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REVIEW ARTICLE

The Efficacy of Multi-component Positive Psychology Interventions: A Systematic Review and Meta-analysis of Randomized Controlled Trials

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Abstract
Recently, we see a sharp increase in the number of multi-component positive psychology interventions (MPPIs). The aim of the current study is to examine the efficacy of MPPIs, through a systematic review and meta-analysis. We included 50 randomized controlled trials that were published in 51 articles between 1998 and August 2018. We found standardized mean differences of Hedges' $g = 0.34$ for subjective well-being, Hedges' $g = 0.39$ for psychological well-being, indicating small to moderate effects, and Hedges' $g = 0.29$ for depression, and Hedges' $g = 0.35$ for anxiety and stress, indicating small effects. Removing outliers led to a considerable decrease in effect sizes for subjective well-being and depression, a slight decrease for psychological well-being, and a strong increase in the effect size for stress. Removing low quality studies led to a considerable decrease in the effect sizes for subjective well-being, psychological well-being, and depression, and a slight decrease for anxiety, but a strong increase for stress. Moderator analyses only showed a significant effect for study quality, showing larger effect sizes for low quality studies compared to studies of moderate and high quality. In addition, a larger effect size for anxiety was found in studies from non-Western countries compared to studies from Western countries. In sum, this systematic review and meta-analysis found evidence for the efficacy of MPPIs in improving mental health. We conclude that MPPIs have a small effect on subjective well-being and depression, and a small to moderate effect on psychological well-being. In addition, they may have a small to moderate effect on anxiety and a moderate effect on stress, but definite conclusions of the effects of MPPIs on these outcomes cannot me made due to the limited number of studies. Further well-conducted research among diverse populations is necessary to strengthen claims on the efficacy of MPPIs.

Keywords Positive psychology · Well-being · Positive mental health · Multicomponent · Randomized controlled trials · Meta-analysis

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1 Introduction

The positive psychology movement intended to redirect the course of psychological research: away from a focus on pathology, diseases and deficits, and towards the study of human strengths, flourishing and the optimal functioning of individuals, groups, and institutions (Gable and Haidt 2005; Seligman and Csikszentmihalyi 2000; Sheldon and King 2001). Since its inauguration in 1998, the movement has made a considerable impact on the scientific community, with an exponential growth of publications (Donaldson et al. 2015; Hart and Sasso 2011; Hendriks et al. 2018b; Kim et al. 2018; Rusk and Waters 2013). Positive psychology builds on the ideas of humanistic psychology, but employs state-of the art-research methods to ensure scientific rigor (Froh 2004; Sheldon and Kasser 2001). Studies that investigate the efficacy of so-called positive psychology interventions (PPIs), are a cornerstone of psychological inquiry.

There has been much discussion on the definition of PPIs. A broad definition was introduced by Sin and Lyubomirsky (2009), who defined PPIs as all interventions that aim at increasing positive feelings, behaviors, and cognitions. Narrower definitions were suggested by Bolier et al. (2013b), who added that these interventions 'should have been explicitly developed in line with the theoretical tradition of positive psychology' (Bolier et al. (2013b) and Parks and Biswas-Diener (2013), who suggested that an intervention can only be regarded as a PPI if sufficient empirical evidence exists suggesting significant effects for the intervention (Parks and Biswas-Diener 2013). Schueller and Parks (2014) argued that in addition to the (positive) aim of an intervention, the pathways through which the interventions operate is a second essential component when deciding if an intervention can be considered as a PPI. Building on these suggestions, we define positive psychology interventions as interventions aiming at increasing positive feelings, behaviors, and cognitions, while also using theoretically and empirically based pathways or strategies to increase well-being.

To date, two meta-analyses have been published that examined the overall efficacy of PPIs. The first meta-analysis included 51 controlled studies and found large effects for enhanced well-being ($r=0.29$, $d\cong0.61$) and depressive symptoms ($r=0.31$, $d\cong0.65$) (Sin and Lyubomirsky 2009). The second meta-analysis included 39 randomized controlled trials (RCTs) (Bolier et al. (2013a, b) and reported small effect sizes ($d=0.34$) for subjective well-being, psychological well-being ($d=0.20$), and depression ($d=0.20$). Bolier et al. (2013a, b) argued that the effect sizes in the meta-analysis by Sin and Lyubomirsky might be overestimated, due to the application of less stricter inclusion criteria, for example by including non-randomized controlled trials and studies in the field of mindfulness and life review therapy.

1.1 Multi-component Positive Psychology Interventions (MPPIs)

A differentiation can be made between single component intervention studies and multi-component intervention studies. Single component intervention studies usually consist of one or more positive psychology activities targeting one component of well-being. For example, studies on the effects of gratitude interventions (DeSteno et al. 2015; Digdon and Koble 2011; Isik and Erguner-Tekinalp 2017; Lau and Cheng 2011), engaging in acts of kindness (Alden and Trew 2013; Buchanan and Bardi 2010; O'Connell et al. 2016), and strengths-based interventions (Proyer et al. 2015; Toback et al. 2016). MPPIs may

be considered as interventions that contain a variety of evidence-based individual exercises and targeting two or more theoretically relevant hedonic and eudaimonic well-being components, that are conducted within an integral program. Examples of theoretical components are the components of the PERMA-model (i.e. positive emotions, engagement, relationships, meaning, and accomplishment) by Seligman (2018), and the components of the Synergetic Change Model (i.e. emotions, goals and habits, virtues and relationships, comprehension and coping, attention and awareness), which was developed by Rusk et al. (2018).

1.2 Present Study

Over the years, there is a growing body of research on the efficacy of MPPIs. The primary aim of this meta-analysis is to examine the efficacy of MPPIs on well-being and distress in both the general public and in clinical populations. MPPIs contain a wide variety of positive activities that target different domains of mental well-being. Consequently, we expect that MPPIs have larger effects than have been found in prior meta-analyses of mainly single component interventions, both at post-treatment and at follow-up measurements. The secondary aims were to identify moderators that may influence the relation between the intervention and the outcomes, determine the quality of the studies, and examine potential publication bias.

2 Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews and meta-analyses (Moher et al. 2010) and the recommendations of the Cochrane Back Review group (Higgins et al. 2011) were followed in the planning and the implementation of the meta-analysis.

2.1 Search Strategy

A systematic literature search was conducted in the following three databases: PubMed, PsycINFO and Scopus, from 1998 to August 2018. The last run was conducted on the 31st of July 2018. The search was conducted by the first and third author. The databases were searched with the following terms: positive psychology, well-being, happiness, happy, flourishing, life satisfaction, satisfaction with, optimism, gratitude, strengths, forgiveness, compassion and random. The search strings were adapted to the according database (see the "Appendix 1"). Additionally, reference lists of four meta-analyses (Bolier et al. 2013a, b; Chakhssi et al. 2018; Dickens 2017; Sin and Lyubomirsky 2009) and six review articles on PPIs (Casellas-Grau et al. 2014; Macaskill 2016; Rashid 2015; Sutipan et al. 2016; Walsh et al. 2017; Woodworth et al. 2016) were checked. Several experts in the field of positive psychology also suggested additional studies.

2.2 Selection of Studies

After removal of duplicates, titles and abstracts were screened by two reviewers (first and second author). Full texts of potentially relevant articles were assessed. Studies were

included based on the following criteria: (1) studies were RCTs; (2) studies were administered to adults in clinical and non-clinical populations; (3) interventions were comprised of at least two positive activities and two modules that were explicitly based on strategies aiming at hedonic and eudaimonic well-being components and conducted within an integral program; (4) studies were published in peer reviewed journals; (5) studies used outcome measures to examine the effects on subjective and psychological well-being, depression, anxiety, and stress. Excluded were: (1) cluster randomized controlled trials; (2) interventions that were primarily focused on one component such as mindfulness-based therapies, Acceptance and Commitment therapy, loving kindness meditation, forgiveness therapy, compassion focused therapy, hope therapy, and self-management; (3) studies that did not provide sufficient data to calculate post-treatment effect sizes per condition and the corresponding author was unable to provide the necessary data upon request; (4) studies that were published in book chapters, dissertations, and studies in grey literature; (5) articles that were not published in English.

2.3 Data Extraction

The first author performed the data extraction, which was then verified by the second author. Any disagreements were resolved by consensus and through consultation with the last author. The following data was gathered: authors, year of publication, country of origin, condition of participants (clinical or non-clinical), intervention type (PPI or PPI plus other intervention type), delivery form (group-based, individual therapy or self-help), description of control group (active or non-active), number of sessions, duration of session period, follow-up assessment, number or participants per condition at post-test level, mean age and standard deviation of participants, percentage of female participants, retention rate at post-test level per condition, type of outcome and used questionnaires. Self-help refers to interventions through self-help books or instructions by email, and web-based self-help applications. Individual therapy refers to an intervention that was delivered by therapists during face-to-face sessions. Following Gosling et al. (2010), we classified North America, Western Europe, Israel, Australia, and New Zealand as Western-countries, other countries were classified as non-Western. For the meta-analyses, we extracted means and standard deviations at post-test. In case of insufficient data or unclear reporting, we contacted the authors through e-mail. In total, fifteen authors were contacted, of which eight provided sufficient additional data to be able to include the study in our analysis.

2.4 Quality Assessment

The first and third author independently assessed the quality of each study using the Cochrane Collaboration's tool for assessing risk of bias in RCTs (Higgins et al. 2011) with six criteria: (1) sequence generation: was there a detailed description of method that was used to generate the allocation sequences (e.g. referring to random numbers, using a computer with random number generator, coin tossing, drawing of lots); (2) allocation concealment: could the processes of enrolling of participants not be foreseen by participants or investigators, for example through the use of numbered, opaque, sealed envelopes or central allocation (web-based applications); (3) were outcome measures blinded, administered by an independent person or via online assessment; (4) was there a description of the withdrawals/drop-outs; (5) was a power analysis carried out or was the group size per condition larger than 50; (6) was an intention-to-treat analysis conducted, or were there

zero drop-outs. One point was appointed for each criterion met. The quality of a study was assessed as 'high' when a minimum of five criteria were met, 'moderate' when three to four criteria were met, and 'low' when less than three criteria were met. Consensus between the two reviewers was reached through discussion.

