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Peer Reviewer of *World Journal of Psychiatry*, Xin-Ke Li, PhD, Associate Professor, College of Medical Informatics, Chongqing Medical University, Chongqing 400016, China. zmdcg@126.com

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Thinking about worry: A systematic review and meta-analysis on the assessment of metacognitions in children and adolescents

Laura M Köcher, Kai Schneider, Hanna Christiansen

ORCID number: Laura M Köcher 0000-0002-1546-038X; Kai Schneider 0000-0002-9450-7843; Hanna Christiansen 0000-0002-8104-0711.

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Laura M Köcher, Hanna Christiansen, Department of Psychology, University of Marburg, Marburg 35037, Germany

Kai Schneider, Department of Clinical Child and Adolescent Psychology, University of Landau, Landau 76829, Germany

Corresponding author: Laura M Köcher, MSc, Research Associate, Department of Psychology, University of Marburg, Frankfurter Straße 35, Marburg 35037, Germany. laura.koecher@uni-marburg.de

Abstract

BACKGROUND

The metacognitive model of generalized anxiety disorder identifies three forms of metacognition: Positive metacognitive beliefs about worry (POS), negative metacognitive beliefs about worry (NEG), and meta-worry. Though this model was originally developed relying on adult samples, it has since been applied to children and youth in different studies, and results mostly support its validity for this group. As the roles of POS, meta-worry, and age-effects do not appear to be fully clarified for children and adolescents yet, an integration of studies on children and adolescents and the metacognitive model is both timely and worthwhile.

AIM

To summarize the current research on relationships, age-effects, and measurements for POS, NEG, and meta-worry in childhood and youth.

METHODS

We carried out a literature search in the electronic databases PsycINFO, PubMed, PSYINDEX, and ERIC in 2017 and updated in 2020. Empirical research in German or English language on metacognition was included with child and adolescent samples diagnosed with anxiety disorders or healthy controls if POS, NEG, or meta-worry were measured. Studies were included for meta-analysis if they reported correlations between these metacognitions and anxiety or worry. Consensus rating for eligibility was done for 20.89% of full-texts with 90.32% agreement. Risk of bias was assessed with the appraisal tool for cross-sectional studies and consensus rating of appraisal tool for cross-sectional studies for 20.83% of included studies attaining agreement of intraclass correlation = 0.898. Overall, correlations between metacognitions, anxiety and worry were calculated with RevMan 5.4.1, assuming random-effects models. Meta-regressions with

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mean age as the covariate were performed *via* the online tool MetaMar 2.7.0. PROSPERO-ID: CRD42018078852.

RESULTS

Overall, $k = 763$ records and $k = 78$ additional records were identified. Of those, $k = 48$ studies with 12839 participants were included and of those, $k = 24$ studies were included for meta-analysis. Most studies showed consistent NEG correlations with worry and anxiety, as well as higher values for clinical than for non-clinical samples. POS findings were less consistent. Meta-analysis revealed large effects for NEG correlating with worry and anxiety, small to medium effects for POS correlating with worry and anxiety, as well as small to medium effects for POS correlating with NEG. Meta-regressions did not reveal mean age as a significant covariate. Meta-worry was assessed in only one study. We identified eight questionnaires and one interview-format that assess metacognition about worry in children and adolescents.

CONCLUSION

POS and NEG are measurable from the age of seven upwards and correlate with anxiety and worry without influences by age. Meta-worry requires further investigation.

Key Words: Metacognition; Anxiety; Child; Adolescent; Measures; Meta-analysis

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Core Tip: Systematic review and meta-analysis showed that positive metacognitive beliefs about worry and negative metacognitive beliefs about worry correlate with worry and anxiety, as claimed in the metacognitive model of generalized anxiety disorder. Studies tended not to report significant correlations between age and positive metacognitive beliefs about worry or negative metacognitive beliefs about worry. Mean age was not a significant covariate in meta-regressions. No conclusions about meta-worry's influence can be drawn. We need an adequate measurement of meta-worry, and measurements applying to young children should undergo further investigation. Studies showed moderate to large heterogeneity, and the power of meta-regression might have been low. As mostly cross-sectional data were collected, no causal conclusions can be drawn.

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INTRODUCTION

Anxiety disorders in children and adolescents reveal a 6.5% prevalence, making them the most prevalent mental disorder in this age group worldwide[1]. They are associated with various negative effects, *e.g.*, impaired school performance, sleep and social functions, increased risk of comorbidities (such as depression or other anxiety disorders), and persistence into adulthood[2-5]. A key feature of anxiety is worry. Worries are understood as repetitive, chained thoughts about potentially negative future events, and they are fear-related[6,7]. These thoughts are common, occurring in 60.1% of children and adolescents[8]. Almost every second preschooler has worries, and even more children worry as they grow older[9]. Worry is associated with anxiety symptoms in community samples as well as in samples consisting of children with anxiety disorders[10,11]. Children with anxiety disorders suffer more intense worries than healthy children[12]. The frequency of worry itself, however, does not seem to be problematic. However, worries seem to become pathological when they are experienced as intense and uncontrollable[13]. Excessive worry is a core criterion of

general anxiety disorder (GAD)[14], and domain-specific worries are a diagnostic criterion of separation anxiety disorder (SAD)[13]. When compared specifically, children with diagnosed anxiety disorders reveal significantly more self-reported worry than healthy children, and children with GAD scored higher on worry assessments than children suffering from other anxiety disorders[11]. Worry is thus a central feature of anxiety in childhood and youth.

In line with the importance of evaluating worries as intense and uncontrollable, both worry itself and "thinking about worry" play key roles in anxiety disorders. Such higher-level thinking is described as metacognition, a concept first defined by Flavell [15] as "knowledge and cognition about cognitive phenomena" (S. 906). Metacognitions are known to be involved in the development and maintenance of mental disorders such as depression and anxiety or obsessive-compulsive disorders (OCD) [16-20]. For pathological worries to develop, Wells[19-21] emphasizes three forms of metacognition that play decisive roles: Positive metacognitive beliefs about worry (POS), negative metacognitive beliefs about worry (NEG), and meta-worry. POS refer to the usefulness of various thoughts (*e.g.*, "Worrying helps me to avoid problems in the future"[22]). NEG can be understood as trait-beliefs that a person generally holds about worries[21]. They include the appraisal of one's own thoughts as uncontrollable and imply negative consequences of worries (*e.g.*, "Worrying is dangerous for me"[22]). Meta-worry can be described as the state of worrying about worry[21]. Wells describes his assumptions about how these metacognitive constructs interact with each other and with worry, behavior, thought control strategies, and emotion in the metacognitive model of GAD[19-21].

The metacognitive model of GAD postulates that an intense, negative thought is what initially triggers worry. Worrying is then especially likely to become a coping strategy when someone tends to think about worry's usefulness (POS). If general beliefs that worry is dangerous or uncontrollable (NEG) have been activated, one starts to worry about current worries (meta-worry). Meta-worry provokes emotions such as anxiety, which only exacerbates worry and meta-worry. Anxiety is misattributed as a consequence of the worries themselves, which in turn reinforces NEG. As this thought spiral continues, meta-worry triggers coping strategies such as reassurance, avoidance behavior, or substance abuse. As these dysfunctional attempts prevent the person from experiencing that worries are controllable and harmless, meta-worry and NEG about the danger of worries are reinforced. Meta-worry can also lead to thought-control strategies such as suppression, and if these fail, meta-worry and NEG will persist (for details and figural display of the metacognitive model of GAD see Wells[21]).

The metacognitive model has been investigated in children and adolescents in different studies. Esbjørn *et al*[23] showed that metacognitive processes, in addition to the effects of gender, age, and anxiety, account for 14% of the variance of worry and an additional 11% of the variance of anxiety in a healthy sample of children. In a second study, patients with GAD reported more POS and NEG than children with other anxiety disorders or healthy controls, and children with anxiety disorders reported more NEG than healthy controls[23]. Another study by Ellis and Hudson[24] also showed that adolescents with anxiety disorders described more POS and NEG than a control group. These findings support assumptions of the metacognitive model of GAD and support its validity in childhood and youth. However, there are also contradictory findings that question this validity. For example, some studies failed to detect any significant relationships between POS and worry or anxiety in children[25,26] or found no differences in either POS or NEG between clinical and non-clinical participants[27,28].

In addition, the question arises as to the age that these metacognitions about worry develop and whether they change with age. Ellis and Hudson[29] noted that few studies on the metacognitive model included children under 12 years of age. There have also been mixed results about the relationship with age, as some studies show correlations between metacognitions and age[24] while other studies do not[30]. When transferring adult models like the metacognitive model of GAD to children, the experience and cognitive skills of children must be taken into account[24]. Metacognitive skills are assumed to be gradually acquired[31]: At 3 years of age, children can name mental processes and distinguish them from the external environment[32,33]. From the age of four, children understand that thoughts can refer to non-real or non-present things[34]. Seven-year-old children know when, what, and at what frequency they themselves or others are thinking[33-35]. However, more recent results indicate that already 3- to 5-year-old children can demonstrate metacognitive knowledge when measured with an age-appropriate interview[36].

