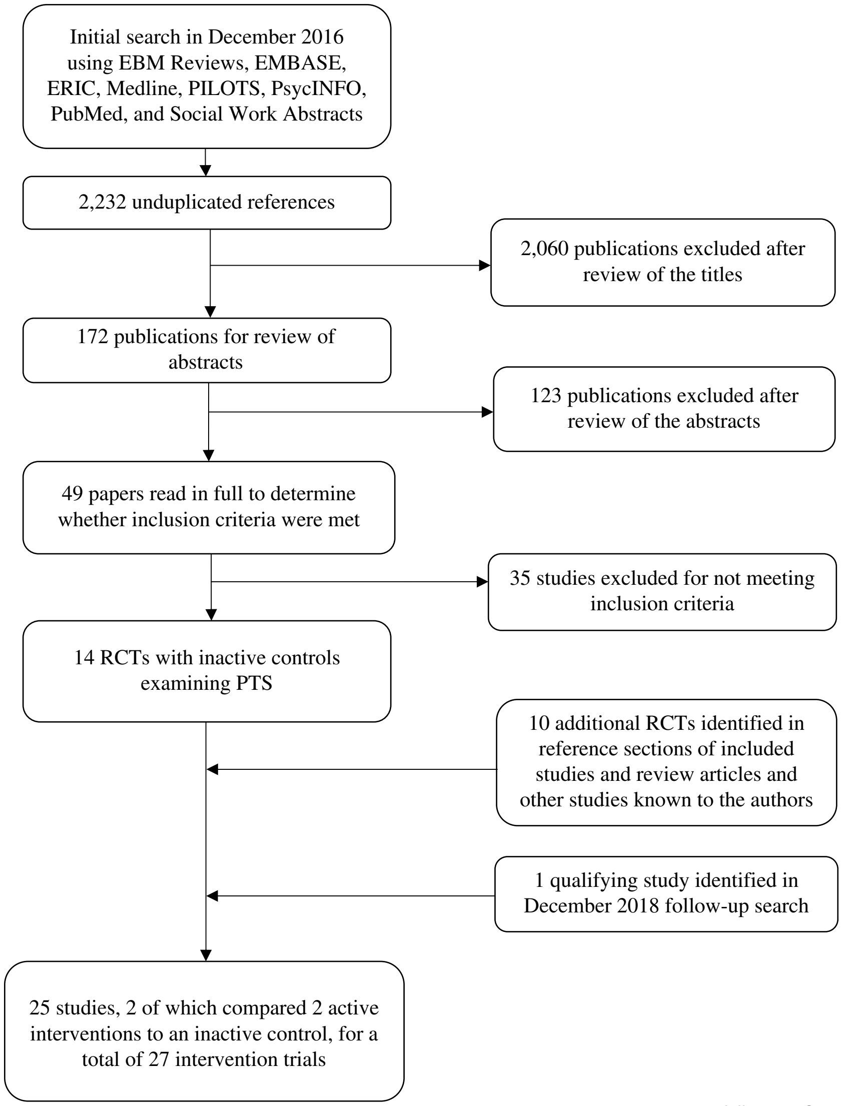

Figure 1. Flowchart of Literature Search.
Abbreviations: PTS, posttraumatic stress; RCT, randomized controlled trial.

transient error. Therefore, 0.04 was subtracted from each of the values of the reported Cronbach's alpha statistics as recommended by Schmidt and Hunter.[59] When reliability was not reported,[49] the average of the reported reliability statistics was used.

For each model, residual diagnostics was performed to identify outliers and influential points. A Baujat plot was also used to visualize the influence of each study on the overall effect and contribution to the overall heterogeneity.[60] Sensitivity analyses through removal of identified outliers and studies with a relatively high influence on the summary effect size were also conducted.

Association between Intervention Effects on PTS and on Functional Impairment—In addition to PTS, functional impairment was assessed in 13 of the 27 intervention trials included in this review. The estimates of the intervention effects on functional impairment in each of these trials were computed. The association between the intervention effects on PTS and on functional impairment was then estimated with the Spearman's correlation coefficient.