2.5 Statistical Analyses

Data analyses were performed with the program Comprehensive Meta-Analysis (CMA, version 3.3.070). We used the means, standard deviations, and sample sizes for each study, to calculate the effect size using dichotomous outcomes. For each comparison between a PPI and a control group, Hedges' *g* effect sizes were calculated to assess the between-group differences at post-test. These effect sizes were calculated by subtracting the average score of the PPI group from the average score of the comparison group (both at post-test) and dividing the result by the pooled standard deviations obtained from the two groups. We used Hedges' *g* because this effect size measure is more accurate than Cohen's *d* when study sample sizes of the studies are small (Cuijpers 2016), which is the case in more than half of the studies we included. Similarly to Cohen's *d,* Hedges' *g* effect sizes of 0–0.32 can be considered as small, effect sizes of 0.33–0.55 as moderate, and effect sizes of 0.56–1.2 as large (Lipsey and Wilson 1993). In the calculation of effect sizes for depression, stress, and anxiety we used the scores on instruments that explicitly measured these outcomes. For subjective and psychological well-being, we also used scores from instruments related to these constructs of well-being. See "Appendix 1" for detailed information on the used instruments per outcome. If more than one measure was used for a particular outcome in one study, the pooled effect size was calculated. Thus, each study provided only one effect size for all outcomes. When available, we computed between-group effect sizes (Hedges' *g*) for follow-up differences. Follow-up effects were calculated if there was a minimum of five studies per outcome.

Due to the diverse populations, we expected considerable heterogeneity. Therefore, we performed the meta-analysis using a random effects model, with a 95% confidence interval and using a two-tailed test. Separate meta-analyses were performed for subjective well-being, psychological well-being, depression, anxiety, and stress. Forest plots of post between-group effect sizes were produced for each outcome variable, both with and without outliers. We considered a study as an outlier when its 95% confidence interval (CI) was outside the 95% CI of the overall mean effect size (on either side). We tested for statistical heterogeneity between studies using the I^2 statistics, a measure of how much variance between studies can be attributed to differences between studies, beyond the expected chance (Higgins and Green 2011). We used the I^2 statistic to estimate the percentage of heterogeneity across the studies not attributable to random sample error alone. A value of 0% indicated no heterogeneity. Values of 25, 50, and 75% reflected low, moderate, and high degrees of heterogeneity, respectively (Higgins and Thompson 2002). Significant heterogeneity was indicated by a significant Q-statistic ($p < 0.05$), meaning that one or more variables were present that moderated the observed effect size.

Exploratory subgroup analyses were conducted to examine the moderating effects of the following variables: (1) population types: clinical and non-clinical; (2) intervention: MPPI and MPPI combined with another therapy form; (3) delivery mode: group intervention, individual therapy, and self-help; (4) control group: active and non-active controls; (5) number of sessions: eight or less, more than eight; (6) duration of program: 8 weeks or

less, more than 8 weeks; (7) quality rating: low quality (score of 0, 1, 2), moderate quality (score of 3, 4), high quality (score of 5, 6); (8) region: Western or non-Western.

We assessed publication bias in the following ways. First, we created a funnel plot by plotting the overall mean effect size against study size. Absence of publication bias is present when there is a symmetric distribution of studies around the effect size, while a higher concentration of studies on one side of the effect size than on the other indicates publication bias (Sterne et al. 2008). Second, we calculated a fail-safe N, a formal test of funnel plot asymmetry, for each analysis. This fail-safe N indicates the number of unpublished non-significant studies that would be required to lower the overall effect size below significance (Egger et al. 1997; Orwin 1983). Findings were considered robust if the fail-safe $N \geq 5k + 10$, where k is the number of studies (Rosenberg 2005). Third, we used the trim- and-fill method (Duval and Tweedie 2000). This procedure imputes the effect sizes of missing studies and produces an adjusted effect size accounting for the missing studies.

3 Results

3.1 Study Selection

In total we found 8532 records: 2203 from PubMed, 4155 from PsycINFO, 19,610 from Scopus, 260 from searching reference lists and four studies were suggested by third parties. After removal of duplicates, 7662 records remained for screening. Of these, we discarded 7338 articles based on screening title and abstract that did not meet the inclusion criteria. We then assessed 324 full-text articles. Finally, 51 articles with a total of 50 studies met the inclusion criteria and were included in the meta-analysis. Results from one study was published in two articles (Asl et al. 2014, 2016), and two articles reported outcomes of two studies (Ivtzan et al. 2018; Seligman et al. 2006). Figure 1 displays the selection process in a flow diagram.

3.2 Study Characteristics

The studies included a total of 6141 participants at post measurement level. Sample sizes of the MPPI condition ranged from 8 to 450, with a median of 35. Twenty-four studies (48%) were conducted among clinical populations and 26 among non-clinical populations (52%). Delivery modes were group-based ($n = 28$, 43%), through self-help books/instructions by e-mail ($n = 19$, 41%) or online/web-based self-help applications ($n = 16$, 84%), and individual therapy ($n = 3$, 6%). Twenty-three control conditions (46%) were active control groups (placebo, $n = 8$, 16%; cognitive behavioral therapy, $n = 6$, 12%; treatment as usual, $n = 6$, 12%; mindfulness meditation, $n = 2$, 4% and dialectical behavioral therapy, $n = 1$, 2%). Twenty-seven control conditions (54%) were non-active control groups (wait-list, $n = 18$, 36%; no intervention, $n = 9$, 18%). The number of sessions varied between 1 and 28, with an average of 8.6 sessions (SD = 5.73). The duration of the MPPI varied between 1 day and 22 weeks, with an average of 8.1 weeks (SD = 3.88). Two studies did not report the duration period. Twenty-two (44%) studies reported follow-up effects. The mean age of the participants in the intervention groups ($n = 42$) was 39.7 years (SD = 13.07). The average retention rate was 74% for the MPPI groups ($n = 48$), and 79% for the control groups ($n = 48$). The average percentage of female participants in the intervention groups was 67% ($n = 44$). It should be noted that not all studies reported the exact age, retention rate

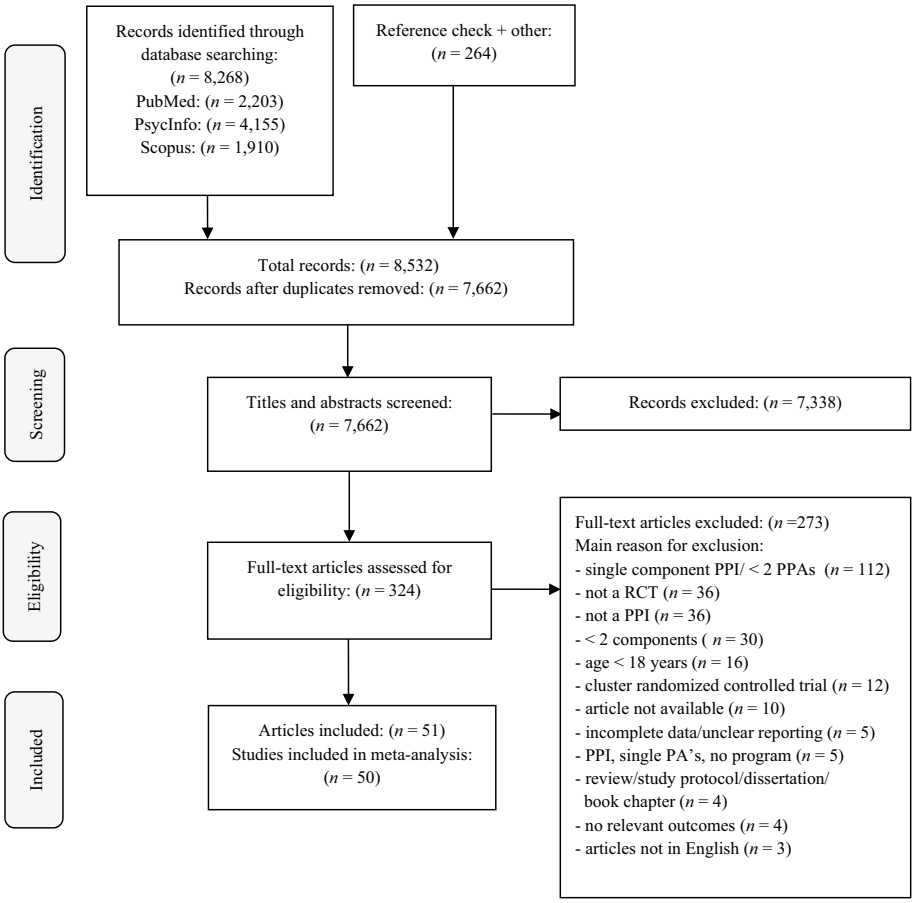

Fig. 1 Results of literature search and selection process

or number of female participants. The main characteristics of the studies are presented in Table 1.

3.3 Study Measures

Outcomes that were classified as subjective well-being included happiness, emotional and subjective well-being, satisfaction with life, positive affect, quality of life, and well-being. Outcomes that were classified as psychological well-being included flourishing, authentic living, personal growth, meaning, autonomy, (work) engagement, psychological capital, environmental well-being, positive relations, purpose in life, and self-acceptance. All studies included at least one measure of a particular outcome.

In total, we found 39 studies that measured subjective well-being, 24 studies measured psychological well-being, 31 studies measured depression, 11 studies measured anxiety, and eight studies measured stress. An overview of the questionnaires that were used to measure the outcomes is shown in "Appendix 3". Five studies included two measures for subjective well-being, which were pooled by the authors of the current meta-analysis

Table 1 Main study characteristics of included studies of the meta-analyses of multicomponent positive psychology interventions

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Antoine, 2018, France	Healthy adults	PPI	Self-help	NI	6, 6 weeks	–	Ne = 45 Nc = 94	37.0	69.5[b]	76% 63%	Dep: BDI, Anx: STAI
Asgharipoor, 2012, Iran	Patients with major depression	PPI	Group	CBT	6, 12 weeks	–	Ne = 9 Nc = 9	26.4 (5.9)	72	100% 100%	SWB: OHI; PWB: SWS pwb subscale Dep: BDI; Stress: SUDS
Asl, 2014, 2016, Iran	Infertile women	PPI	Group	Waitlist	6, 6 weeks	–	Ne = 18 Nc = 18	30.5 (5.7)	100	83% 89%	SWB: OHI Dep: BDI
Bolier, 2013b, the Netherlands	Mildly depressed adults	PPI	Self-help: online,	Waitlist	6, 9 weeks	4 months	Ne = 143 Nc = 141	43.5 (11.7)	80	66% 84%	SWB: MHC-SF ewb subscale, PWB: MHC-SF pwb subscale, Dep: CES-D, Anx: HADS-A
Cantarella, 2017, Italy	Elderly	PPI	Group	Placebo	6, 8 weeks	–	Ne = 16 Nc = 16	69.4 (6,6)	–	100%	SWB: WHO-QoL Brief, PWB: Ben-SSC
Carr, 2015, Ireland	Patients with major depression	PPI	Group	TAU	20, 20 weeks	3 months	Ne = 28 Nc = 29	41.0	66	70% 73%	Dep: BDI
Celano, 2017, USA	Patients with major depression	PPI	Self-help	CBT	6, 6 weeks	6 weeks	Ne = 29 Nc = 29	44.0 (10.0)	69	97% 94%	SWB: PANAS Dep: QIDS-SR
Cerezo, 2014, Spain	Women with breast cancer	PPI	Group	Waitlist	14, 14 weeks	–	Ne = 87 Nc = 88	50.0 (9.6)	100	86% 83.0%	SWB: SWLS