To evaluate the age at which children first think about their worries (*i.e.* metacognition about worry), an age-appropriate assessment is needed. Many studies use questionnaires to measure metacognition in children[23,24,27]. However, a recent review's authors concluded that questionnaires for younger children yield mixed results for factor structure, internal consistency, and age-appropriateness, and they emphasize the need for further development and psychometric analysis of assessments for metacognition in childhood[37].

The present systematic review synthesizes the latest findings about metacognition on worry in children and adolescents. Current knowledge for POS, NEG, and meta-worry as well as their development is summarized, as are available assessments of POS, NEG, and meta-worry for children and adolescents. In so doing, we posed the questions below:

What evidence is there for positive relationships between POS, NEG, and meta-worry with each other and with worry and anxiety in children and adolescents?

At what age do children report POS, NEG, and meta-worry, and does age play any role in relationships with worry and anxiety?

Which methods are currently applicable to assess POS, NEG, and meta-worry in childhood and youth?

To answer these questions, we conducted a systematic review of the recent literature. We synthesized the tested relationships between POS, NEG, meta-worry with each other, worry, and anxiety in order to compare those results with the postulated relationships in the metacognitive model of GAD. For further validation, we compared non-clinical samples and clinical samples consisting of children and adolescents with anxiety disorders, as the latter are likely to exhibit more NEG and meta-worry according to the metacognitive model of GAD, while that does not necessarily apply to POS (compare Wells[21]). To assess potential age effects, we summarized results for age of onset and developmental patterns for POS, NEG, and meta-worry. Different methods of assessing POS, NEG, and meta-worry and reported reliability measures, their usage in age-ranges, and the numbers of studies are resumed.

Depending on the studies identified, we conducted additional meta-analysis based on effect sizes of POS, NEG, and meta-worry correlations with each other and with anxiety and worry. Whenever possible, we performed meta-regressions to analyze whether age is a significant covariate for these relationships.

MATERIALS AND METHODS

Literature search

This systematic review was registered with PROSPERO (International prospective register of systematic reviews, PROSPERO-ID: CRD42018078852, last update: January 26, 2021) and is based on the PRISMA Statement[38] and the PRISMA-P Statement [39]. The literature search was first run on September 24, 2017 and updated on February 6, 2020.

The search string "(children OR adolescents*) AND (meta cognition* OR metacognition* OR meta-cognitive belief* OR meta cognitive belief*) AND (anxiety OR worry OR phobia)" was used in the following databases: PsycINFO, PubMed, and PSYINDEX. In addition, available full-texts of the database ERIC were searched with the same search string. In the first search (2017), we set no limitations to obtain a preferably broad impression of the state of research. In the second search (2020), the period was limited to publication dates between 2017 and 2020. We identified additional studies through a backward search of reference lists by screening additive publications of research groups and, to include the gray literature, the screening of doctoral theses. After identifying records through the databases and additional searches, duplicates were removed. Afterwards, titles, key words, and abstracts in all records were screened by the first author. The full-text versions of the remaining records were analyzed for eligibility. Doctoral theses were only included if the data had not been published in a journal. In case of the latter, the publication was included and the doctoral thesis was excluded from analysis. The study selection process was conducted by one reviewer (Köcher LM). Additionally, 20.89% ($k = 33$) of the full-texts were independently rated for eligibility by another reviewer (Schneider K). Overall, 90.32% of the ratings were in agreement. In case of discrepancies, a third reviewer (Christiansen H) was consulted, and consensus was reached for the remaining 9.68% ($k = 3$) of records.

Study selection

Empirical studies reporting quantitative data were included in the systematic review, which fulfilled the following criteria: (1) Participants were 18 years of age or younger; (2) Non-clinical samples and/or clinical samples with anxiety disorders were investigated. We followed the classification for anxiety disorders in the fifth edition of the “Diagnostic and Statistical Manual of Mental Disorders” (DSM-5)[40], including the following diagnoses: GAD, SAD, social anxiety disorder (SoD), specific phobia, agoraphobia, and panic disorder; (3) POS, NEG, and/or meta-worry were assessed as an outcome variable; (4) The study was published in English or German language; and (5) The study had been published by February 6, 2020.

To be included in our meta-analysis, studies also had to fulfill these criteria: (6) Bivariate correlation coefficients for relationships between POS/NEG/meta-worry with each other/anxiety/worry were reported; and (7) Data were not reported in a study that had already been included in our meta-analysis.

Data extraction

The first author extracted the following information from the included studies: Author(s), year of publication, title, country, study design, sample size, study population (non-clinical and/or clinical, and related diagnoses), participants’ age range and/or mean age, gender distribution, measurement of POS/NEG/meta-worry and reliability, anxiety measurement, worry measurement, relationship of POS/NEG/meta-worry with each other/anxiety/worry/age, and group differences between clinical and non-clinical subgroups in POS/NEG/meta-worry.

The study characteristics coded for meta-analysis and meta-regression by the first author were: Effect sizes of correlations between POS/NEG/meta-worry with each other/anxiety/worry, sample size, and mean age. If studies reported correlational coefficients split for different subgroups such as male or female participants, or clinical or non-clinical participants, correlations were coded separately for subgroups and then combined to a single correlation according to the following procedure: Correlations were transformed into Fisher’s *z* scores and weighted by subsample size, then the mean of both values was inversely *z*-transformed into product-moment-correlation coefficients. If a study reported a subsample’s data in a previous study that we had already included in the meta-analysis, only the other subsample’s data were coded for this study. For meta-regressions, studies were only included if they reported the mean age of their samples. If mean age was reported for split subgroups, values were coded for each of these subgroups and mean of the mean ages, weighted by subsample sizes, was calculated and used for meta-regression.

Risk of bias

To assess the risk of bias, each study was rated on the Appraisal tool for Cross-Sectional Studies (AXIS)[41] by one reviewer (Köcher LM). AXIS-scores range between 0 and 20 and were clustered in the categories high (0-6), moderate (7-13), and low risk of bias (14-20) for a global rating. Additionally, 20.83% of studies ($k = 10$) were rated by an independent reviewer in our working group. Our interrater agreement (intraclass correlation = 0.898) can be considered as good[42].

Statistical analysis

Statistical analysis was performed by the first author and reviewed by the third author at the Department of Psychology, Philipps University Marburg. Coded correlation coefficients were transformed into Fisher’s *z* scale for meta-analysis. For reports of summary correlations, all summary Fisher’s *z* were back-transformed into Pearson’s product-moment correlations. Cohen’s criteria[43] were used to interpret overall effect sizes. Random-effect models were used for analysis because of assumed heterogeneity in addition to sampling error. Calculations were computed using the computer program RevMan, version 5.4.1[44]. To show actual dispersion of overall effects, prediction intervals are reported in addition to CIs, as proposed by IntHout *et al*[45], and calculated based on the T^2 -estimate[46]. Heterogeneity was tested using *Q*-statistic and I^2 . Interpretations of I^2 are based on benchmarks proposed by Higgins *et al*[47]. Results of each meta-analysis are graphically illustrated in forest plots. A set of meta-regressions was conducted to test whether mean age of the included studies moderated the analyzed correlations significantly. Other potential covariates such as sample type (clinical *vs* non-clinical) were not examined due to the low number of $k = 1$ study[25] included in the meta-analysis with a clinical sample only. Meta-regressions were run using the free online meta-analysis tool Meta-Mar, version 2.7.0[48].