Interpretation of the Results: Number Needed to Treat (NNT) Analysis—The number needed to treat (NNT), an aggregate measure of clinical benefit, was derived from the overall estimated effect size and its 80% PI using a method proposed by Furukawa and Leucht.[61] The prevalence of PTSD in the aftermath of mass trauma when no intervention has been implemented (ie, the control event rate, or CER) was set at 15.9% based on a meta-analysis of studies that assessed PTSD rates using well-recognized diagnostic interviews to examine Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)[62] PTSD criteria in children and adolescents.[8]

Assessment of the Methodological Quality of the Included Studies—Six methodological features were rated: random allocation sequence, knowledge of intervention affecting the selection of study participants, deviation from the intended intervention, management of missing outcome data, blinding of outcome assessors, and selective reporting of results.

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Study	Event Type	Income Level of Country of Study	Population	Sample Size Age Grade
Barron, et al (2016)[35]	PV	Palestine Middle-Income	T	N = 154 11-15 years; high school
Berger & Gelkopf (2009)[36]	ND	Sri Lanka Middle-Income	NT	N = 166 9-14 years
Berger, et al (2007)[37]	PV	Israel High-Income	NT	N = 142 Grades 2- 6
Berger, et al (2012)[38]	PV	Israel High-Income	NT	N = 154 11-13 years
Betancourt, et al (2014)[31]	PV	Sierra Leone Low-Income	T	N = 436 15-24 years
Chemtob, et al (2002)[39]	ND	United States High-Income	T	N = 32 6-12 years
Chen, et al (2014)[33]	ND	China Middle-Income	T	N = 32 Mean Age 14.5 (SD = 6 .71)
Ertl, et al (2011)[34]	PV	Northern Uganda Low-Income	T	N = 78 12-25 years
Gelkopf & Berger (2009)[40]	PV	Israel High-Income	NT	N = 107 12-14.5 years
Gordon, et al (2008)[41]	PV	Kosovo Middle-Income	T	N = 77 14-18 years
Hermenau, et al (2013)[42]	PV	DRC Low-Income	T	N = 30 16-25 years
Jordans, et al (2010)[43]	PV	Nepal Low-Income	T	N = 325 11-14 years
Lesmana, et al (2009)[44]	PV	Indonesia Low-Income	T	N = 226 6-12 years
Mahmoudi-Ghareai, et al (2009)[45]	ND	Iran Middle-Income	T	N = 85 11-18 years
McMullen, et al (2013)[46]	PV	DRC Low-Income	T	N = 48 13-17 years
O'Callaghan, et al (2013)[47]	PV	DRC Low-Income	T	N = 52 12-17 years
O'Callaghan, et al (2014)[48]	PV	DRC Low-Income	NT	N = 159 7-18 years
Ooi, et al (2016)[49]	PV	Australia High-Income	NT[a]	N = 82 10-17 years
Panter-Brick, et al (2018)[32]	PV	Jordan Middle-Income	T	N = 603 12-18 years
Pityaratstian, et al (2015)[50]	ND	Thailand Middle-Income	T	N = 36 10-15 years
Qouta, et al (2012)[51]	PV	Gaza Middle-Income	NT	N = 482 10-13 years
Ruf, et al (2010)[52]	PV	Germany High-Income	T	N = 25 7-16 years
Tol, et al (2008)[53]	PV	Indonesia Middle-Income	T	N = 403 7-15 years
Tol, et al (2012)[54]	PV	Sri Lanka Middle-Income	T	N = 399 9-12 years
Tol, et al (2014)[55]	PV	Burundi Low-Income	T	N = 329 8-17 years

Table 1. Study Characteristics of Trials Included in the Current Meta-Analysis
Note: Event Type refers to natural disaster (ND) and political violence (PV); Population refers to targeted (T) and non-targeted (NT) samples. DRC = Democratic Republic of the Congo.

[a] Because the study excluded participants with clinical levels of posttraumatic stress disorder, the population was classified as non-targeted to allow for clearer comparison with other studies.