Table 1 (continued)

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Chaves, 2017, Spain	Women with major depression	PPI	Group	CBT	10, 10 weeks	–	Ne = 34 Nc = 39	51.6 (10.4)	100	72% 80%	SWB: SWLS: PWB: PWBS Dep: BDI; Anx: BAI
Cheung, 2017, USA	Women with breast cancer	PPI	Group	CBT	5, 5 weeks	1 months	Ne = 14 Nc = 13	53.4 (11.2)	100	71% 85%	SWB: DES Dep: CES-D
Cohn, 2014, USA	Adults with type 2 diabetes	PPI	Self-help: online	Placebo	8, 9 weeks	–	Ne = 25 Nc = 17	54 (median)	51	79%	SWB: PANAS Dep: CES-D; Stress: PSS
Cullen, 2016, UK	Adults with acquired brain injury (ABI)	PPI	Individual	TAU	8, 8 weeks	11 weeks	Ne = 10 Nc = 10	57 (median)	37	71% 71%	SWB: AHI Dep, Anx, Stress: DASS-21
Dowlatabadi, 2016, Iran	Women with breast cancer	PPI	Group	NI	10, 10 weeks	–	Ne = 17 Nc = 17	36.6 (5.5)	100	76% 81%	SWB: OHI Dep: BDI
Drozd, 2014a, Norway	Healthy adults	PPI	Self-help: online	Waitlist	13, 4 weeks	5 months	Ne = 108 Nc = 88	30.6 (8.4)	75	96% 94%	SWB: PANAS
Drozd, 2014b, Norway	HIV patients with depressive symptoms	PPI	Self-help: online	Waitlist	14, 5 weeks	–	Ne = 36 Nc = 31	48.2 (9.3)	7.5	72% 94%	SWB: SWS Dep: CES-D
Dyrbye, 2016, USA	Healthy adults	PPI	Self-help: online	NI	10, 10 weeks		Ne = 145 Nc = 145	–	32	94% 98%	SWB: Slas PWB: EWS, GJS/PJSC, WES

Table 1 (continued)

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Feicht, 2013, Germany	Healthy adults	PPI	Self-help: online	Waitlist	21, 7 weeks	4 weeks	Ne = 72 Nc = 57	37.2 (9.0)	69	94% 100%	SWB: VAS; PWB: FS Stress: SWSS
Gelfin, 2018, Israel	Healthy adults	PPI	Self-help: online	Waitlist	6, 6 weeks	4 weeks	Ne = 25 Nc = 29	36.0 (10.5) (all)	74 (all)	51% 71%	SWB: SHI, PPI, SWLS
Guo, 2016, China	Undergraduate students	PPI	Group	NI	8, 8 weeks	3 months	Ne = 34 Nc = 42	20.4 (1.2)	95	81% 98%	PWB: GSE Dep: BDI
Hausmann, 2017, USA	Adults with osteoarthritis	PPI	Self-help	Placebo	6, 6 weeks	3 months	Ne = 19 Nc = 19	69.2 (11.3)	19	91% 91%	SWB: PANAS, SWLS
Hendriks, 2018a, Suriname	Healthy adults	PPI	Group	Waitlist	7, 7 weeks	–	Ne = 80 Nc = 78	36.3 (9.6)	60	91% 91%	SWB: MHC-SF- ewb subscale; PWB: MHC SF – pwb subscale, Dep, Anx, Stress: DASS-21
Huffman, 2011, USA	Patients with acute cardiovascular disease	PPI	Group	Relaxation	8, 8 weeks	–	Ne = 9 Nc1 = 7 Nc2 = 7	–	–	90% 70% 70%	SWB: SHS Dep: CES-D Anx: HADS-A
Hwang, 2016, China	Student with depressive symptoms	PPI	Group	MM	12, 6 weeks	–	Ne = 8 Nc = 8	22.7 (2.3)	67	73% 73% 80%	SWB: SPANE PWB: FS

Table 1 (continued)

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Ivtzan, 2016, UK	Healthy adults	PPI + MM	Self-help: online	Waitlist	8, 8 weeks	1 months	Ne = 53 Nc = 115	40.7 (11.3) 31.5 (13,5)	78 57	24% 53%	SWB: PHI; PWB: GSE, PWBS, MLQP, COS, APM Dep: BDI; Stress: PSS
Ivtzan, 2018, UK study 1	Healthy adults		Self-help	Waitlist	8, 8 weeks		Ne = 22 Nc = 21	39.8 (15.2)	78	39% 38%	SWB: PANAS-pa PWB: MLQ-P, SCS
Ivtzan, 2018, HK study 2	Healthy adults	PPI + MM	Self-help	Waitlist	8, 8 weeks		Ne = 19 Nc = 17	24.3 (8.5)	39	35% 31%	SWB: PANAS-pa PWB: MLQ-P, SCS
Joutsenniemi, 2014, Finland	Healthy adults	PPI	Self-help: e-mail based	Placebo	28, 13 weeks	–	Ne = 417 Nc = 433	42.0	83	40% 37% 42%	PWB: HFS Dep: BDI
Kahler, 2015, USA	Healthy adults, smoker	PPI	Group	TAU	6, 8 weeks	26 weeks	Ne = 35 Nc = 31	46.0 (13.4)	50	94% 87%	SWB: CES D-pa Dep: CES-D
Khayatan, 2014, Iran	Women with multiple sclerosis	PPI	Group	NI	6,6 weeks	–	Ne = 15 Nc = 15	31.1 (6.4)	100	100% 100%	Dep: BDI
Koydemir, 2016, Turkey	University students	PPI	Self-help: online	Waitlist	5, 8 weeks	–	Ne = 44 Nc = 36	18.7 (1.0)	48	–	SWB: SHS PWB: WHO-QOL ph/sr

Table 1 (continued)

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Lü, 2013, China	Individuals with low trait positive affect	PPI	Group	NI	8, 8 weeks	–	Ne = 16 Nc = 18	20.0 (4.3)	–	100% 100%	SWB: PANAS
Luthans, 2008, USA	Healthy adults	PPI + CBT	Self-help	Placebo	2, 2 weeks	–	Ne = 187 Nc = 177	32.2	–	- -	PWB: PCQ
Luthans, 2010, USA	Healthy adults	PPI + CBT	Group	CBT	1, 1 day	–	Ne = 153 Nc = 89	21.1	42	- -	PWB: PCQ
Mohammadi, 2018, Iran	Patients with heart disease	PPI	Group	Placebo	8, 8 weeks	–	Nc = 31 Ne = 30	52.5 (5.4)	23	97% 93%	SWB: OHI Dep: HADS-D, Anx: HADS-A
Moskowitz, 2017, USA	Adults with HIV	PPI	Individual	Placebo	6, 5 months	5 months	Ne = 74 Nc = 76	36.0 (9.9)	7.0	73% 80%	SWB: DES Dep: CES-D
Müller, 2016, USA	Patients, various (muscular) diseases	PPI	Self-help	Placebo	4, 4–8 weeks	2.5 months	Ne = 39 Nc = 38	59.4 (11.8)	70	77% 85%	SWB: PANAS Dep: HADS-D
Myers, 2017, USA	Healthy adults	PPI	Self-help: online	TAU	7, 1 months	1 months	Ne = 90 Nc = 128	41.9 (11.8)	77	69% 67%	PWB: I COPPE Scale
Neumeier, 2017, Germany	Healthy adults	PPI	Group	Waitlist	7		Ne = 90 Nc = 128	41..2 (12.3)	67	63% 89%	SWB: SHS, SAS
Nikrahan, 2016, Iran	Cardiac patients	PPI	Group	Waitlist	6, 6 weeks	8 weeks	Ne = 32 Nc = 12	56.6 (8.7)	43	78% 87%	SWB: OHI Dep: BDI
Page, 2013, Australia	Healthy adults	PPI	Group	NI	6, 6 weeks	6 months	Ne = 18 Nc = 13	39.7 (10.0)	73	58% 43%	SWB: SWLS, PANAS PWB: SPWB

Table 1 (continued)

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Peters, 2017, the Netherlands	Patients with chronic pain	PPI	Self-help: online	CBT	8, 8 weeks	6 months	Ne = 85 Nc = 80	48.5 (12.0)	85	73% 69% 80%	SWB: BMIS + other Dep: HADS-D Anx: HADS-A
Proyer, 2016, Switzerland	Healthy adults	PPI	Group	Waitlist	5, 12	1 months	Ne = 50 Nc = 50	45.7 (12.8)	69	33%	SWB: AHI PWB: OTH
Roepke, 2015, USA	Adults with depression symptoms	PPI + CBT	Self-help: phone based	Waitlist	1 months	6 weeks	Ne = 93 Nc = 93	40.1 (12.4)	70	22% 19% 42%	SWB: SWLS Dep: CES-D Anx: GADS
Rogerson, 2016, USA	Healthy adults	PPI + CBT	Group	Waitlist	5, 5 weeks	–	Ne = 14 Nc = 14	–	–	93% 100%	PWB: RAW
Sanjuan, 2016, Spain	Cardiac patients	PPI	Group	TAU	24, 8 weeks	–	Ne = 57 Nc = 51	54.4 (9.1)	17	88% 84%	SWB: PANAS Dep: SCL-90-R
Schotanus-Dijkstra, 2017, the Netherlands	Adults with low or moderate well-being	PPI	Self-help: e-mail support	Waitlist	8, 9 weeks	6 months	Ne = 137 Nc = 138	47.8 (10.9)	86	89% 95%	SWB -MHC-SF- ewb subscale; PWB: MHC-SF, pwb subscale, Dep: HADS-D Anx: HADS-A
Schueller, 2012, USA	Self-help–seeking participants	PPI	Self-help: online	NI	6, 6 weeks	–	Ne = 151 Nc = 204	–	–	47% 57%	Dep: CES-D

Table 1 (continued)

First author, year, country	Condition of participants	Intervention type	Delivery	Control group	Sessions, duration	Follow up	N post	Mean age/ SD	% female[a]	Retention PPI controls	Outcome measures
Seligman, 2006, USA, study 1	Students, mild depressive symptoms	PPI	Group	NI	6, 6 weeks	3 months	Ne = 19 Nc = 21	–	42	–	SWB: SWLS Dep: BDI
Seligman, 2006, USA, study 2	Adults with major depressive disorder	PPI	Individual	TAU	14, 12 weeks	–	Ne = 11 Nc1 = 9	–	69	87% 60% 71%	SWB: SWLS PWB: PPTI Dep: HRSD
Uliaszek, 2016, Canada	University students	PPI + DBT	Group	DBT	12, 12 weeks	–	Ne = 15 Nc = 22	22.2 (5.0)	78	56% 85%	PWB: PPTI/; Dep/Anx: SCL-90-R D/A; Stress: DTS

Anx anxiety; *CBT* cognitive behavioral therapy; *DBT* dialectical behavior therapy; *Dep* depression; *MM* mindfulness meditation; *PPI* positive psychology intervention; *PWB* psychological well-being; *SWB* subjective well-being. Abbreviations of questionnaires are listed in "Appendix 2"

[a]% of females at post-test, intervention and control groups

[b]At baseline

(Cheung et al. 2017; Gelfin et al. 2018; Hausmann et al. 2017; Hendriks 2018; Mohammadi et al. 2018). Six studies (Chaves et al. 2017; Dyrbye et al. 2016; Ivtzan et al. 2016; Mohammadi et al. 2018; Myers et al. 2017; Rogerson et al. 2016) included two or more measures for psychological well-being that were pooled.