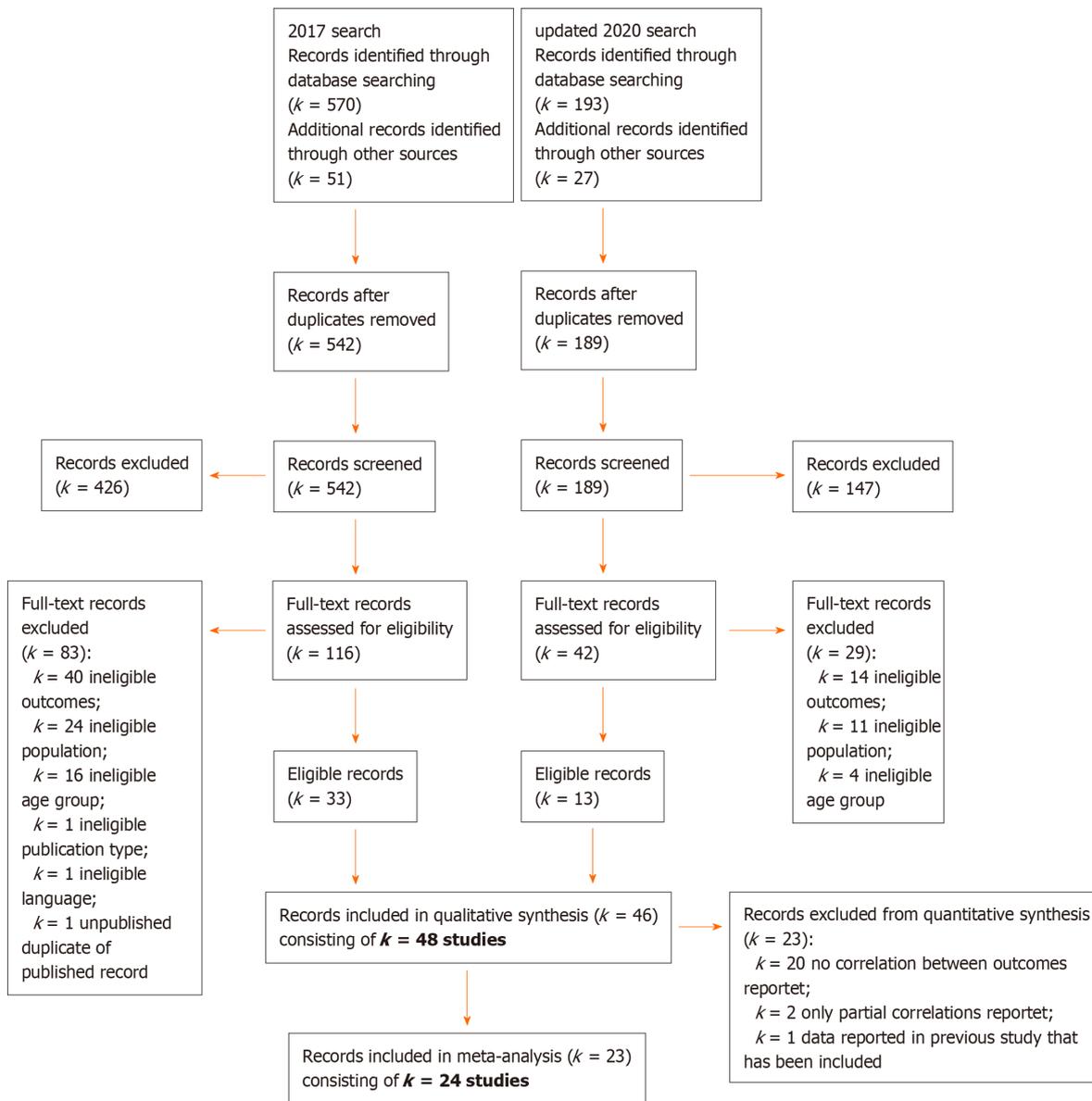


Figure 1 Adapted PRISMA Flowchart for study selection in this systematic review and meta-analysis.

RESULTS

Study selection

Figure 1 shows this review’s selection process divided into the first search in 2017 and the search updated in 2020. Overall, $k = 763$ records were identified through database searching. A total of $k = 78$ additional records were identified through other sources. Initially, a total of $k = 110$ duplicates were removed. Next, the first author screened the titles and abstracts of the identified studies. $k = 158$ records remained in the selection process after screening. Overall, $k = 46$ records fulfilled our inclusion criteria. Of those, each of two records reported two studies[23,49], resulting in $k = 48$ studies overall included in this systematic literature review. In two cases, working groups analyzed the same datasets in two independently published records[27,28,50,51]. For quantitative synthesis, $k = 24$ studies fulfilled our inclusion criteria and were included in meta-analysis.

Characteristics of studies included in this systematic review

An overview of the included studies and study characteristics is found in Table 1. They contain $k = 47$ published studies carried out in Australia, Canada, Denmark, Germany, Italy, Iran, Turkey, the United Kingdom or Ireland, and United States between 2003 and 2020. The $k = 1$ remaining study is characterized as gray literature and was submitted in 2014 to qualify for a doctorate degree at a German university.

Table 1 Overview of studies included in the systematic review

Ref.	Sample	n	Female (%)	Age in year (range), mean ± SD	Risk of bias	POS/NEG/meta-worry	Worry	Anxiety
Babaei <i>et al</i> [55]	NC	200	NA	NA	Mod (9)	MCQ-30	-	GHQ-scale
Bacow <i>et al</i> [27]	Total/C ^{1,2,3,4} /NC	98/78/20	NA/63%/65%	(7-17) NA/(NA) 11.9 ± 3.1/(NA) 12.4 ± 3.0	Low (14)	MCQ-C	ADIS-C-section	ADIS-C/P
Bacow <i>et al</i> [28]	Total/C ^{1,2,3,4} /NC	98/78/20	NA/63%/65%	(7-17) NA/(NA) 11.9 ± 3.1/(NA) 12.4 ± 3.0	Low (14)	MCQ-C	PSWQ-C; ADIS-C-section	ADIS-C/P
Benedetto <i>et al</i> [64]	NC	184	53%	(11-13) 12.0 ± 0.9	Mod (13)	MCQ-C	PSWQ-C	RCMAS-2
Benedetto <i>et al</i> [49], study1	NC	191	49%	(13-18) 16.4 ± 1.76 ^a	Mod (13)	MCQ-C	-	RCMAS-2
Benedetto <i>et al</i> [49], study2	C ^{1,5} /NC ^b	14/14	57%/NA	(12-17) 14.9 ± 1.6/NA	Low (14)	MCQ-C	-	RCMAS-2
Boysan <i>et al</i> [92]	NC	805	49%	(11-17) 13.9 ± 1.4	Low (14)	MCQ-C	-	STAI-C
Carr and Szabó [72]	NC	93	48%	(7-12) 10.0 ± 1.2	Low (16)	MCQ-C	CAWS	-
Cartwright-Hatton <i>et al</i> [53]	C ⁶ /NC	(11)/166	(64%)/66%	NA/(13-17) 15.3 ± NA	Mod (12)	MCQ-A	-	RCMAS
Donovan <i>et al</i> [80]	Total/C ¹ /NC	50/25/25	60%/NA/NA	(7-12) 9.9 ± 1.5/NA/NA	Low (14)	MCQ-C	PSWQ-C	ADIS-C
Donovan <i>et al</i> [65]	NC	114	51%	(8-12) 9.9 ± 1.3	Low (15)	MCQ-C	PSWQ-C	-
Ellis and Hudson [24]	Total/C ^{1,5} /NC	123/81/42	NA/57%/52%	(12-17) NA/(NA) 14.1 ± 1.5/(NA) 13.7 ± 1.4	Low (15)	MCQ-A	PSWQ	ADIS-C/P; SCAS-C/P
Esbjørn <i>et al</i> [23], study1	NC	587	55%	(9-17) 12.5 ± 0.9 ^a	Mod (12)	MCQ-C ₃₀	PSWQ-C	SCARED-R
Esbjørn <i>et al</i> [23], study2	Total/C ^{1,4,7,3} /NC	93/50/43	NA/NA/NA	(7-12) 9.8 ± 1.6/NA/NA	Mod (13)	MCQ-C ₃₀	-	ADIS-C/P
Esbjørn <i>et al</i> [93]	NC	111	64%	(8-12) 10.1 ± 1.4	Low (15)	MCQ-C ₃₀	PSWQ-C	ADIS-C/P; RCADS
Esbjørn <i>et al</i> [66]	NC	974	55%	(9-17)	Low (15)	MCQ-C ₃₀	PSWQ-C	SCARED-R
Esbjørn <i>et al</i> [56]	C ¹	44	50%	(7-13) 9.7 ± 1.6	Low (15)	MCQ-C ₃₀	PSWQ-C	ADIS; RCADS
Fergus and Limbers[57]	NC (TG)/NC (CG)	39/34	62%/71%	(NA) 13.8 ± 0.5/(NA) 13.8 ± 0.7	Low (17)	MCQ-C	-	CTAS
Fisak <i>et al</i> [73]	NC	175	66%	(11-18) 13.9 ± 1.5	Mod (12)	MCQ-C;MWQ	PSWQ-C	-
Francis <i>et al</i> [50]	NC	312	55%	(9-15) 11.9 ± 1.2	Low (15)	MCQ-C	PSWQ-C	SCAS;MASC
Francis <i>et al</i> [51]	NC	312	55%	(9-15) 11.9 ± 1.2	Mod (14)	MCQ-C	PSWQ-C	-
Gallagher and Cartwright-Hatton[94]	NC	168	85%	(16-18) 17.2 ± 0.9	Mod (11)	MCQ-30	-	STAI-T
Gini <i>et al</i> [67]	NC	1169	48%	(14-17) 15.8 ± 1.1	Mod (11)	MCQ-30	PSWQ-C	GAD7
Hearn <i>et al</i> [25]	C ³	126	60%	(8-17) 11.3 ± 2.7	Mod (13)	MCQ-C	PSWQ-C(SF)	ADIS;SPAI-10-C/P