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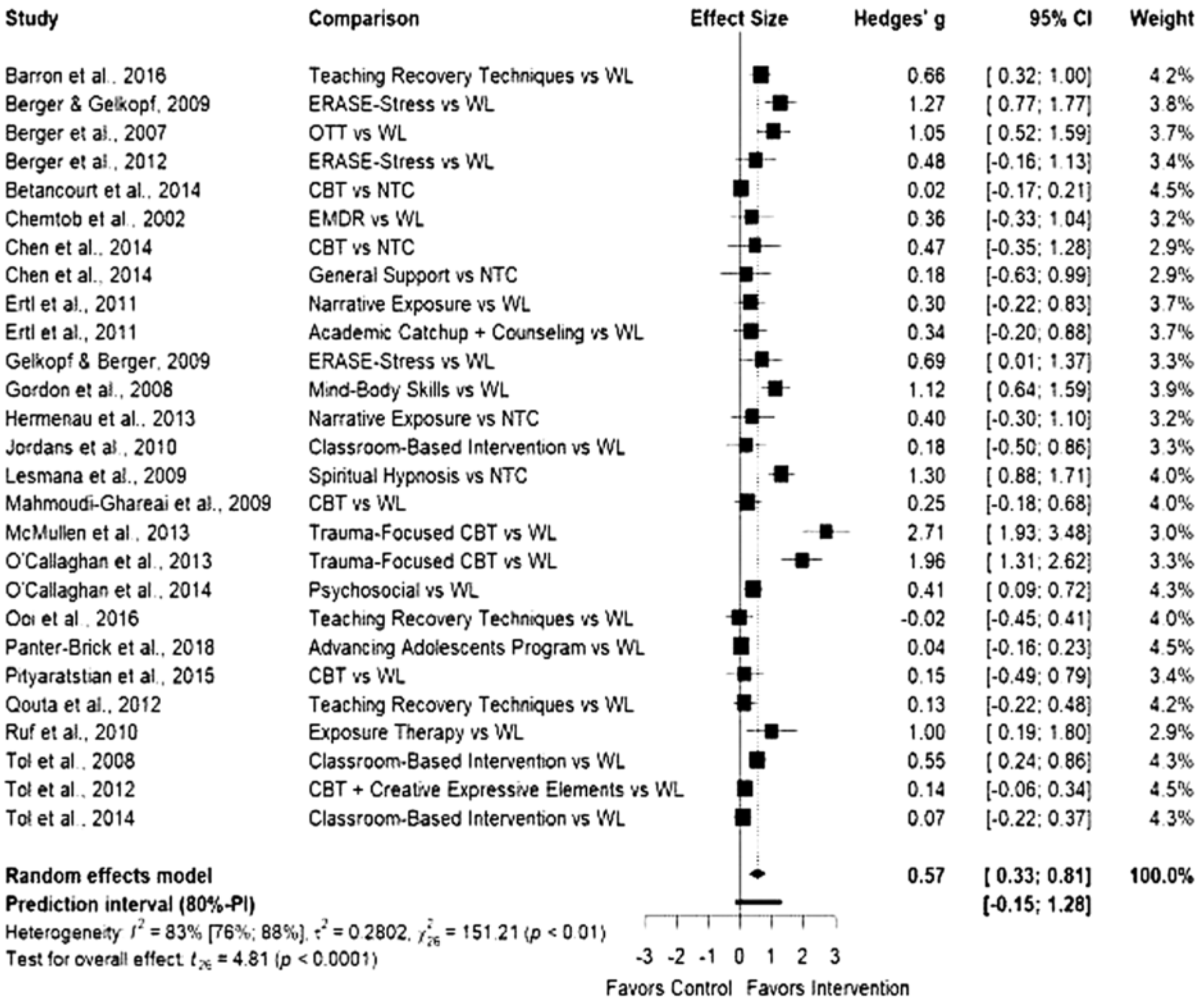

Figure 2. Forest Plot of Intervention Effects Relative to Inactive Controls.
Abbreviations: CBT, Cognitive Behavioral Therapy; EMDR, Eye Movement Desensitization and Reprocessing therapy; ERASE Stress, Enhancing Resiliency among Students Experiencing Stress; NTC, non-treatment control; OTT, Overshadowing the Threat of Terrorism; WL, waitlist.

Assessment of Publication Bias—Publication bias was assessed by visually inspecting funnel plots and by performing the Egger's regression test for funnel plot asymmetry.[63] The trim and fill analysis[64] was conducted to assess the impact of any potential publication bias.

Statistical Software—The following R packages (R Foundation for Statistical Computing; Vienna, Austria) were used for the analysis: (1) *compute.es*[65] to compute the effect sizes; and (2) *metafor*[66] and *meta*[67] to fit the random effects and mixed effects models of the meta-analysis, perform the residuals and case-deletion diagnostics, and assess publication bias through funnel plots. The attenuation correction was performed with software designed by Schmidt and Hunter.[59]

Report: Results of the Analysis

A total of 27 trials (N = 4,662 participants) from 25 studies were selected for the meta-analysis. Of the 25 studies, 19 were implemented following political violence and six were implemented after a natural disaster. With the one-level random effects model, the overall effect size of the 27 intervention trials on PTS was 0.57 (95% CI = [0.33; 0.81]; $P < .0001$; 80% PI = [−0.15; 1.28]; Figure 2). These results were similar to the findings obtained with the multi-level random effects model and disattenuation correction method (Table 2). The proportion of variation in effect sizes that is due to heterogeneity between studies rather than sampling error (I^2) in the one-level model was high (83%; 95% CI = [76%; 88%]).