3.4 Quality Assessment

The quality score of the studies ranged from one to six, the mean score was 3.22 (SD = 1.77). Thirteen studies were rated as high-quality studies (26%), with four studies (8%) meeting all the six quality criteria. Twenty-one studies (42%) were of moderate quality and 16 studies (32%) were rated as low-quality studies. Twenty-eight studies (56%) reported adequately how randomization took place. In 24 studies (48%), the allocation of the participants was concealed. In 29 studies (58%), the blinding of outcome assessment was described. An adequate description of drop-outs was provided in 37 studies (74%). Twenty-two studies (44%) had a population size larger than 50 per allocated arm or the population size was based on a power calculation. Twenty-one studies (42%) analyzed outcomes on the basis of an intention-to-treat analysis or had zero drop-outs. The outcome of the quality assessment is shown in Table 2.

3.5 Post-treatment Effects of MPPI's

We calculated post-treatment for the following outcomes: subjective well-being, psychological well-being, depression, anxiety, and stress. This was done for all studies, studies excluding outliers, and we also calculated the effects sizes for all outcomes excluding low quality studies. Follow-up effects including outliers were calculated for all outcomes except for stress. Follow-up effects excluding outliers was only calculated for subjective well-being and depression, due to the limited number of studies reporting follow-up effects on these outcomes. The main results are presented in Table 3.

3.5.1 Effects on Subjective Well-Being

For subjective well-being, a significant small to moderate effect was observed ($g = 0.34$, 95% CI 0.18–0.50, $p < 0.001$) at post-treatment based on 39 comparisons. The effect sizes of the studies ranged from −0.86 to 2.26. Heterogeneity analysis revealed a significant and high level of heterogeneity ($I^2 = 80.24$, Q: 192.27, $p < 0.001$). Removing eight outliers reduced both the effect size ($g = 0.24$, 95% CI 0.15–0.33, $p < 0.001$) and the heterogeneity, which was small ($I^2 = 25.29$, $Q = 40.16$, $p < 0.001$). When low-quality studies were excluded, the effect size remained small ($g = 0.26$, 95% CI 0.07–0.44, $p < 0.01$) with a high level of heterogeneity ($I^2 = 82.10$, $Q = 139.63$, $p < 0.001$). The forest plot in Fig. 2 displays the post-treatment effects, including outliers.

3.5.2 Effects on Psychological Well-Being

For psychological well-being, a significant moderate effect was observed ($g = 0.39$, 95% CI 0.23–0.55, $p < 0.001$) at post-treatment based on 24 comparisons. Effect sizes ranged from to −0.44 to 1.58. Heterogeneity was significant and high ($I^2 = 77.55$, $Q = 102.44$, $p < 0.001$) Removing six outliers reduced the effect size ($g = 0.35$, 95% CI 0.22–0.48, $p < 0.001$). After omitting outliers, heterogeneity was reduced to moderate ($I^2 = 42.59$, $Q = 29.61$, $p < 0.05$).

Table 2 Quality assessment of RCTs

Studies	SG	AC	BOA	DW	PA	ITT	Tally	Quality
Bolier et al. (2013b)	1	1	0	1	1	1	5	High
Celano et al. (2017)	1	1	1	1	0	1	5	High
Drozd et al. (2014)	1	1	1	1	1	1	6	High
Dyrbye et al. (2016)	1	1	1	1	1	0	5	High
Feicht et al. (2013)	1	1	1	1	1	0	5	High
Hendriks (2018)	1	1	1	1	1	1	6	High
Ivtzan et al. (2016)	1	1	1	1	1	0	5	High
Joutsenniemi et al. (2014)	1	1	1	1	1	1	6	High
Kahler et al. (2015)	1	1	1	1	0	1	5	High
Moskowitz et al. (2017)	1	0	1	1	1	1	5	High
Myers et al. (2018)	1	1	1	0	1	1	5	High
Roepke et al. (2015)	1	1	1	1	1	1	6	High
Schotanus-Dijkstra et al. (2017)	1	0	1	1	1	1	5	High
Carr and Finnegan (2015)	0	0	1	1	0	1	3	Moderate
Cohn et al. (2014)	1	0	0	1	1	0	3	Moderate
Chaves et al. (2017)	0	1	1	1	0	1	4	Moderate
Cheung et al. (2017)	1	1	1	1	0	0	4	Moderate
Cohn et al. (2014)	1	1	1	1	0	0	4	Moderate
Cullen et al. (2016)	1	1	1	1	0	0	4	Moderate
Drozd (2014b)	0	1	0	1	0	1	3	Moderate
Hausmann et al. (2017)	1	1	0	1	0	1	4	Moderate
Ivtzan et al. (2018), study 1	1	1	0	0	1	1	4	Moderate
Ivtzan et al. (2018), study 2	1	1	0	0	1	1	4	Moderate
Luthans et al. (2008)	1	1	1	0	1	0	4	Moderate
Mohammadi et al. (2018)	1	0	1	0	1	1	4	Moderate
Müller et al. (2016)	1	0	1	1	0	0	3	Moderate
Nikrahan et al. (2016)	1	0	1	1	0	0	3	Moderate
Page and Vella-Brodrick (2013)	0	1	0	1	1	1	4	Moderate
Peters et al. (2017)	1	0	1	1	1	0	4	Moderate
Proyer et al. (2016)	1	0	1	1	1	0	4	Moderate
Rogerson et al. (2016)	1	0	1	1	0	0	3	Moderate
Sanjuan et al. (2016)	1	0	1	1	0	0	3	Moderate
Schueller and Parks (2012)	0	1	1	1	1	0	4	Moderate
Uliaszek et al. (2016)	0	0	1	1	0	1	3	Moderate
Antoine et al. (2018)	0	0	0	1	1	0	2	Low
Asgharipoor et al. (2012)	0	0	0	0	0	0	0	Low
Asl et al. (2014)/Asl et al. (2016)	0	0	0	1	0	0	1	Low
Cantarella et al. (2017)	0	0	0	1	0	1	2	Low
Dowlatabadi et al. (2016)	0	0	0	0	0	0	0	Low
Gelfin et al. (2018)	0	0	0	0	0	0	0	Low
Guo et al. (2016)	0	0	0	1	0	0	1	Low
Huffman et al. (2011)	0	1	0	0	0	0	1	Low
Hwang et al. (2016)	1	0	0	1	0	0	2	Low
Khayatan et al. (2014)	0	0	0	0	0	0	0	Low

Table 2 (continued)

Studies	SG	AC	BOA	DW	PA	ITT	Tally	Quality
Koydemir and Sun-Selisik (2016)	0	1	1	0	0	0	2	Low
Lü et al. (2013)	0	0	0	1	0	0	1	Low
Luthans et al. (2010)	0	0	0	0	1	0	1	Low
Neumeier et al. (2017)	0	0	0	1	1	0	2	Low
Seligman et al. (2006), study 1	0	0	0	0	0	0	0	Low
Seligman et al. (2006), study 2	0	0	1	1	0	0	2	Low

SG sequence generation, *AC* allocation concealment, *BOA* blinding of main outcome assessments, *DW* description of withdrawals/drop-outs, *PA* power analysis or N > 50, *ITT* intention-to-treat analysis/0 drop-outs

When studies of low quality were excluded, the effect size was reduced ($g = 0.31$, 95% CI 0.15–0.47, $p < 0.05$), with a significant moderate to high level of heterogeneity ($I^2 = 75.75$, $Q = 65.99$, $p < 0.001$). The forest plot in Fig. 3 displays the post-treatment effects.

3.5.3 Effects on Depression

For depression (25 comparisons), a significant small effect was observed ($g = 0.32$, 95% CI 0.13–0.51, $p < 0.001$) at post-treatment. Effect sizes of studies ranged from − 1.50 to 3.05. Heterogeneity was significant and high ($I^2 = 80.55$, $Q = 123.40$, $p < 0.001$). Removing one outlier (Guo et al. 2016) reduced the effect size ($g = 0.21$, 95% CI 0.07–0.36, $p = 0.004$) and heterogeneity was moderate ($I^2 = 65.16$, $Q = 66.01$, $p = 0.000$). When studies with a low quality were excluded, the effect size was no longer significant. The post-treatment effects are displayed in a forest plot in Fig. 4.

3.5.4 Effects on Anxiety

For anxiety, a significant small to moderate effect was observed ($g = 0.35$, 95% CI 0.23–0.48, $p < 0.001$) at post-treatment based on 11 comparisons. Effect sizes of studies ranged from − 0.70 to 1.16, and there were no outliers. The level of heterogeneity was not significant. When two low quality studies were excluded, the effect size was slightly reduced ($g = 0.33$, 95% CI 0.19–0.46, $p < 0.001$) and the heterogeneity remained insignificant. The forest plot in Fig. 5 displays the post-treatment effects.

3.5.5 Effects on Stress

For stress, a significant small to moderate effect was observed ($g = 0.35$, 95% CI 0.03–0.66, $p < 0.05$) at post-treatment, based on 8 comparisons. Effect sizes of studies ranged from − 2.25 to 1.89. Heterogeneity was low ($I^2 = 20.19$, $Q = 65.32$, $p < 0.01$). When one outlier was removed, the effect size increased ($g = 0.49$, 95% CI 0.28–0.69, $p < 0.001$). Heterogeneity was no longer significant. When one low quality study was excluded, the effect size remained moderate ($g = 0.48$, 95% CI 0.28–0.69, $p < 0.001$) and the heterogeneity remained insignificant. The forest plot in Fig. 6 displays the post-treatment effects.