Hearn <i>et al</i> [74]	Total/C ^{1,3} /NC	60/40/20	70%/NA/NA	(8-12) 9.9 ± 1.3/NA/NA	Low (15)	MCQ-C	PSWQ-C(SF)	ADIS; SCAS
Hearn <i>et al</i> [26]	Total/C ³ (TG)/C ³ (WL)	125/95/30	60%/NA/NA	(8-17) 11.3 ± 2.7/NA/NA	Low (17)	MCQ-C	PSWQ-C(SF)	ADIS; SPAI-10
Holmes <i>et al</i> [59]	C ¹	1	0%	10	Low (16)	MCQ-C	PSWQ-C	ADIS-C/P;SCAS-C/P
Holmes <i>et al</i> [58]	Total/C ¹ (TG)/C ¹ (WL)	42/20/22	67%/NA/NA	(7-12) 9.6 ± 1.4/NA/NA	Low (17)	MCQ-C	PSWQ-C	ADIS-C/P;SCAS-C/P
Irak[78]	NC	470	44%	(8-17) 12.2 ± 2.8	Mod (12)	MCQ-C	-	STAI-C
Kertz and Woodruff-Borden [75]	NC	80	71%	(8-12) 9.6 ± 1.1	Mod (12)	MCQ-C	PSWQ-C(SF)	RCMAS
Laugesen <i>et al</i> [71]	NC	528	49%	(14-18) 15.6 ± 0.9	Low (15)	WW-II	PSWQ-C	WAQ
Lønfeldt <i>et al</i> [76]	NC	188	66%	(7-12) 10.0 ± 1.4	Low (14)	MCQ-C ₃₀	-	ADIS-P; RCADS
Lønfeldt <i>et al</i> [77]	NC	1062	55%	(9-17) 12.3 ± 1.7	Low (14)	MCQ-C ₃₀	-	SCARED-R
Mather and Cartwright-Hatton[95]	NC	166	66%	(13-17) 15.1 ± 1.4	Mod (12)	MCQ-A	-	RCMAS
Matthews <i>et al</i> [81]	NC	223	56%	(13-16) NA	Mod (13)	MCQ-A	-	-
Naumann[68]	NC	972	52%	(7-14) 10.6 ± 1.5	Low (14)	MKF-K	PSWQ-C	SCAS
Normann <i>et al</i> [60]	C ^{1,4,3,7}	44	50%	(7-12) 9.9 ± 1.6	Low (14)	MCQ-C ₃₀	-	ADIS-C/P; SCARED-R
Reinholdt-Dunne <i>et al</i> [79]	C ^{1,4,3,7} /NC	169/182	53%/55%	(7-14) 9.9 ± 1.8/(7-12) 10.0 ± 1.4	Low (16)	MCQ-C ₃₀	-	RCADS
Sanger and Dorjee[61]	NC (TG)/NC (CG)	20/25	50%/68%	(16-18) 16.6 ± 0.6/(16-18) 17.1 ± 0.6	Mod (12)	MCQ-A	-	-
Simons and Vloet [62]	C ⁷	3	100%	(14-17) 15.3 ± 1.5	Mod (13)	MCQ-A	SCAS-scale	SCAS
Smith and Hudson[52]	Total/C ^{1,3,2,7,4,8} /NC	83/49/34	60%/NA/NA	(7-12) 9.2 ± 1.6/NA/NA	Mod (13)	MCQ-C	-	ADIS-C/P; SCAS
Thorslund <i>et al</i> [63]	C ^{1,3,9}	10	70%	(14-17) 15.2 ± NA	Low (14)	MCQ-C	PSWQ-C	MINIKid
White and Hudson[30]	NC	187	31%	(7-12) 10.6 ± 1.7	Low (15)	MCQ-CR	PSWQ-C	SCAS
Wilson <i>et al</i> [82]	NC	72	54%	(11-16) 13.2 ± 1.0	Mod (13)	MCQ-A	PSWQ-C	MASC
Wilson and Hall [69]	NC	151	56%	(13-16) 15.1 ± 1.0	Mod (12)	MCQ-A	TCQ-scale	-
Wilson and Hughes[70]	NC	57	61%	(6-10) NA	Mod (12)	Interview	PSWQ-C	MASC
Yavuz <i>et al</i> [96]	NC	1817	54%	(14-17) 15.4 ± 1.1	Mod (12)	MCQ-C	-	NMP-Q
Zimmermann <i>et al</i> [54]	NC	221	55%	(13-17) 14.9 ± 1.4	Mod (12)	MCQ-A	-	SBB-ANZ

^aMean was only reported for subsamples and has been weighted on sample size.

^bSubsample from study 1.

Superscript numbers show diagnosis of clinical groups in descending order:

- ¹Generalized Anxiety disorder.
²Obsessive-compulsive-disorder.
³Social Anxiety Disorder.
⁴Separation Anxiety disorder.
⁵Other Anxiety disorder.
⁶Any emotional disorder.
⁷Specific Phobia.
⁸Post-traumatic stress disorder.
⁹Panic disorder/ agora phobia.

NA: Not available; TG: Treatment group; WL: Waiting list; CG: Control group; POS: Positive beliefs about worry; NEG: Negative beliefs about worry; Mod: Moderate; MCQ-30: Metacognitions Questionnaire-30-Item Version; MCQ-C: Metacognitions Questionnaire for children; MCQ-A: Metacognitions Questionnaire-Adolescent Version; MKF-K: Metakognitions-Fragebogen für Kinder; MCQ-CR: Revised Metacognitions Questionnaire for Children; MCQ-C₃₀: Metacognitions Questionnaire for Children-30Item Version; MWQ: Meta-Worry Questionnaire; ADIS-C/P: Anxiety Disorders Interview Schedule Child/Parent Versions; PSWQ: Penn State Worry Questionnaire; PSWQ-C: Penn State Worry Questionnaire for Children; WAQ: Worry and Anxiety Questionnaire; RCMAS,RCMAS-2: Revised Children's Manifest Anxiety Scale; STAI-C: State-Trait Anxiety Inventory for Children; CAWS: Child and Adolescent Worry Scale; SCAS: Spence Children's Anxiety Scale; SCARED-R: Revised Version of the Screen for Child Anxiety Related Emotional Disorders; MASC: Multidimensional Anxiety Scale for Children; GHQ: General Health Questionnaire; TCQ: Thought Control Questionnaire; SPAI-10: Social Phobia and Anxiety Inventory for Children; CTAS: Children's Test Anxiety Scale; MINI Kid: Mini International Neuropsychiatric Interview for Children and Adolescents; GAD7: 7-item Generalized Anxiety Disorder scale; NMP-Q: Nomophobia Questionnaire; SBB-ANZ: Diagnostik-System für Psychische Störungen nach ICD-10 und DSM-IV für Kinder und Jugendliche - Selbstbeurteilungsfragebogen Angst- und Zwangsstörungen; SD: Standard deviation.

A total of $n = 12839$ participants were examined in the included studies. Median sample size was $n = 138.50$ per study, range $n = 1$ to $n = 1817$. Gender distribution was reported in $k = 46$ studies. Overall, a mean of 56.84% of participants per study described themselves as female, ranging from 0% to 100% per study. The age of participants ranged from 6 to 18 years. $k = 30$ studies involved a non-clinical sample, $k = 8$ studies involved a purely clinical sample, and $k = 10$ studies included both a clinical group and a non-clinical group. The non-clinical samples were usually convenience samples recruited from schools. Studies with clinical samples included the primary diagnoses GAD, SAD, SoD, panic disorder/agoraphobia, and specific phobia. In three studies, OCD or post-traumatic stress disorder were classified as anxiety disorders[27,28,52]. Patients with these primary disorders represented a percentage of 8.1% to 18.4% of patients included with anxiety disorders. Most studies revealed a cross-sectional design. Three studies included a retest-measurement to assess test-retest correlations for validating different questionnaires[53-55]. Nine studies followed a longitudinal design in the form of intervention studies with pre-post- (and follow-up) measurement points[26,56-63].

Risk of bias

We used the AXIS-tool to assess the risk of bias. Most of the studies were classified as low risk of bias ($k = 25$) and moderate risk of bias ($k = 23$), whereas no study was classified as having a high risk of bias (see Table 1).

What evidence is there for positive relationships between POS, NEG, and meta-worry with each other, worry, and anxiety for children and adolescents?

Relationships between POS, NEG, meta-worry, and worry: Table 2 provides an overview of the relationships reported in the included studies. In total, $k = 18$ studies researched the relationships between POS, NEG, and worry. Most thereof demonstrated correlations between worry and both POS and NEG[24,51,64-70]. Moreover, two studies collected POS exclusively and reported significant correlations between worry and POS[71,72]. Two studies showed that POS and NEG contribute to worry as unique predictors[23,73], and another study that exclusively measured POS identified it as a unique predictor of worry[72]. However, other studies found that worry correlated only with NEG, not with POS[26,30,74,75]. Another study detected a correlation between POS and worry that disappeared after the authors controlled for worry contents, while worry nevertheless continued to correlate with NEG[28]. One study detected no group differences in worry between participants who described POS or NEG verbally in open-ended questions and those who did not[70]. Only one study investigated the relationship between meta-worry and worry and observed positive correlations between them[73].