Residual diagnostics identified two outliers: the studies conducted by McMullen and colleagues[46] (rstudent = 3.83; Cook's d = 0.40; *dfbeta* = 0.80) and by O'Callaghan and colleagues[47] (rstudent = 2.47; Cook's d = 0.21; *dfbeta* = 0.50). After removing these two outliers, the overall effect size in a one-level random effects model was 0.44 (95% CI = [0.27; 0.61]; $P < .0001$; 80% PI = [−0.02; 0.90]). The Baujat plot identified eight studies[31,32,36,41,44,46,47,54] as having a large influence on the summary effect and/or a large contribution to the overall heterogeneity (Figure 3). A random effects meta-analysis without these eight studies yielded a summary effect of 0.37 (95% CI = [0.24; 0.51]; $P < .0001$; 80% PI = [0.15; 0.60]) with reduced heterogeneity

One-Level Model	Multi-Level Model with Research Teams as Clusters	Schmidt-Hunter[40] Method Correcting for Instrument Reliability
$g = 0.57$ 95% CI = (0.33; 0.81); $P < .0001$ 80% PI = (−0.15; 1.28) Q($df = 26$) = 151.21; $P < .0001$ $Tau^2 = 0.28$ (0.15; 0.66) $I^2 = 83\%$ (76% ; 88%)	$g = 0.53$ 95% CI = (0.28; 0.78); $P < .0001$ 80% PI = (−0.16; 1.22) Q($df = 26$) = 151.22; $P < .0001$ σ^2(cluster) = 0.10 (0.00; 0.40) σ^2(cluster/study) = 0.17 (0.06; 0.45)	Delta = 0.49 (SD = 0.58) 95% CI = (0.25; 0.73) 80% CRI = (−0.25; 1.23) % Artifact = 15.0%
Moderator Analysis		
Traumatic Event	Political Violence	$k = 21$ $g = 0.60$ 95% CI = (0.30; 0.90); $P = .0005$ 80% PI = (−0.19; 1.40) Q = 137.19; $df = 20$; $P < .0001$ $I^2 = 91\%$ (84% ; 96%)
	Natural Disaster	$k = 6$ $g = 0.47$ 95% CI = (0.001; 0.94); $P = .0498$ 80% PI = (−0.13; 1.07) Q = 12.27; $df = 5$; $P = .0313$ $I^2 = 58\%$ (0% ; 91%)
	Difference	0.13; 95% CI = (−0.48; 0.75); $P = .6559$
Population	Targeted	$k = 20$ $g = 0.58$ 95% CI = (0.26; 0.89); $P = .0011$ 80% PI = (−0.23; 1.38) Q = 125.34; $df = 19$; $P < .0001$ $I^2 = 90\%$ (83% ; 96%)
	Non-Targeted	$k = 7$ $g = 0.55$ 95% CI = (0.11; 0.99); $P = .0225$ 80% PI = (−0.10; 1.19) Q = 23.50; $df = 6$; $P = .0006$ $I^2 = 76\%$ (39% ; 95%)
	Difference	−0.02; 95% CI = (−0.58; 0.55); $P = .9516$
Country Income Level	High	$k = 6$ $g = 0.56$ 95% CI = (0.11; 1.01); $P = .0247$ 80% PI = (0.00; 1.12) Q = 11.70; $df = 5$; $P = .0392$ $I^2 = 55\%$ (0% ; 91%)
	Middle	$k = 11$ $g = 0.44$ 95% CI = (0.16; 0.72); $P = .0059$ 80% PI = (−0.08; 0.95) Q = 43.16; $df = 10$; P < .0001 $I^2 = 80\%$ (53% ; 94%)

Table 2. Overall Meta-Analysis Findings and Moderator Analysis of Intervention Effects on PTS *(continued)*

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One-Level Model	Multi-Level Model with Research Teams as Clusters	Schmidt-Hunter[40] Method Correcting for Instrument Reliability
	Low	$k = 10$ $g = 0.74$ 95% CI = (0.10; 1.37); $P = .0279$ 80% PI = (−0.47; 1.94) Q = 94.16; $df = 9$; $P < .0001$ $I^2 = 94\%$ (87% ; 98%)
	Difference (High - Low)	−0.15; 95% CI = (−0.99; 0.70); $P = .7175$
	Difference (Middle - Low)	−0.27; 95% CI = (−0.88; 0.35); $P = .3737$