Table 3 Between—group effects

Outcome measures	# studies	Hedge's *g*	95% CI	Z	Heterogeneity		Fail-safe N
					Q value	I^2	
All studies post-treatment							
Subjective well-being	39	0.34	(0.18–0.50)	4.15***	191.28***	80.24	755
Psychological well-being	24	0.39	(0.23–0.55)	4.88***	102.44***	77.55	459
Depression	31	0.29	(0.14–0.45)	3.76***	131.35***	77.16	346
Anxiety	11	0.35	(0.23–0.48)	5.77***	12.19ns	17.94	92
Stress	8	0.35	(0.03–0.66)	2.16*	20.19**	65.32	24
Studies post-treatment, excl. outliers							
Subjective well-being	31	0.24	(0.15–0.33)	5.23***	40.16ns	25.29	–
Psychological well-being	18	0.35	(0.22–0.48)	5.31***	29.61**	42.59	–
Depression	28	0.21	(0.07–0.29)	3.10**	60.63***	55.47	–
Stress	7	0.49	(0.28–0.69)	4.66***	7.85ns	23.53	
Studies post-treatment, excl. low quality studies							
Subjective well-being	26	0.26	(0.07–0.44)	2.76**	139.63***	82.10	–
Psychological well-being	17	0.31	(0.15–0.47)	3.78***	65.99***	75.75	–
Depression	21	0.14	(0.03–0.26)	2.43*	42.53**	52.97	–
Anxiety	9	0.33	(0.19–0.46)	4.79***	10.75ns	25,57	–
Stress	7	0.49	(0.28–0.69)	4.66***	7.85ns	23,53	–
Follow-up effects							
Subjective well-being	17	0.27	(0.07–0.48)	2.61**	56.80***	71.83	–
Psychological well-being	5	0.32	(0.01–0.63)	1.99*	19.91***	79.91	–
Depression	15	0.45	(0.15–0.76)	2.91**	88.29***	84.14	–
Anxiety	5	0.09	(−0.44 to 0.62)	0.33ns	36.23***	88.95	–
Follow-up effects excl. outliers							
Subjective well-being	14	0.24	(0.15–0.37)	2.48*	33.26***	60.91	–
Depression	14	0.31	(0.07–0.54)	2.57*	43.88***	70.38	–

For anxiety there were no outliers. Follow-up effects for stress and follow-up effects exclusive outliers for psychological well-being, anxiety, and stress were not calculated because there were less than 5 studies per category

ns non-significant

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

3.5.6 Subgroup Analyses

We did not find any significant results for subjective well-being and psychological well-being. For depression, significant higher effect sizes were found for low quality studies compared to studies with a high quality. Studies of low quality ($n = 10$) had a large effect size ($g = 0.75$, 95% CI 0.47–1.04, $p < 0.001$), whereas studies of high quality ($n = 9$) had a small effect size ($g = 0.22$, 95% CI 0.00–0.45, $p < 0.01$).

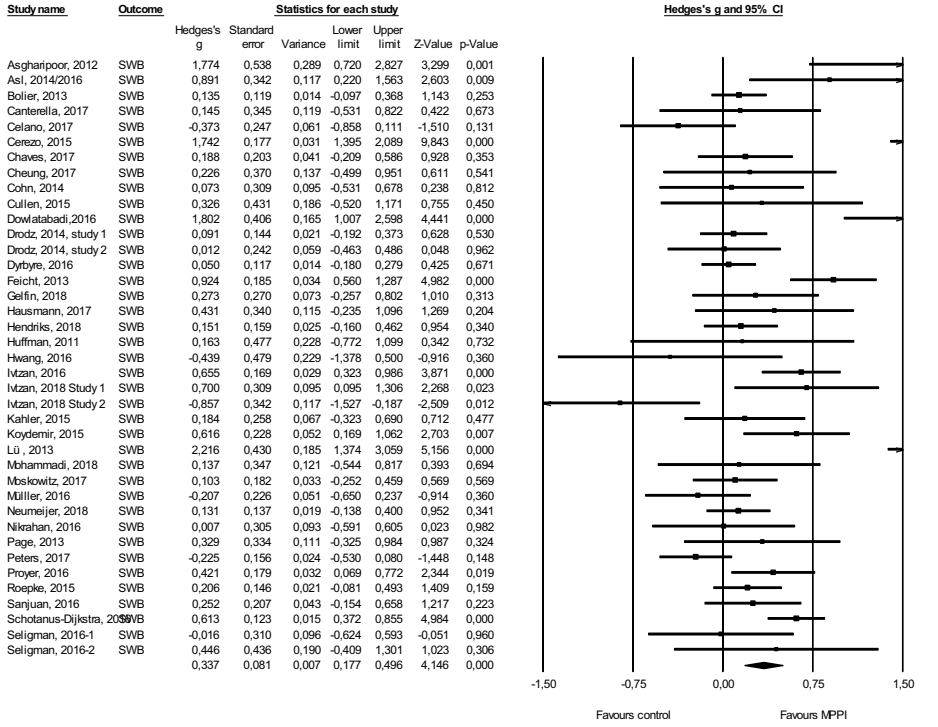

Fig. 2 Post-test effects of MPPIs on subjective well-being (SWB), including outliers

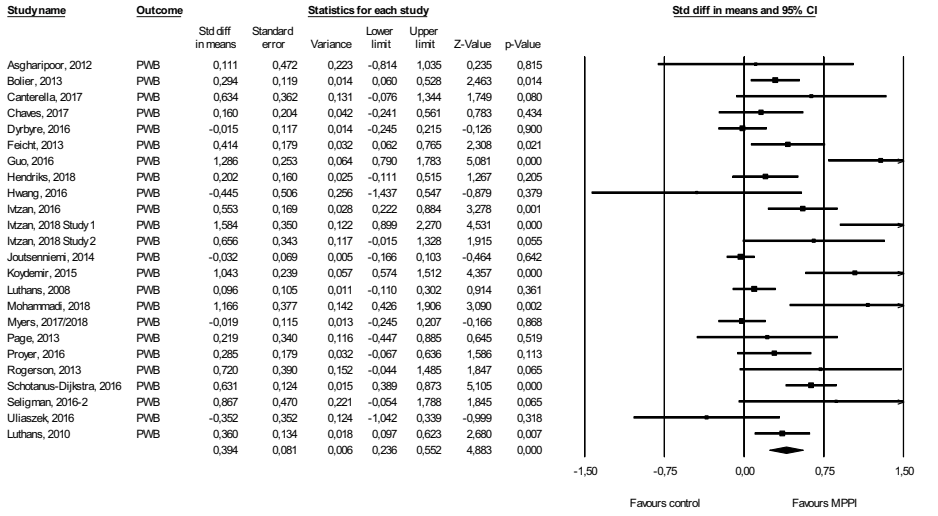

Fig. 3 Post-test effects of MPPIs on psychological well-being (PWB), including outliers

Study name	Outcome	Statistics for each study						
		Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Antoine, 2018	Depression	0,393	0,182	0,033	0,036	0,749	2,160	0,031
Asgharipoor, 2012	Depression	-0,600	0,460	0,212	-1,502	0,301	-1,305	0,192
Asl, 2014/2016	Depression	0,899	0,343	0,117	0,227	1,570	2,622	0,009
Bolier, 2013	Depression	0,239	0,119	0,014	0,006	0,472	2,011	0,044
Carr, 2016	Depression	0,396	0,293	0,086	-0,177	0,970	1,354	0,176
Celano, 2017	Depression	0,061	0,245	0,060	-0,420	0,541	0,248	0,804
Chaves, 2017	Depression	-0,076	0,203	0,041	-0,473	0,321	-0,373	0,709
Cheung, 2017	Depression	0,382	0,372	0,138	-0,347	1,110	1,026	0,305
Cohn, 2014	Depression	0,340	0,311	0,097	-0,268	0,949	1,096	0,273
Cullen, 2015	Depression	0,478	0,459	0,210	-0,421	1,377	1,042	0,297
Dowlatabadi,2016	Depression	1,097	0,366	0,134	0,381	1,814	3,001	0,003
Drodz, 2014, study 2	Depression	0,032	0,242	0,059	-0,443	0,506	0,131	0,896
Guo, 2016	Depression	2,448	0,303	0,092	1,855	3,042	8,090	0,000
Hendriks, 2018	Depression	0,375	0,160	0,026	0,062	0,688	2,347	0,019
Huffman, 2011	Depression	0,064	0,477	0,227	-0,870	0,998	0,134	0,894
Ivtzan, 2016	Depression	0,738	0,170	0,029	0,405	1,071	4,338	0,000
Joutsenniemi, 2014	Depression	-0,008	0,069	0,005	-0,143	0,126	-0,122	0,903
Kahler, 2015	Depression	-0,167	0,258	0,067	-0,673	0,339	-0,647	0,518
Khayatan, 2014	Depression	1,203	0,388	0,150	0,443	1,963	3,103	0,002
Mohammadi, 2018	Depression	0,294	0,265	0,070	-0,226	0,813	1,107	0,268
Moskowitz, 2017	Depression	-0,078	0,182	0,033	-0,434	0,278	-0,429	0,668
Milller, 2016	Depression	-0,036	0,226	0,051	-0,479	0,406	-0,162	0,872
Nikrahan, 2016	Depression	-0,052	0,305	0,093	-0,651	0,546	-0,172	0,864
Peters, 2017	Depression	-0,077	0,153	0,023	-0,377	0,222	-0,506	0,613
Roepke, 2015	Depression	0,309	0,147	0,022	0,021	0,597	2,103	0,035
Sanjuan, 2016	Depression	-0,211	0,207	0,043	-0,617	0,194	-1,021	0,307
Schotanus-Dijkstra, 2016	Depression	0,423	0,122	0,015	0,185	0,662	3,482	0,000
Schueller, 2012	Depression	-0,039	0,107	0,011	-0,249	0,171	-0,361	0,718
Seligman, 2016-1	Depression	0,466	0,315	0,099	-0,151	1,083	1,481	0,139
Seligman, 2016-2	Depression	1,401	0,484	0,234	0,452	2,350	2,893	0,004
Uliaszek, 2016	Depression	-0,225	0,343	0,118	-0,897	0,447	-0,656	0,512
		0,294	0,078	0,006	0,141	0,448	3,755	0,000