Results of meta-analysis: Table 3 shows our meta-analysis results. Meta-analysis ($k = 13$) for correlation between POS and worry resulted in an overall small to medium effect size [$r = 0.27$ (0.22, 0.33), $P < 0.001$]. Q -Test for heterogeneity was significant ($Q =$

Table 2 Extracted correlational coefficient on measures of positive beliefs about worry/negative beliefs about worry and worry/anxiety

Ref.	Worry		Anxiety		POS	Age	
	POS	NEG	POS	NEG	NEG	POS	NEG
Babaei <i>et al</i> [55]	-	-	-0.053	-0.303 ^b	0.21 ^b	-	-
Bacow <i>et al</i> [27]	-	-	-	-	-	NA	NA
Bacow <i>et al</i> [28]	0.21 ^a	0.55 ^b	-	-	-	-	-
Benedetto <i>et al</i> [64]	0.23 ^b	0.70 ^b	0.29 ^b	0.65 ^b	0.30 ^b	-	-
Benedetto <i>et al</i> [49], study1	-	-	0.20 ^{3,a} ; 0.01 ⁴	0.56 ^{3,b} ; 0.48 ^{4,b}	0.17 ³ ; 0.31 ^{4,b}	-	-
Benedetto <i>et al</i> [49], study2	-	-	-0.68 ^{1,a} ; 0.38 ²	0.56 ^{1,a} ; 0.42 ²	-0.41 ¹ ; 0.69 ^{2,b}	-	-
Boysan <i>et al</i> [92]	-	-	-	-	-	-	-
Carr and Szabó[72]	0.35 ^c	-	-	-	-	0.02	-
Cartwright-Hatton <i>et al</i> [53]	-	-	0.32 ^c	0.67 ^c	-	-	-
Donovan <i>et al</i> [80]	-	-	-	-	-	-	-
Donovan <i>et al</i> [65]	0.22 ^a	0.72 ^b	-	-	0.20 ^a	-	-
Ellis and Hudson[24]	0.49 ^b	0.84 ^b	0.46 ^b	0.72 ^b	-	0.16	0.16
Esbjörn <i>et al</i> [23], study1	-	-	-	-	-	-	-
Esbjörn <i>et al</i> [23], study2	-	-	-	-	-	-	-
Esbjörn <i>et al</i> [93]	-	-	-	-	-	-	-
Esbjörn <i>et al</i> [66]	0.25 ^c	0.31 ^c	0.17 ^c	0.55 ^c	0.25 ^c	-	-
Esbjörn <i>et al</i> [56]	-	-	-	-	-	-	-
Fergus and Limbers[57]	-	-	-	-	-	-	-
Fisak <i>et al</i> [73]	-	-	-	-	-	-	-
Francis <i>et al</i> [50]	-	-	-	-	-	-	-
Francis <i>et al</i> [51]	0.39 ^b	0.69 ^b	-	-	0.31 ^b	-	-
Gallagher and Cartwright-Hatton[94]	-	-	-	-	-	-	-
Gini <i>et al</i> [67]	0.32 ^c	0.65 ^c	0.22 ^c	0.60 ^c	0.16 ^c	-	-
Hearn <i>et al</i> [25]	0.16	0.50 ^b	0.02	0.39 ^b	0.08	-	-
Hearn <i>et al</i> [74]	-	-	-	-	-	-	-
Hearn <i>et al</i> [26]	0.02	0.48 ^b	0.01	0.36 ^b	-	-	-
Holmes <i>et al</i> [59]	-	-	-	-	-	-	-
Holmes <i>et al</i> [58]	-	-	-	-	-	-	-
Irak[78]	-	-	0.194 ^c	0.412 ^c	-	-	-
Kertz and Woodruff-Borden[75]	0.14 (P)	0.53 ^c (P)	-	-	-	-	-
Laugesen <i>et al</i> [71]	0.37 ^c (P)	-	-	-	-	-	-
Lønfeldt <i>et al</i> [76]	-	-	0.31 ^b	0.57 ^b	0.30 ^b	0.10	0.06
Lønfeldt <i>et al</i> [77]	-	-	0.19 ^a	0.58 ^a	0.23 ^c	-0.01	-0.08 ^a
Mather and Cartwright-Hatton[95]	-	-	-	-	-	-	-
Matthews <i>et al</i> [81]	-	-	-	-	0.47 ^a	-0.05	-0.18 ^b
Naumann[68]	0.20 ^b	0.63 ^b	0.20 ^b	0.55 ^b	0.07	-	-
Normann <i>et al</i> [60]	-	-	-	-	-	-	-
Reinholdt-Dunne <i>et al</i> [79]	-	-	0.09 ¹ ; 0.36 ^{2,b}	0.62 ^{1,b} ; 0.68 ^{2,b}	0.05 ¹ ; 0.29 ^{2,b}	0.10 ¹ ; -0.10 ²	0 ¹ ; 0 ²
Sanger and Dorjee[61]	-	-	-	-	-	-	-
Simons and Vloet[62]	-	-	-	-	-	-	-

Smith and Hudson[52]	-	-	0.30 ^b	0.47 ^b	0.36 ^b	-	-
Thorslund <i>et al</i> [63]	-	-	-	-	-	-	-
White and Hudson[30]	0.08	0.65 ^b	0.20 ^b	0.56 ^b	0.27 ^a	0.06	0.07
Wilson <i>et al</i> [82]	0.35 ^b	0.74 ^b	0.19	0.51 ^a	NA	< 0.16	< 0.16
Wilson and Hall[69]	0.33 ^c	0.51 ^c	-	-	0.29 ^c	-	-
Wilson and Hughes[70]	-	-	-	-	-	-	-
Yavuz <i>et al</i> [96]	-	-	-	-	-	-	-
Zimmermann <i>et al</i> [54]	-	-	0.22 ^b	0.57 ^b	-	0.16 ^a	0.12

¹Clinical group.

²Non-clinical group.

³Female subsample.

⁴Male subsample.

^a $P < 0.05$.

^b $P < 0.01$.

^c $P < 0.001$.

NA: Not available; POS: Positive beliefs about worry; NEG: Negative beliefs about worry; (P): Partial correlation.

Table 3 Summary of results for random effect models for meta-analysis on correlational coefficient on measures of positive beliefs about worry/negative beliefs about worry and worry/anxiety

Meta-analysis	Overall effect							Heterogeneity test		
	<i>k</i>	<i>r</i>	95%CI, <i>r</i>	95%PI, <i>r</i>	Fisher's <i>z</i>	95%CI, <i>z</i>	<i>Z</i>	<i>Q</i>	<i>I</i> ²	<i>T</i> ²
POS and worry	13	0.27	(0.22, 0.33)	(0.08, 0.45)	0.28	(0.22, 0.34)	9.56, $P < 0.001$	36.14, $P < 0.001$	67 %	0.01
NEG and worry	12	0.64	(0.55, 0.72)	(0.27, 1.25)	0.76	(0.62, 0.90)	10.49, $P < 0.001$	233.90, $P < 0.001$	95 %	0.06
POS and anxiety	18	0.20	(0.16, 0.25)	(0.00, 0.38)	0.20	(0.16, 0.25)	8.54, $P < 0.001$	52.11, $P < 0.001$	67 %	0.01
NEG and anxiety	18	0.53	(0.46, 0.60)	(0.19, 0.76)	0.59	(0.50, 0.69)	12.32, $P < 0.001$	234.07, $P < 0.001$	93 %	0.04
POS and NEG	17	0.24	(0.18, 0.28)	(0.04, 0.41)	0.24	(0.18, 0.29)	8.49, $P < 0.001$	66.44, $P < 0.001$	76 %	0.01

k: Number of studies included in meta-analysis; *r*: Pearson's product-moment correlation; CI: Confidence interval; PI: Prediction interval; SE: Standard error; POS: Positive beliefs about worry; NEG: Negative beliefs about worry.

36.14, $P < 0.001$), and inconsistency can be described as moderate to high ($I^2 = 67\%$). For correlation between NEG and worry ($k = 12$), the overall correlation coefficient was $r = 0.64$ (0.55, 0.72), $P < 0.001$, indicating a large effect. Heterogeneity tests resulted in significant and substantial inconsistency: $I^2 = 95\%$, $Q = 233.90$, $P < 0.001$. Forest plots for meta-analysis are depicted in Figures 2 and 3. As only one study examined meta-worry[73], we could not conduct a meta-analysis for a correlation with worry.