Table 2. *(continued).* Overall Meta-Analysis Findings and Moderator Analysis of Intervention Effects on PTS
Note:% Artifact = proportion of variance accounted for by the measurement artifacts; CI = confidence interval; CRI = credibility interval of delta; Delta = mean true effect size; g = summary intervention effect size (Hedge's g); I^2 = the proportion of variation in correlation estimates that is due to heterogeneity between studies rather than sampling error; k = number of studies; PI = prediction interval; Q = the total amount of dispersion among effect sizes; Tau^2 = estimated amount of total heterogeneity.

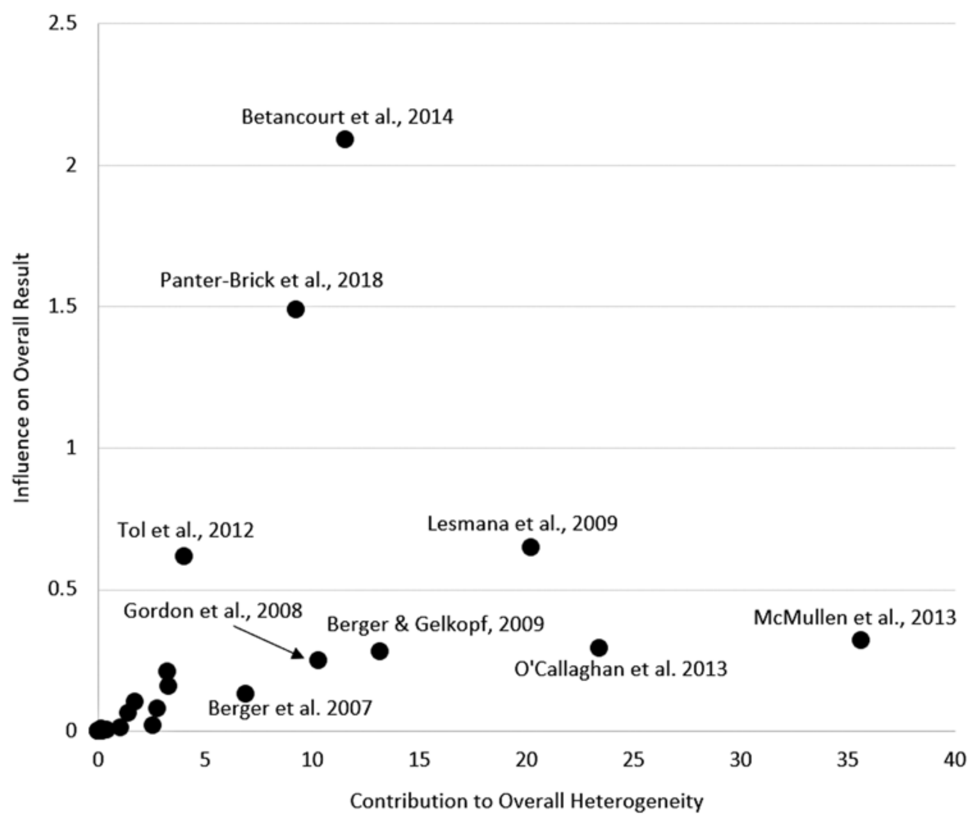

Figure 3. Baujat Plot Visualizing the Contribution of Individual Studies to the Summary Effect and Overall Heterogeneity.

among intervention effect sizes (Q = 23.90; $df = 18$; $P = .1584$; $I^2 = 30\%$ with 95% CI = [0% ; 64%]).

The moderator analysis using mixed effects models failed to find any statistically significant difference in effect sizes across the categories of the tested moderators (Table 2). The intervention effects on PTS and on functional impairment were highly positively correlated (Spearman's $r = 0.90$; 95% CI = [0.66; 0.97]; $P < .0001$]; Figure 4).