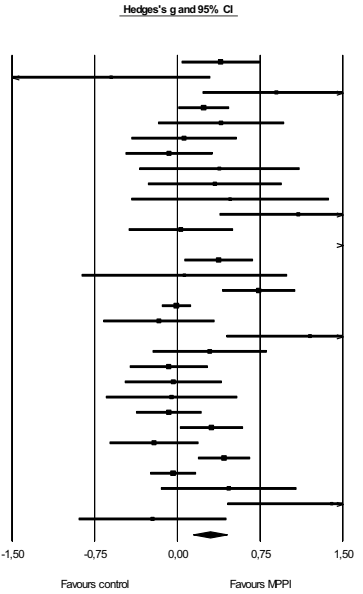

Fig. 4 Post-test effects of MPPIs on depression, including outliers

Study name	Outcome	Statistics for each study						
		Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Antoine, 2018	Anxiety	0,563	0,183	0,034	0,204	0,923	3,071	0,002
Bolier, 2013	Anxiety	0,297	0,119	0,014	0,064	0,530	2,494	0,013
Chaves, 2017	Anxiety	0,082	0,203	0,041	-0,315	0,479	0,405	0,686
Cullen, 2015	Anxiety	0,159	0,440	0,193	-0,703	1,020	0,361	0,718
Hendriks, 2018	Anxiety	0,334	0,159	0,025	0,022	0,647	2,096	0,036
Huffman, 2011	Anxiety	0,487	0,484	0,234	-0,462	1,436	1,006	0,315
Mohammadi, 2018	Anxiety	0,629	0,270	0,073	0,100	1,159	2,328	0,020
Peters, 2017	Anxiety	0,177	0,153	0,023	-0,123	0,476	1,154	0,249
Roepke, 2015	Anxiety	0,290	0,147	0,022	0,002	0,577	1,973	0,049
Schotanus-Dijkstra, 2016	Anxiety	0,623	0,123	0,015	0,381	0,864	5,057	0,000
Uliaszek, 2016	Anxiety	-0,026	0,342	0,117	-0,696	0,644	-0,075	0,940
		0,354	0,062	0,004	0,234	0,475	5,764	0,000

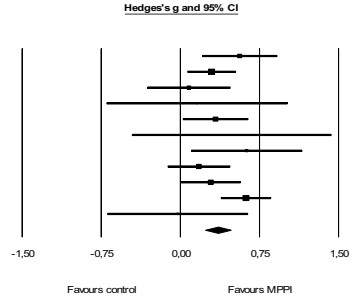

Fig. 5 Post-test effects of MPPIs on anxiety, including outliers

Study name	Outcome	Statistics for each study						
		Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Asgharipoor, 2012	Stress	-1,280	0,497	0,247	-2,254	-0,306	-2,575	0,010
Cohn, 2014	Stress	0,305	0,310	0,096	-0,304	0,913	0,982	0,326
Cullen, 2015	Stress	0,069	0,439	0,193	-0,792	0,929	0,157	0,875
Feicht, 2013	Stress	0,635	0,181	0,033	0,281	0,989	3,517	0,000
Hendriks, 2018	Stress	0,328	0,159	0,025	0,015	0,640	2,056	0,040
Ivtzan, 2016	Stress	0,656	0,169	0,029	0,325	0,988	3,880	0,000
Rogerson, 2013	Stress	1,116	0,396	0,157	0,340	1,893	2,819	0,005
Uliaszek, 2016	Stress	0,082	0,342	0,117	-0,588	0,752	0,240	0,810
		0,347	0,161	0,026	0,032	0,662	2,161	0,031

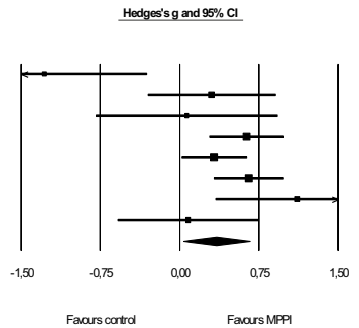

Fig. 6 Post-test effects of MPPIs on stress, including outliers

In addition, the region of origin of the studies also had a significant moderating effect on this outcome: studies from non-Western countries ($n=8$) had a large effect size ($g=0.72$, 95% CI 0.41–1.03, $p<0.001$), whereas studies from Western countries ($n=23$) had a small effect size ($g=0.27$, 95% CI 0.01–0.33, $p<0.05$). All outcomes of the subgroup analyses are shown in "Appendix 3".

3.5.7 Publication Bias

The possibility of publication bias was determined for subjective well-being, psychological well-being, and depression because of the small number of studies included for anxiety and stress. We found some indications of publication bias, but the results were not conclusive. The funnel plots for subjective well-being, psychological well-being, and depression were somewhat asymmetrical, with a few more studies showing a positive outcome. However, the fail-safe numbers were higher for subjective well-being (755), psychological well-being (459), and depression (346) than required (205, 130, and 155 respectively). Contrary to the funnel plots, Egger's regression intercept was significant for psychological well-being (2.23, t=2.96, $df=22$, $p<0.01$) and depression (1.50, t=2.06, $df=29$, $p<0.05$), but not significant for subjective well-being (0.72, t=0.79, $df=37$, $p=0.43$) Finally, when possible missing studies were imputed using the Duval and Tweedie's trim-and-fill method, the adjusted effect sizes increased for subjective well-being ($g=0.45$, 95% CI 0.34–0.67), but decreased for psychological well-being ($g=0.24$, 95% CI 0.23–0.55) and depression ($g=0.20$, 95% CI 0.17–0.48). In sum, potential missing publications may have influenced the results of the meta-analyses.

3.5.8 Follow-Up Effects

Follow-up periods ranged from 1 to 12 months. Analysis showed a significant small effect ($g=0.27$, 95% CI 0.07–0.48, $p<0.01$) for subjective well-being at follow-up measurement (17 comparisons). After removal of three outliers, the effect size decreased ($g=0.24$, 95% CI 0.05–0.43, $p<0.05$). The effects for depression at follow-up measurement (15 comparisons) were moderate ($g=0.45$, 95% CI 0.15–0.76, $p<0.01$), but this effect-size dropped to small after removing one outlier ($g=0.31$, 95% CI 0.07–0.54, $p<0.01$). The follow-up effect size for psychological well-being was also small ($g=0.32$, 95% CI 0.00–0.70, $p<0.05$). We did not calculate follow-up effect sizes for psychological well-being, anxiety, and stress due to the small number of studies reporting follow-up effects (5, 5, and 3 respectively).

4 Discussion

4.1 Main Findings

The aim of this study was to examine the efficacy of multi-component positive psychology interventions (MPPIs) across randomized controlled trials. Following a systematic literature search, we included 51 articles describing 50 studies on the effects of MPPIs in our meta-analysis. We conclude that over the past 6 years, there has been a sharp increase in the number of RCTs involving MPPIs. In comparison, a meta-analysis of PPIs by Bolier et al. (2013a, b) that featured studies from 1998 to November 2012, included 34 single

component PPIs and merely five MPPIs. Analyses of all studies suggest that MPPIs have small to moderate effect sizes for subjective well-being ($g = 0.34$), psychological well-being ($g = 0.39$), anxiety ($g = 0.35$), and stress ($g = 0.35$), and a small effect size for depression ($g = 0.29$). After removing outliers, the effect sizes decreased for subjective well-being ($g = 0.24$), psychological well-being ($g = 0.35$), and depression ($g = 0.21$), but increased for stress ($g = 0.49$). There were no outliers for anxiety. Removing low quality studies led to similar conclusions compared to the analyses without the low quality studies, in part because the outliers were often of low quality. Follow-up results showed small effects for subjective well-being ($g = 0.27$), and psychological well-being ($g = 0.32$). The effect size for depression increased to moderate ($g = 0.45$), while the effect size for anxiety sharply dropped ($g = 0.09$). Follow-up effects for stress were not calculated due to the limited amount of studies that included follow-up assessments.

Our findings on subjective well-being, psychological well-being, and depression are in line with two previous meta-analyses of RCT's on the effect of PPIs. Bolier et al. (2013a, b) reported small effects on these outcomes, and a recent meta-analysis by Chakhssi et al. (2018) in clinical samples with psychiatric or somatic disorders, also reported small effects on well-being and depression. According to the Synergistic Change Model (Rusk et al. 2018) lasting positive change as a result of a PPI, is most likely to occur when interventions are targeted at multiple domains of positive functioning. The model suggests that targeting multiple domains decreases the risk of relapse and increases the likelihood of spillover effects and synergy between the various activities. We expected to find higher effect sizes for all outcomes well-being and depression, since MPPIs target multi-domains of positive functioning. Although larger effect sizes on subjective well-being, psychological well-being, and depression were not found, compared to the studies of Bolier et al. (2013a, b) and Chakhssi et al. (2018), the effect sizes were still of small to moderate magnitude. Our meta-analysis is the first that found promising results for PPIs on anxiety, and stress in particular. Still, the total number of studies that reported on these outcomes was limited, so caution is warranted when drawing conclusions on the effects of MPPIs on anxiety and stress.

Explorative subgroup analyses revealed mainly no significant results, indicating that we could not identify study or intervention characteristics that led to more or less effectivity of MPPIs. We only found that two moderators may have influenced the outcomes on depression. Low quality studies had a significant higher effect size than moderate or high quality studies. Our finding that studies of lower quality have a higher effect size on depression is in line with the findings of the meta-analysis of Bolier et al. (2013a, b). However, they reported a higher effect size for low quality studies compared to studies from moderate quality, rather than studies of high quality. In addition, Bolier and colleagues also reported significant higher effects for low quality studies compared to moderate quality studies on subjective well-being and psychological well-being, whereas we did not. The meta-analysis by Chakhssi et al. (2018) reported a significant moderating effect of study quality only for well-being, and not for depression. Differences can be explained by the fact that all meta-analyses used different criteria to measure quality. Bolier and colleagues assessed the study quality on five criteria, of which two criteria differed from the criteria that were used in our study, whereas Chakhssi and colleagues used six criteria, of which five were the same as the criteria we used.

In addition, we found that the region of origin of the studies had a significant moderating effect on depression: studies from non-Western countries reported higher effect sizes than studies from Western countries. Differences in effect sizes between Western and non-Western countries are possibly confounded by study quality, because six of the ten

low-quality studies on depression were from non-Western countries. The findings in relation to the lower quality of studies from non-Western countries and possible large effect sizes are in line with a meta-analysis that we recently conducted on the efficacy of PPIs from non-Western countries (Hendriks et al. 2018b). This study, that included 28 RCTs, showed that PPIs from non-Western countries have moderate effect sizes on well-being, and large effects on depression and anxiety. Quality analysis, using the same six criteria that were used in this current study, revealed a mean quality score of 1.79 (SD = 1.7), indicating a low quality. The quality analysis of the current meta-analysis showed that non-Western studies had a mean rating score of 1.89 (SD = 1.8), compared to a mean rating score of 3.62 (SD = 1.5) for Western countries. This difference was significant ($p < 0.05$). Lower quality may contribute to higher effect sizes. An important aspect is sample size. Prior studies have shown that trials with small sample sizes tend to overestimate effect sizes (Slavin and Smith 2009; Zhang et al. 2013). Our analyses showed that the intervention groups in the studies from non-Western countries had much smaller sample sizes (mean = 27), than the groups in the studies from Western countries (mean = 71).

4.2 Strengths and Limitations

One of the strengths of this meta-analysis is its methodological rigor. It was conducted according to The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews and meta-analyses (Moher et al. 2009, 2010) and the recommendations of the Cochrane Back Review group (Higgins et al. 2011). Another strength is the differentiation of the intervention by region. In general, PPI studies from non-Western countries tend to report larger effect-size than studies from Western countries. Our moderator analysis showed the moderating effect is significant for depression. This finding may contribute to a better understanding of the moderating effect of the region on the efficacy of PPIs, or at least to a broader examination on the possible reasons why there are differences. We recommend that other researchers further examine the relationship between the ethnic/cultural background of the participants and the outcomes of interventions.