Relationships between POS, NEG, meta-worry, and anxiety: $k = 21$ studies analyzed the association between POS and NEG and anxiety symptoms. Correlations between POS, NEG, and anxiety were demonstrated in the majority of studies[24,30,52-54,64,66-68,76-78]. However, other study findings contradict those results. Three studies revealed correlations between anxiety and NEG, while anxiety failed to correlate with POS[25,26,70]. NEG contributed to anxiety as a unique predictor in one study, while POS did not predict anxiety significantly[23]. In study 1 by Benedetto *et al*[49], anxiety did correlate with NEG in female and male participants, whereas POS and anxiety correlated significantly in female subjects only. In study 2, those two correlations were proven in adolescents with an anxiety disorder only but not in a non-clinical sample [49]. Another study showed that NEG correlated with anxiety in clinical and non-clinical groups, while POS were only associated with anxiety in a clinical group[79]. In the study by Wilson and Hughes[70], children's anxiety scores did not differ as to

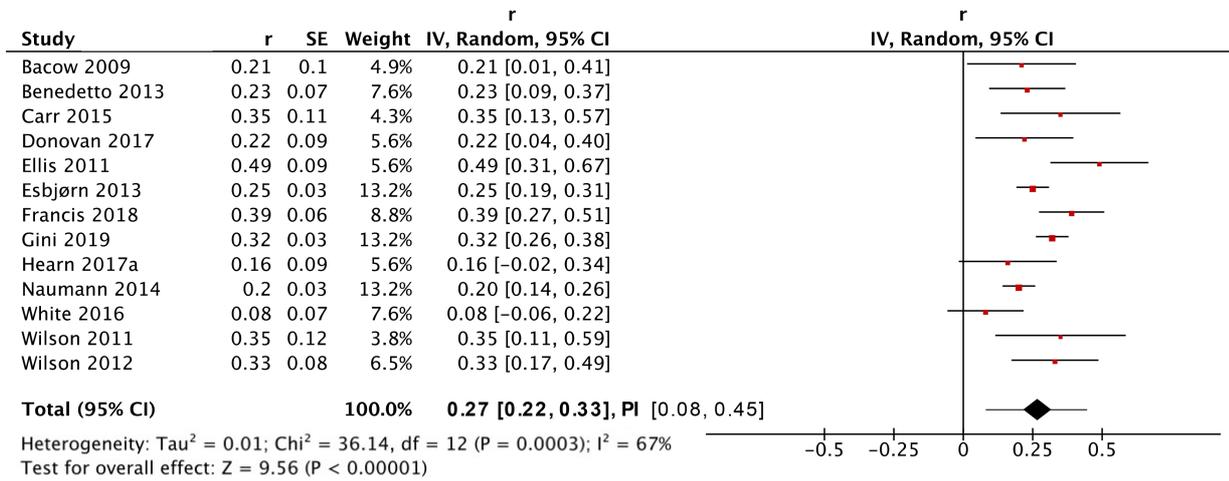


Figure 2 Meta-analysis forest plot on the correlation between measures of positive metacognitive beliefs about worry and worry. CI: Confidence interval; SE: Standard error.

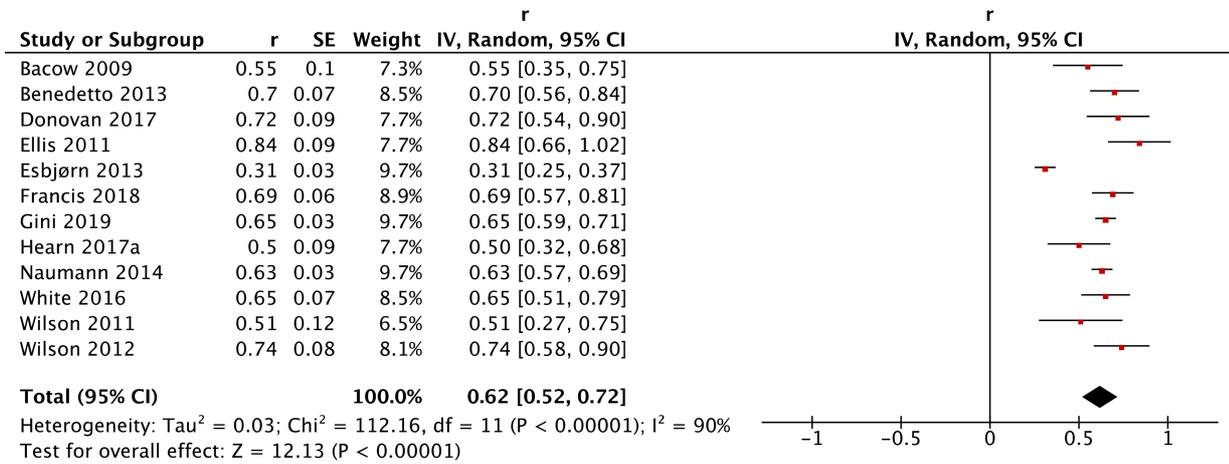


Figure 3 Meta-analysis forest plot on the correlation between measures of negative metacognitive beliefs about worry and worry. CI: Confidence interval; SE: Standard error.

whether they reported NEG or POS. One study even identified a negative correlation between NEG and anxiety, while POS did not correlate with anxiety[55]. No study examined whether meta-worry was related to anxiety. Extracted relationships are shown in [Table 2](#).

Results of meta-analysis: For the correlation between POS and anxiety, we identified $k = 18$ studies for meta-analysis. The overall effect size was small [$r = 0.20$, 95%CI (0.16, 0.25), $P < 0.001$]. Q -Test for heterogeneity was significant ($Q = 52.11$, $P < 0.001$) and the amount of inconsistency is moderate to high ($I^2 = 67\%$). Testing of overall-effect size when correlating NEG and anxiety ($k = 18$) resulted in a large effect [$r = 0.53$ (0.46, 0.60), $P < 0.001$]. With respect to heterogeneity, the Q -statistic is significant ($Q = 234.07$, $P < 0.001$), and results speak for inconsistency ($I^2 = 93\%$). Our meta-analysis results are displayed in [Table 3](#), the forest plots in [Figures 4 and 5](#). No meta-analyses for correlations between worry and meta-worry were possible as no study investigated potential relationships between those variables.

Clinical vs non-clinical groups: A total of $k = 10$ studies included both clinical and non-clinical samples. Three studies showed that their clinical sample held significantly higher POS and NEG than the non-clinical group[24,52,79]. In other studies, clinical participants reported more NEG than non-clinical participants, POS revealed no group difference[49,53,74,80]. One study found that both investigated clinical samples (GAD, other anxiety disorders) held significant higher NEG than a non-clinical group, but only patients with GAD differed from healthy controls in case of POS[23]. Two studies

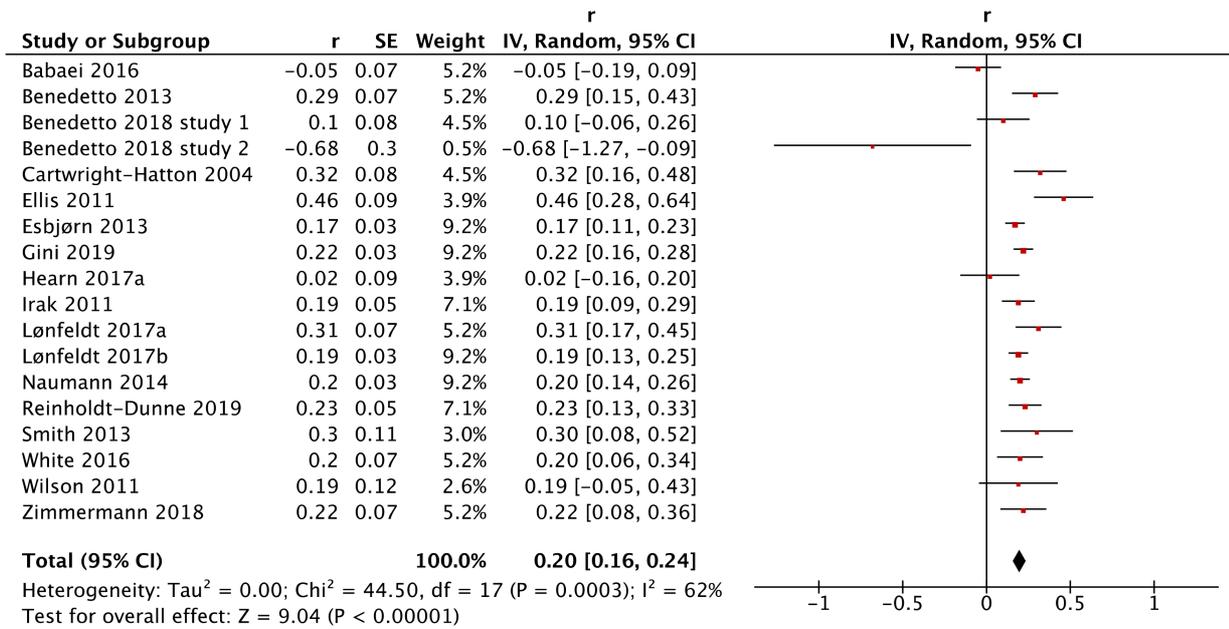


Figure 4 Meta-analysis forest plot on the correlation between measures of positive metacognitive beliefs about worry and anxiety. CI: Confidence interval; SE: Standard error.