Interpretation of the Results: NNT

The overall estimate of the intervention effect was 0.57, with an 80% PI of (-0.15; 1.28). For a CER of 15.9%, the average NNT is 5.71, indicating that 17.5% of youth receiving the intervention will have a favorable outcome compared to their counterparts not receiving the intervention. For the 80% PI upper bound of 1.28, the NNT is 2.21 (ie, 45.2% of youth receiving the intervention will have a better outcome than those not receiving

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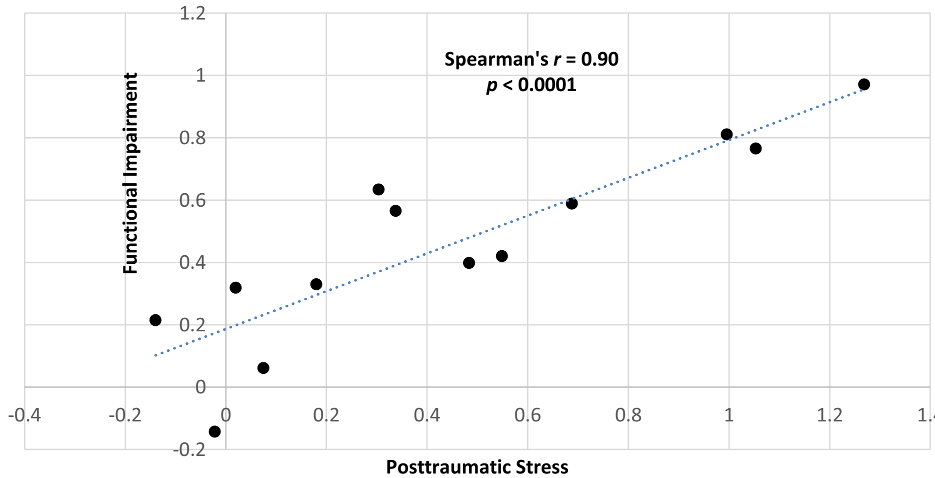

Figure 4. Scatterplot Depicting Relationship between Intervention Effect Size on Posttraumatic Stress and on Functional Impairment ($k = 13$).

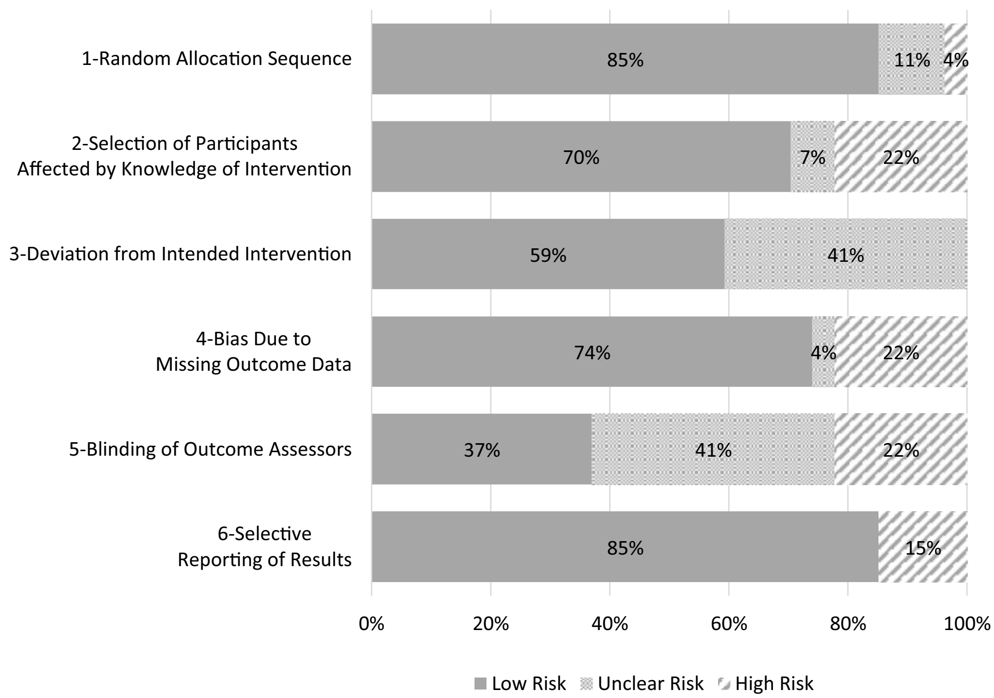

Figure 5. Ratings for Risk of Bias in Included Studies.

the intervention). The 80% PI lower bound of -0.15 translates into a harmful effect of the intervention (Number Needed to Harm) of 25.60. In other words, four out of 100 youth receiving the intervention will have an unfavorable outcome compared to those not receiving the intervention.