We believe there are several limitations related to the findings of this study. First, there is a relatively small number of studies on anxiety ($n = 11$) and stress ($n = 8$). In order to draw firmer conclusions on the effects of MPPIs on these outcomes, more RCTs are needed. Second, there is also a limited number of studies for all subgroups. For example, while for psychological well-being there were 18 studies conducted among non-clinical populations, we only found six studies among clinical populations that measured the effects of the MPPIs. With such a small sample of studies, definite conclusions on the effects of MPPI on psychological well-being among the clinical population cannot be drawn. With a limited number of studies and, on average, a high level of heterogeneity, the impact of excluding a single study could also have a high impact. This was illustrated in our findings for stress: based on eight studies we found an effect size of $g = 0.35$ (a small to moderate effect). However, after removing one outlier (of low quality) the effect size for stress increased to $g = 0.49$ (moderate effect). The third limitation applies to the quality of the studies, or better said: the lack thereof. Only 26% of the studies could be classified as high-quality studies ($n = 13$), 42% of the studies ($n = 21$) were classified as moderate, and 32% of the studies were classified as low-quality studies ($n = 16$). The main reasons for the lack of quality are the omission of randomization procedures (52% of the studies), the failure to state whether or not allocation

of the participants was concealed (52%), and the failure to state whether or not the outcome assessment was blinded (42%). Furthermore, 29 studies (58%) conducted completers-only analyses, as opposed to intention-to-treat analyses, thereby increasing the risk of selection bias (Yelland et al. 2015). Another aspect is that the majority of the studies is weakly powered: 28 of the 50 studies (56%) had a population less than 50 participants per condition. Twenty-two studies (44%) even had less than 30 participants in the intervention group. Studies with low power have a weak predictive value, have a low probability of finding an effect or exaggerate the magnitude of the effect when an effect is discovered (Button et al. 2013; Slavin and Smith 2009).

5 Conclusion and Implications

Despite the limitations, we conclude that MPPIs have a small effect on subjective well-being and depression, and a small to moderate effect on psychological well-being, and possibly anxiety and stress. However, the limitations also warrant some implications for future research. Firstly, there is a need for a more rigorous methodological approach in studies in the field of positive psychology, which should lead to higher quality studies. This recommendation is a reoccurring one, which have been stated in some previous PPI meta-analyses as well (Bolier et al. (2013a, b; Weiss et al. 2016). Considering the explicit call for more rigorous research methods to study well-being which is often heard in positive psychology (Diener 2009; Froh 2004; Linley and Joseph 2004; Linley et al. 2006), we recommend that future studies should at least be based on a power-analysis to avoid the risk that clinical trials fail to detect meaningful differences (Adams-Huet and Ahn 2009), or include a minimum of 50 participants per condition. We also highly recommend that future studies pay more attention to methodological reporting and follow protocols guidelines such as the CONSORT (Moher et al. 2010) or the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines (Chan et al. 2013). In light of the growing number of RCTs from non-Western countries, this recommendation particular applies to studies from such countries, since nine of the eleven non-Western studies we included had a low study quality rating. Secondly, due to the high heterogeneity of the studies it was not possible to determine the optimal conditions under which studies could maximize their efficacy, for example the most effective intervention period or number of sessions. In conclusion, our findings show for the first time the overall efficacy of MPPIs and the subgroup analyses contribute to a better understanding of the effectiveness of MPPIs. Future studies among of higher quality and more diverse populations could enrich the field of positive psychology and mental health and contribute to more insight into the optimal conditions to design the most effective positive psychology interventions.

Authors' Contributions The meta-analyses and data-analyses were conducted by TH, who also wrote the manuscript. The literature search was conducted by TH and MS, the risk of bias analysis was conducted by TH and AH. JdJ was an advisor in the project. EB was the editor of the article. All authors contributed to the writing of the manuscript and approved the final manuscript.

Compliance with Ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1

See Table 4.

Table 4 Strings of the search strategy

PUBMED*: ((well-being[Title/Abstract] OR happiness[Title/Abstract] OR happy[Title/Abstract] OR flourishing[Title/Abstract] OR "life satisfaction"[Title/Abstract] OR "satisfaction with life"[Title/Abstract] OR optimism[Title/Abstract] OR gratitude[Title/Abstract] OR strengths[Title/Abstract] OR forgiveness[Title/Abstract] OR compassion[Title/Abstract] OR "positive psych*"[Title/Abstract])) AND "random"*[Title/Abstract]*

PSYCINFO: *well-being or happiness or happy or flourishing or "life satisfaction" or "satisfaction with life" or optimism or gratitude or strengths or forgiveness or compassion or "positive psych*").ti. and ("well-being" or happiness or happy or flourishing or "life satisfaction" or "satisfaction with life" or optimism or gratitude or strengths or forgiveness or compassion or "positive psych*"). ab. and random*.af*

SCOPUS: *#1 well-being or happiness or happy or flourishing or "life satisfaction" or "satisfaction with life" or optimism or gratitude or strengths or forgiveness or compassion or "positive psych* #2 AND ABS(well-being or happiness or happy or flourishing or "life satisfaction" or "satisfaction with life" or optimism or gratitude or strengths or forgiveness or compassion or "positive psych*")AND TITLE-ABS-KEY(random*)) AND DOCTYPE(ar) AND PUBYEAR > 1997 AND (LIMIT-TO (SUBJAREA,"MEDI") OR LIMIT-TO (SUBJAREA,"HEAL") OR LIMIT-TO (SUBJAREA,"PSYC") OR LIMIT-TO (SUBJAREA,"SOCI") OR LIMIT-TO (SUBJAREA,"NURS") OR LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"MULT")) AND (LIMIT-TO (LANGUAGE,"English")) AND (LIMIT-TO (AFFILCOUNTRY,"United States")) AND (LIMIT-TO (EXACTKEYWORD,"Human") OR LIMIT-TO (EXACTKEYWORD,"Article") OR LIMIT-TO (EXACTKEYWORD,"Humans") OR LIMIT-TO (EXACTKEYWORD,"Controlled Study") OR LIMIT-TO (EXACTKEYWORD,"Male") OR LIMIT-TO (EXACTKEYWORD,"Female") OR LIMIT-TO (EXACTKEYWORD,"Adult") OR LIMIT-TO (EXACTKEYWORD,"Randomized Controlled Trial") OR LIMIT-TO (EXACTKEYWORD,"Controlled Clinical Trial") OR LIMIT-TO (EXACTKEYWORD,"Middle Aged") OR LIMIT-TO (EXACTKEYWORD,"Aged") OR LIMIT-TO (EXACTKEYWORD,"Clinical Trial") OR LIMIT-TO (EXACTKEYWORD,"Physiology") OR LIMIT-TO (EXACTKEYWORD,"Priority Journal") OR LIMIT-TO (EXACTKEYWORD,"Major Clinical Study") OR LIMIT-TO (EXACTKEYWORD,"Young Adult") OR LIMIT-TO (EXACTKEYWORD,"Treatment Outcome") OR LIMIT-TO (EXACTKEYWORD,"Methodology") OR LIMIT-TO (EXACTKEYWORD,"Quality Of Life") OR LIMIT-TO (EXACTKEYWORD,"Clinical Article") OR LIMIT-TO (EXACTKEYWORD,"Procedures") OR LIMIT-TO (EXACTKEYWORD,"Questionnaire") OR LIMIT-TO (EXACTKEYWORD,"Human Experiment") OR LIMIT-TO (EXACTKEYWORD,"Normal Human") OR LIMIT-TO (EXACTKEYWORD,"Wellbeing") OR LIMIT-TO (EXACTKEYWORD,"Double Blind Procedure") OR LIMIT-TO (EXACTKEYWORD,"Randomization") OR LIMIT-TO (EXACTKEYWORD,"Depression") OR LIMIT-TO (EXACTKEYWORD,"Outcome Assessment") OR LIMIT-TO (EXACTKEYWORD,"Random Allocation") OR LIMIT-TO (EXACTKEYWORD,"Follow Up") OR LIMIT-TO (EXACTKEYWORD,"Questionnaires") OR LIMIT-TO (EXACTKEYWORD,"Exercise Therapy") OR LIMIT-TO (EXACTKEYWORD,"Time") OR LIMIT-TO (EXACTKEYWORD,"Animals") OR LIMIT-TO (EXACTKEYWORD,"Double-Blind Method") OR LIMIT-TO (EXACTKEYWORD,"Well-being") OR LIMIT-TO (EXACTKEYWORD,"Psychology") OR LIMIT-TO (EXACTKEYWORD,"Psychological Aspect") OR LIMIT-TO (EXACTKEYWORD,"Stress, Mechanical") OR LIMIT-TO (EXACTKEYWORD,"Training") OR LIMIT-TO (EXACTKEYWORD,"Physical Activity") OR LIMIT-TO (EXACTKEYWORD,"Strength") OR LIMIT-TO (EXACTKEYWORD,"Mental Health") OR LIMIT-TO (EXACTKEYWORD,"Placebo") OR LIMIT-TO (EXACTKEYWORD,"Health Status") OR LIMIT-TO (EXACTKEYWORD,"Happiness") OR LIMIT-TO (EXACTKEYWORD,"Personal Satisfaction") OR LIMIT-TO (EXACTKEYWORD,"Self Concept") OR LIMIT-TO (EXACTKEYWORD,"Life Satisfaction") OR LIMIT-TO (EXACTKEYWORD,"Follow-Up Studies") OR LIMIT-TO (EXACTKEYWORD,"Anxiety") OR LIMIT-TO (EXACTKEYWORD,"Satisfaction") OR LIMIT-TO (EXACTKEYWORD,"Psychological Well Being") OR LIMIT-TO (EXACTKEYWORD,"Self Report") OR LIMIT-TO (EXACTKEYWORD,"Instrumentation") OR LIMIT-TO (EXACTKEYWORD,"Emotion") OR LIMIT-TO (EXACTKEYWORD,"Adaptation, Psychological") OR LIMIT-TO (EXACTKEYWORD,"United States") OR LIMIT-TO (EXACTKEYWORD,"Fatigue") OR LIMIT-TO (EXACTKEYWORD,"Social Support") OR LIMIT-TO (EXACTKEYWORD,"Affect") OR LIMIT-TO (EXACTKEYWORD,"Pilot Study")*

Appendix 2

See Table 5.