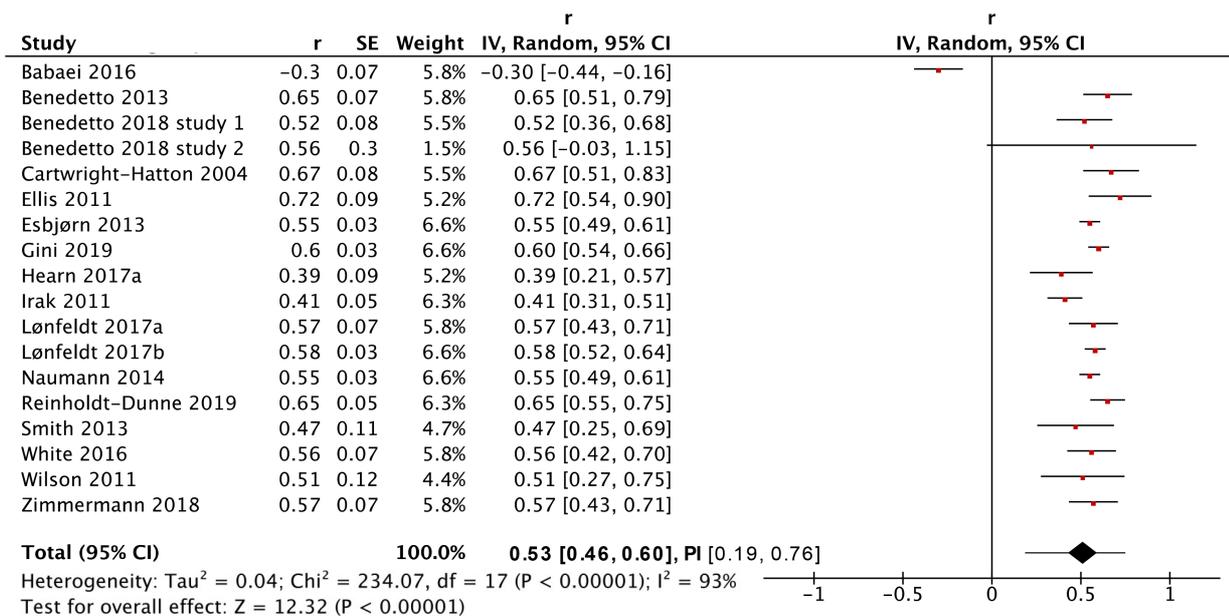


Figure 5 Meta-analysis forest plot on the correlation between measures of negative metacognitive beliefs about worry and anxiety. CI: Confidence interval; SE: Standard error.

failed to demonstrate significant differences between a non-clinical sample and patients with anxiety disorders for POS or NEG[27,28]. Furthermore, $k = 4$ studies compared different anxiety disorders with each another specifically. The findings by Bacow *et al*[27] indicate that children and adolescents with OCD, SAD, SoD, and non-clinical controls do not differ in POS or NEG. Another study reported no group differences between patients with GAD and patients with SoD for POS or NEG[74]. Ellis and Hudson[24] detected no differences either between their sample with GAD and one with other anxiety disorders. Nevertheless, in their study 2, Esbjørn *et al*[23] demonstrated that patients with GAD had higher NEG than those with other anxiety disorders, whereas POS did not differ between groups.

Relationships between POS, NEG, and meta-worry: Correlations between POS and NEG were explored in $k = 19$ studies, as shown in Table 2. Most studies identified a

positive correlation between POS and NEG[30,51,52,55,64-67,69,76,77,81]. In Benedetto *et al*[49] study 1, POS and NEG correlated positively with each other for male but not female participants. In their second study, a correlation between POS and NEG only became evident in a non-clinical sample, not a clinical one. Reinholdt-Dunne *et al*[79] reported the same result. Still other working groups failed to demonstrate any significant correlation between POS and NEG[25,26,68,82], and none analyzed relationships between POS and NEG with meta-worry.

Results of meta-analysis: We excluded one study from meta-analysis that showed a correlation between POS and NEG since they reported no effect size for correlation [82]. Overall effect size for the POS with NEG correlation ($k = 17$) was small to medium, $r = 0.24$ (0.18, 0.28), $P < 0.001$. Heterogeneity was shown to be significant ($Q = 66.44$, $P < 0.001$), and inconsistency was high ($I^2 = 76\%$). Results are displayed in Table 3 and Figure 6.

At what age do children report POS, NEG, and meta-worry, and does age play a role in relationships with worry and anxiety?

Onset of metacognitive beliefs about worry: $k = 31$ studies examined metacognitive beliefs in children under the age of 12 years, and $k = 14$ studies included populations from age 7 years upwards. Only one study investigated metacognition in children as young as six[70]. Those authors asked children between 6 and 10 years of age to fill out open-ended questions about POS and NEG. Fifty-six percent of children expressed one or more POS, and 77% of children expressed one or more NEG; they observed no age-related differences in the numbers who named POS or NEG[70]. Six-year-old children thus do not seem to differ from older children in their POS and NEG. Other studies analyzed how well young children understand metacognitive questionnaires. Smith and Hudson[52] found that six items on the often used Metacognitions Questionnaire for Children[28] were not adequately understood by 35.8% to 78.6% of the 7- and 8-year-olds they investigated. White and Hudson[30] changed those six items and included a fifth answer option, "I don't understand". Their new instrument, the Revised Metacognitions Questionnaire for Children[30], was tested in a sample of 187 7- to 12-year-old children. No item, including the six newly changed items, was marked as "I don't understand" by more than 25% of 7-year-olds and 17% of 8-year-olds, indicating that the vast majority of this age group (75%-83%) was indeed able to rate their POS and NEG[30]. A small negative correlation was found between age and the number of not-understood items, and a similar significant group difference between 7- to 8-year-olds and 9- to 12-year-olds appeared, indicating that children understand POS and NEG better as they age[30].

Relationship between age and metacognition about worry: Table 2 contains an overview of extracted relationships. Of all included studies, only a minority investigated whether metacognitive beliefs change with age ($k = 12$). Most of those studies did not detect any correlation between POS and NEG, neither with participants' age nor age-related differences[24,27,28,30,72,77,79,82]. In the open-ended questions asked verbally by Wilson and Hughes[70], 56% of children claimed to have at least one POS and 77% at least one NEG. The authors revealed no age-related difference in these answers from children aged 6 to 10 years. In contrast, another study's results suggest that NEG may decline with age, as age did not correlate with POS, but NEG did correlate with age (with a small negative effect[76]). Interestingly, another study identified a small positive correlation between POS and age, but no significant correlation between NEG and age[54]. Another study also demonstrated a significant age effect for POS but none for NEG[78].

Results of meta-regressions with age as covariate: Results of the meta-regressions with mean age as covariate are presented in Table 4. Z-tests for latitudes did not reach significance in any meta-regression, therefore the null hypothesis of no effect cannot be rejected. We therefore found that mean age was not a significant covariate in any of the tested correlations.

Which methods are currently applicable to assess POS, NEG, and meta-worry in childhood and youth?

In total, the authors administered six different questionnaires to assess POS and NEG together. These include the Metacognitions Questionnaire-30-Item Version (MCQ-30) [83], MCQ - Adolescent Version[53], and MCQ for Children (MCQ-C)[28]. The Revised MCQ for Children (MCQ-CR)[30], MCQ for Children-30-Item version (MCQ-C₃₀)[66],

Table 4 Results of meta-regressions on correlational coefficient on measures of positive beliefs about worry/negative beliefs about worry and worry/anxiety with mean age as covariate

Meta-regression		B	SEB	95%lower	95% upper	Z	P
POS and	Intercept	0.5082	0.356	-0.254	1.271	1.429	0.175
Anxiety ¹	Latitude	-0.0265	0.028	-0.086	0.033	-0.958	0.354
POS and	Intercept	-0.0905	0.195	-0.525	0.344	-0.464	0.652
Worry ²	Latitude	0.0302	0.016	-0.005	0.065	1.911	0.085
NEG and	Intercept	0.4427	0.128	0.168	0.718	3.450	0.004 ^b
Anxiety ³	Latitude	0.0094	0.010	-0.012	0.031	0.940	0.363
NEG and	Intercept	0.6482	0.225	0.139	1.157	2.881	0.018 ^a
Worry ⁴	Latitude	0.0004	0.018	-0.040	0.041	0.021	0.984
POS and	Intercept	0.5256	0.260	-0.042	1.093	2.019	0.066
NEG ⁵	Latitude	-0.0286	0.021	-0.074	0.017	-1.357	0.200

¹Based on k: 16 studies.

k: 2 studies[55,67] were excluded as no mean age was reported;

²Based on k: 12 studies.

k: 1 study[67] was excluded as no mean age was reported;

³Based on k: 16 studies.

k: 2 studies[55,67] were excluded as no mean age was reported;

⁴Based on k: 11 studies.

k: 1 study[67] was excluded as no mean age was reported;

⁵Based on k: 14 studies.

k: 3 studies[55,67,81] were excluded as no mean age was reported.

^aP < 0.05.

^bP < 0.01.

B: Point estimate; SEB: Standard error of point estimate; POS: Positive metacognitive beliefs about worry; NEG: Negative metacognitive beliefs about worry.