Risk of Bias in the Included Studies

Three key sources of bias were identified in the selected studies. Influence of knowledge of intervention assignment in the selection of study participants, management of missing outcome data, and blinding status of assessors to participant group assignment emerged as the three most frequent potential sources of bias (Figure 5). Knowledge of intervention assignment may have influenced participant selection in cases where these participants were recruited after randomization had occurred (eg, in the cluster-randomized trials). Nonetheless, the average intervention effect sizes in cluster-randomized trials ($k = 10$; Hedge's $g = 0.42$ with 95% CI = [0.11; 0.74]; $P = .0133$) and in individual-based randomized studies ($k = 17$; Hedge's $g = 0.67$ with 95% CI = [0.29; 1.02]; $P = .0015$) were not statistically different (difference = 0.21; $P = .3933$). The risk of bias due to deviation from the intended intervention was unclear due to lack of information provided in the reports of some of the included studies.

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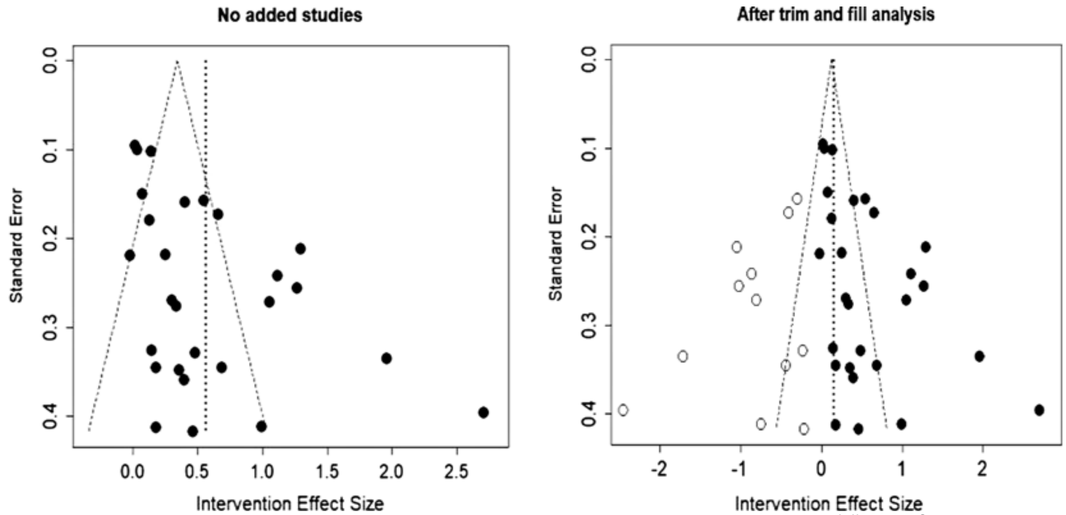

Figure 6. Assessment of Publication Bias with Funnel Plot and With Trim and Fill Analysis.
Note: Filled circles: observed findings; open circles: imputed and added studies after trim and fill analysis. Egger's regression test: $t = 3.54$, $df = 25$, $P = .0016$. Trim-and-fill analysis with L_0 estimator: 12 studies added on the left side, yielding a summary effect size of 0.15, with 95 % CI = (-0.14; 0.45); $P = .3061$). No study added on the right side.

Assessment of Publication Bias and Robustness of the Findings

The funnel plot of the standard errors of intervention effect sizes on the corresponding effect sizes was asymmetric. This asymmetry suggests a publication bias, high heterogeneity among studies, and/or the presence of outliers as identified by the residuals diagnostics (Figure 6).

Discussion

The finding of a medium intervention effect on PTS in RCTs comparing interventions to inactive controls supports the use of psychological and behavioral interventions for youth exposed to mass trauma. Judging from the predictive interval of the summary effect, however, an intervention may perform worse than natural recovery in some cases. Ertl and Neuner[68] described a deterioration effect with some participants benefiting from the intervention and others doing worse. The deleterious effect of the intervention on some of the study participants may not be apparent when examining the average effect of the intervention. Although sub-group analyses of intervention effect can help identify specific groups of individuals for whom the intervention may or may not be effective, they usually require large study sample sizes. Thus, the risk of harm should be addressed systematically in future intervention studies.