Table 5 Abbreviations of questionnaires

Subjective well-being AHI: Authentic Happiness Index[a]; BMIS: Brief Mood Introspection Scale (BMIS); CES-D pa: Center for Epidemiological Studies Depression Scale, positive affect subscale; MHC-SF-ewb subscale: Mental Health Continuum-Short Form—emotional well-being subscale; OHI: Oxford Happiness Index; PANAS: Positive and Negative Affect Schedule; PHI: Pemberton Happiness Index; SHS: Subjective Happiness Scale; SlAs: Standardized linear analog scale; SPANE: Scale of Positive and Negative Experience; SWLS: Satisfaction With Life Scale; SWS: Subjective Well-being Scale; VAS: Visual Analog Scale-Happiness

Psychological well-being APM: Appreciation inventory scale: present moment; COS: Compassion for Others scale; FS: Flourishing Scale; GSE: Generalised self-efficacy scale; HFS: Happiness Flourishing Scale; MHC-SF pwb: Mental Health Continuum Short Form—psychological well-being subscale; MLQP: Meaning in Life Questionnaire—presence subscale; OTH: Orientations to Happiness Questionnaire; PCQ: PsyCap Questionnaire; PPTI: Positive Psychotherapy Inventory; PIL: Purpose In Life Test; PWBS: Psychological Well-Being Scales; RAW: Resilience at Work; SWS: Subjective Well-being Scale pwb subscale

Depression BDI: Beck Depression Index; CES-D: Center for Epidemiological Studies—Depression scale; DASS-21: Depression Anxiety Stress Scale; HADS-D: Hospital Anxiety and Depression Scale, depression; HRSD: Hamilton Rating Scale for Depression; QIDS-SR: 16-item Quick Inventory of Depressive Symptomatology; SCL-90R: Symptom Checklist-90 Revised

Anxiety BAI: Beck Anxiety Inventory; DASS-21: Depression Anxiety Stress Scales; HADS-A: Hospital Anxiety and Depression Scale, anxiety; SCL-90R: Symptom Checklist-90 Revised; STAI: State-Trait Anxiety Inventory

Stress DASS-21: Depression Anxiety Stress Scale; DTS: Distress Tolerance Scale; PSS- Perceived Stress Scale; SUDS: Subjective Units of Distress scale; SWSS: Stress Warning Signals Scale

[a]In a prior meta-analysis by Bolier et al. (2013a, b) the AHI was classified as an instrument to measure psychological well-being since it also focuses on aspects of PWB, such as engagement, or meaning (Seligman et al. 2005)

Appendix 3

See Table 6.

Table 6 Outcomes of moderator analyses

Outcome	Criteria	Value	N	Hedge's *g*	(95% CI)	I^2	Z
Subjective well-being	Population	Clinical	21	0.33	(0.10–0.56)ns	82.41	2.83
		Non-clinical	18	0.34	(0.11–0.57)ns	78.35	2.94
	Intervention	PPI	34	0.37	(0.20–0.55)ns	80.22	4.01
		PPI + other	5	0.11	(− 0.33 to 0.55)ns	83.82	0.48
	Delivery	Group	19	0.50	(0.26–0.74)ns	83.91	4.11
		Individual	3	0.26	(− 0.37 to 0.88)ns	0.00	0.81
		Self-help	17	0.12	(− 0.03 to 0.43)ns	76.79	1.67
	Control	Active		0.38	(0.12–0.63)ns	84.47	2.84
		Non-active	22	0.31	(0.11–0.52)ns	75.62	3.01
	Sessions	≤ 8 sessions	9	0.54	(0.21–0.87)ns	91.77	3.21
		> 8 sessions	30	0.28	(0.09–0.46)ns	67.03	2.95
	Duration	≤ 8 weeks	26	0.48	(0.21–0.75)ns	89.43	3.47
		> 8 weeks	13	0.26	(0.06–0.46)ns	67.33	2.51
	Quality	High	11	0.30	(− 0.03 to 0.54)ns	75.13	1.78
		Moderate	15	0.25	(− 0.01 to 0.52)ns	76.32	3.51
		Low	13	0.55	(0.25–0.86)ns	85.88	1.67
	Region	Western	30	0.25	(0.07–0.43)ns	82.53	3.81
		Non-western	9	0.70	(0.34–1.07)ns	79.46	2.75
Psychological well-being	Population	Clinical	6	0.35	(− 0.02 to 0.71)ns	47.48	1.88
		Non-clinical	18	0.40	(0.22–0.58)ns	81.56	4.40
	Intervention	PPI	18	0.34	(0.15–0.52)ns	78.09	3.58
		PPI + other	6	0.55	(0.23–0.87)ns	76.49	3.39
	Delivery	Group	12	0.38	(0.14–0.62)ns	61.56	3.06
		Individual	1	0.83	(− 0.25 to 1.91)ns	0.000	1.51
		Self-help	11	0.38	(0.17–0.59)ns	85.19	3.55
	Control	Active	11	0.18	(− 0.04 to 0.40)ns	58.11	1.62
		Non-active	13	0.53	(0.34–0.72)ns	76.84	5.54
	Sessions	≤ 8 sessions	7	0.08	(− 0.19 to 0.35)ns	46.20	0.61
		> 8 sessions	17	0.50	(0.33–0.71)ns	75.49	5.75
	Duration	≤ 8 weeks	9	0.20	(− 0.05 to 0.45)ns	73.70	1.60
		> 8 weeks	15	0.50	(0.31–0.72)ns	77.55	5.00
	Quality	High	8	0.24	(0.02–0.47)ns	35.67	2.09
		Medium	7	0.63	(0.31–0.95)ns	19.82	3.87
		Low	9	0.42	(0.15–0.68)ns	28.39	3.09
	Region	Western	18	0.32	(0.15–0.44)ns	73.63	3.76
		Non-western	6	0.64	(0.31–0.98)ns	79.82	3.75

Table 6 (continued)

Outcome	Criteria	Value	N	Hedge's *g*	(95% CI)	I^2	Z
Depression	Population	Clinical	21	0.27	(0.07–0.47)ns	48.67	2.64
		Non-clinical	10	0.34	(0.08–0.60)ns	90.25	2.57
	Intervention	PPI	29	0.27	(0.11–0.43)ns	76.53	3.37
		PPI + other	2	0.52	(− 0.02 to 1.05)ns	72.53	1.90
		PPT	1	0.47	(− 0.46 to 1.39)ns	0.00	0.99
	Delivery	Group	17	0.38	(0.16–0.60)ns	81.23	3.43
		Individual	3	0.40	(− 0.17 to 0.97)ns	77.18	1.39
		Self-help	11	0.17	(− 0.06 to 0.40)ns	62.38	1.44
	Control	Active	17	0.13	(− 0.08 to 0.34)ns	41.32	1.20
		Non-active	14	0.46	(0.25–0.66)ns	84.29	4.28
	Sessions	≤ 8 sessions	24	0.26	(− 0.09 to 0.60)ns	68.66	1.47
		> 8 sessions	7	0.31	(0.13–0.49)ns	77.98	3.36
	Duration	≤ 8 weeks	20	0.37	(0.18–0.56)ns	62.42	3.84
		> 8 weeks	11	0.15	(− 0.11 to 0.41)ns	79.52	1.11
	Quality	High	9	0.22	(0.00–0.45)**	72.30	1.94
		Moderate	12	0.06	(− 0.16 to 0.29)ns	0.00	0.55
		Low	10	0.75	(0.47–1.04)***	84.46	5.15
	Region	Western	23	0.13	(0.41–1.03)*	87.68	4.57
		Non-western	8	0.65	(0.01–0.32)***	56.00	2.10
Anxiety	Population	Clinical	7	0.27	(0.13–0.40)ns	0.00	3.85
		Non-clinical	4	0.49	(0.32–0.70)ns	34.08	5.90
	Intervention	PPI	7	0.36	(0.22–0.50)ns	11.92	0.00
		PPI + other	4	0.29	(− 0.06 to 0.65)ns	0.00	0.11
	Delivery	Group	6	0.40	(0.15–0.44)ns	38.24	4.19
		Individual	1	0.16	(0.31–0.98)ns	0.00	0.35
		Self-help	4	0.32	(0.07–0.47)ns	0.00	3.47
	Control	Active	6	0.21	(0.01–0.41)ns	0.00	2.09
		Non-active	5	0.42	(0.29–0.54)ns	26.90	6.54
	Sessions	≤ 8 sessions	2	0.05	(− 0.29 to 3.97)ns	0.07	0.31
		> 8 sessions	9	0.39	(0.28–0.50)ns	8.72	6.98
	Duration	≤ 8 weeks	4	0.21	(0.05–0.37)ns	0.00	2.50
		> 8 weeks	7	0.47	(0.33–0.61)ns	0.00	6.71
	Quality	High	4	0.40	(0.27–0.53)ns	37.00	5.86
		Moderate	2	0.20	(0.00–0.40)ns	0.00	3.21
		Low	5	0.55	(0.21–0.89)ns	0.00	1.91
	Region	Western	2	0.42	(0.11–0.74)ns	0.00	2.65
		Non-western	9	0.34	(0.20–0.48)ns	28.19	4.72

Table 6 (continued)

Outcome	Criteria	Value	N	Hedge's *g*	(95% CI)	I^2	Z
Stress	Population	Clinical	3	−0.09	(−0.52 to 0.36)ns	73.26	−0.55
		Non-clinical	5	0.53	(0.35–0.71)ns	37.59	3.29
	Intervention	PPI	6	0.18	(−0.19 to 0.54)ns	64.85	0.95
		PPI + other	2	0.82	(0.21–1.41)ns	12.49	2.66
	Delivery	Group	4	0.17	(−0.32 to 0.67)ns	79.62	0.69
		Individual	1	0.07	(−1.07 to 1.20)ns	0.00	0.11
		Self-help	3	0.56	(0.06–1.05)ns	0.00	2.20
	Control	Active	4	−0.08	(−0.53 to 0.37)ns	60.75	−0.34
		Non-active	4	0.16	(0.29–0.93)ns	34.65	3.69
	Sessions	≤8 sessions	3	0.60	(0.04–1.15)ns	50.39	2.12
		>8 sessions	5	0.18	(−0.24 to 0.61)ns	72.34	0.84
	Duration	≤8 weeks	3	−0.13	(−0.65 to 0.40)ns	73.60	−0.47
		>8 weeks	5	0.56	(0.24–0.88)ns	30.91	3.39
	Quality	High	3	0.53	(0.27–0.80)ns	20.09	3.99
		Moderate	4	0.38	(−0.01 to 0.77)ns	37.16	1.90
		Low	1	−1.28	(−2.30 to −0.26)ns	0.00	−2.46
	Region	Western	2	−0.14	(−0.78 to 0.51)ns	89.46	−0.41
		Non-western	6	0.50	(0.13–0.87)ns	21.28	2.67

ns non-significant

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

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*Studies preceded by an asterisk were included in the systematic review and meta-analysis

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