Intervention effects were statistically significant across all categories of moderators examined in the current analysis, indicating that interventions were effective in the context of both political violence and natural disasters, when delivered to targeted or non-targeted populations, and regardless of the country income level where the interventions were delivered. Only one prior meta-analysis has examined the moderating effect of the type of trauma,[12] and this is the first meta-analysis to examine the populations receiving the intervention and the economic resources of the country where the interventions were delivered. The use of participants' event exposures, experiences, and reactions to distinguish intervention populations is likely more precise in reflecting the clinical status and needs of the youth receiving the interventions than are the intervention setting (eg, mental health clinic or school) and provider training used in moderator analyses in other meta-analytic research.[12,15] Besides trauma exposure itself, deficiencies in the social ecology and stressful social conditions (eg, poverty, displacement, unstable and violent living conditions, malnutrition, or disrupted social networks) are a major source of maladaptation for residents in conflict-ridden regions.[69] Prior meta-analyses have examined the continent[12] and region[16] where interventions were delivered but have not specified their findings in terms of available regional resources, despite the fact that all interventions studied by Purgato and colleagues[16] were delivered in low-resource environments.

The estimates of the intervention effects on PTS and on functional impairment were strongly positively correlated. Future studies are needed to clarify this relationship, but this finding suggests that the interventions were effective in addressing both PTS and functional impairment or that functioning improved as PTS decreased.

Interpretation of the Results: NNT

Recognizing that effect sizes computed as Cohen's *d* (or Hedge's *g*) from individual studies or from meta-analyses can be difficult to interpret, Furukawa and Leucht[61] proposed a technique for converting a Cohen's *d* estimate into a NNT, a statistic more familiar to clinicians. The current review provides summary effect sizes that can be used to compute the expected clinical benefit and potential harm of interventions for youth exposed to mass trauma. In the illustration of an application of this analysis, a meta-analysis of PTSD studies of trauma-exposed youth populations not seeking or receiving treatment was used to estimate a PTSD rate of 15.9% (95% CI = 11.5; 21.5).[8] Using this rate as the CER in the NNT analysis, the results indicate that 17.5% of youth would be expected to have a favorable outcome over and above those who improve through natural recovery while 4.0% of youth would be expected to have an unfavorable outcome relative to those who do not receive intervention. In making service decisions, PTSD rates for a specific population should be used as the CER, if available. For example, clinically-elevated PTS may be even higher in

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environments frequently exposed to political violence or natural disaster and in targeted over non-targeted populations; use of these rates would change the NNT outcome. Clinicians and relief agents can perform similar computations with the prevalence of PTSD in their intervention population to predict the potential benefit or harm of an intervention.

Methodological Strength of the Included Studies

The risk of bias analysis revealed several areas of concern related to the studies examined. These included the selection of participants, missing outcome data, and blinding status of assessors. In trials that used a cluster-randomization scheme ($k = 10$),[36-38,40,43,49,51,53-55] the recruitment of individual participants after the randomization may have introduced a selection bias and created an imbalance between groups at baseline. Knowledge of participants' intervention condition before inclusion may have led to differential efforts from the research team in recruiting and enrolling individuals in the trial. Additionally, knowing the intervention arm assignment may have influenced youth or parent consent for inclusion in the trial. The other areas of concern among the included studies involved missing outcome data due to attrition of participants[33(both trials),41,42,49,55] and failure to use blinded assessors.[43,44,50,53,55] Finally, the risk of bias due to deviation from the intended intervention was unclear due to lack of information provided in the reports of some of the included studies.

Limitations

A number of potential moderators were not explored in the current meta-analysis because of inconsistencies in descriptions (eg, therapeutic approach or provider training) or difficulty in accurate measurement (eg, casualty rates, time since event, or duration of conflict). The failure to find moderators to explain the heterogeneity in the reported effect sizes may have been due to a lack of sufficient statistical power to detect a significant association. Future studies may benefit from examining other contextual variables measuring available resources, social support, and sociocultural influences. Finally, a larger sample of studies would have allowed the assessment of potential interaction effects among these moderators through sub-grouping (eg, political violence versus natural disasters in low-income countries).

Conclusion

The current review and meta-analysis provide additional evidence that interventions can alleviate PTS and enhance psychosocial functioning in targeted and non-targeted youth populations exposed to political violence and natural disasters regardless of country income level. Altogether, these findings confirm the benefit of PTS interventions world-wide, despite resource limitations in low-middle income countries. The positive association between the effects of the interventions on PTS and functional impairment suggests that interventions confer a concomitant improvement in symptoms and functioning. Hence these interventions, while reducing youth stress symptoms, may enhance their daily functioning. More research is also needed to examine the cost-effectiveness of interventions and to generate models to guide service providers and organizations in service decision making for both targeted and non-targeted populations and in low-, middle-, and high-income countries.

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