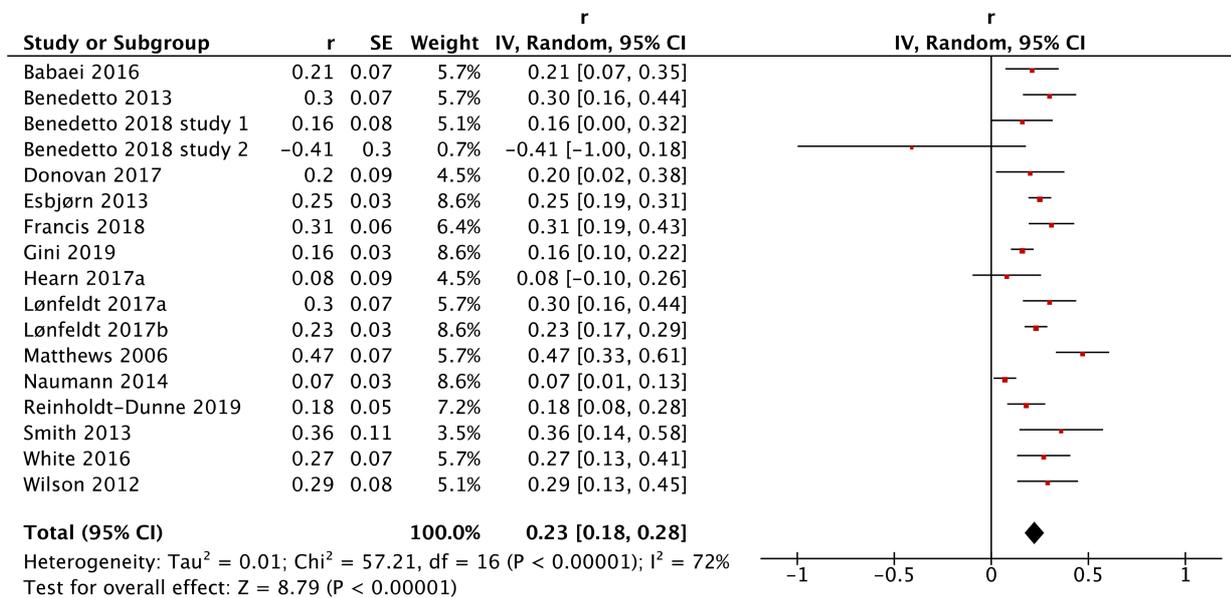


Figure 6 Meta-analysis forest plot on the correlation between measures of positive metacognitive beliefs about worry and negative metacognitive beliefs about worry. CI: Confidence interval; SE: Standard error.

and Metakognitionsfragebogen für Kinder[68] are more recent adaptations. All those questionnaires are variations of the MCQ developed by Cartwright-Hatton and Wells [22]. Despite POS and NEG, it also covers cognitive confidence, the need for control, and cognitive self-consciousness[22]. Furthermore, with Why Worry-II[84], we

extracted one questionnaire that exclusively measures POS. Only one study assessed meta-worry[73]. Its authors administered the meta-worry questionnaire[21] for this purpose.

Of the studies included, only one assessed POS and NEG in children as young as 6 years of age[70]. Due to the lack of reading skills at this age, the children were orally asked these open-ended questions: "Worry can sometimes be helpful and good. Tell me some reasons why worry is good" and "Worry can sometimes be unhelpful and bad. Tell me some reasons why worry is bad"[70]. The authors assigned the children's responses to the categories POS (*e.g.*, solves problems, motivates you, keeps you safe) and NEG (*e.g.*, impacts on activity, is uncontrollable, makes you unwell). An overview of the measurements used in these studies is found in Table 5.

DISCUSSION

To the best of our knowledge, this review is the first to describe systematically measuring instruments for POS and NEG as well as results on the validity of the metacognitive model by meta-analysis on correlations between POS and NEG with each other, worry, and anxiety. Presenting 48 studies, we provide a broad overview of this topic, upon which future research can build. We conducted a consensus rating of 20.89% of full-texts with agreement in 90.32%. Good interrater agreement was attained regarding the risk of bias assessment. No study was rated as showing a high risk of bias. Data from 24 studies could be included in quantitative synthesis to meta-analyze the strength of effect sizes. We were also able to analyze mean age as a moderator in meta-regressions and identify various measurement instruments for different age ranges and newer adaptations like MCQ-CR and MCQ-C₃₀ that enable better coverage of POS and NEG in younger children. The use of orally posed open questions reveals another approach for assessing POS and NEG in even younger children, thus enabling us to investigate the onset of such beliefs about worry[70].

What evidence is there for positive relationships between POS, NEG, and meta-worry with each other, worry, and anxiety in children and adolescents?

NEG correlated in all 14 studies[24,25,26,28,30,51,64-69,75,82] with worry and proved to be an independent predictor of worry in three[23,65,73] out of three studies. Meta-analysis showed large overall correlation between NEG and worry.

NEG also correlated with anxiety in 17[24-26,30,52-55,64,66-68,76-79,82] of 19 studies. Benedetto *et al*[49] study 2 revealed a correlation in their clinical sample only. Surprisingly, another study showed a significant negative relationship of medium effect size between NEG measured with MCQ-30 and anxiety in high school students [55]. The questionnaires used had not been adapted or evaluated for use in adolescents; their contradictory result may be attributable to their not mentioning any specific age range[55]. Overall, the correlation between NEG and anxiety in our meta-analysis revealed was large. NEG predicted anxiety uniquely in three[23,68,75] out of four studies. One study found that NEG was not a significant predictor of anxiety, however[25]. Eight[23,24,49,52,53,74,79,80] out of 10 studies that compared clinical and non-clinical samples showed higher NEG in participants with anxiety disorders, a finding that also supports the metacognitive model. Two studies[27,28] detected no significant group differences.

For POS, 12[24,28,51,64-69,71,72,82] out of 16 studies showed a significant positive relationship with worry, while correlations failed to reach significance in four studies [26,30,48,74]. Meta-analysis resulted in a small overall effect size for the correlation between POS and worry. POS predicted worry in three[23,71,73] out of four studies, while it was not significant in one study[65].

POS correlated with anxiety in 12[24,30,52-54,64,66-68,76-78] out of 19 studies. Studies 1 and 2 of Benedetto *et al*[49] did identify significant correlations but only in their clinical subgroup, while Reinholdt-Dunne *et al*[79] detected a significant correlation in their non-clinical subgroup. In fact, four studies[25,26,55,82] failed to indicate any significant correlations between POS and anxiety. Meta-analysis demonstrated a small to medium effect size for the correlation between POS and anxiety. POS proved to be unique predictors of anxiety in one[68] of three studies, while two studies[73,80] failed to prove POS as a significant predictor. Clinical groups scored higher on POS than non-clinical groups in four[23,24,52,79] out of 10 studies, while six[27,28,49,53,74,80] studies revealed no significant group differences.

Table 5 Measurements of metacognitive beliefs about worry and meta-worry

Measure	Items	Scales	Answer format	Values for reliability	Age	k
MCQ-C	24	4	Do not agree (1) to agree very much (4)	POS: $\alpha = 0.46 - 0.89$, $rtt = 0.82$; NEG: $\alpha = 0.60 - 0.95$, $rtt = 0.76$ [25-28,49,51,52,57,64,65,72,73,74,78]	7-17	22
MCQ-A	30	5	Do not agree (1) to agree very much (4)	POS: $\alpha = 0.80 - 0.90$, $rtt = 0.66$; NEG: $\alpha = 0.80 - 0.87$, $rtt = 0.71$ [24,53,54,81,82]	11-17	9
MCQ-C ₃₀	30	5	Not at all (1) to completely (4)	POS: $\alpha = 0.64 - 0.73$; NEG: $\alpha = 0.71 - 0.79$ [23,76,93]	7-17	8
MCQ-30	30	5	Do not agree (1) to agree very much (4)	POS: $\alpha = 0.88$; NEG: $\alpha = 0.77$ [67]	15-18	3
MCQ-CR	30	5	Not true (1) to Very true (4); I do not understand	POS: $\alpha = 0.77$; NEG: $\alpha = 0.80$ [30]	7-12	1
MKF-K	30	4	Not at all (1) to completely (4)	POS: $\alpha = 0.73$; NEG: $\alpha = 0.70$ [68]	7-14	1
MWQ	7	2	Never (1) to almost always (4)	$\alpha = 0.80 - 0.82$ [73]	11-18	1
WW-II	25	5	Not at all (0) to incapacitating (4)	$\alpha = 0.90$ [71]	7-18	1
Interview	2	2	Open questions	$\kappa = 0.61$ [70]	6-10	1

α : Cronbach's Alpha; rtt : Test-retest-reliability; κ : Cohen's kappa; k : Number of included studies which used the measure; MCQ-30: Metacognitions Questionnaire - 30-Item Version; MCQ-A: Metacognitions Questionnaire - Adolescent Version; MCQ-C: Metacognitions Questionnaire for Children; MCQ-CR: Revised Metacognitions Questionnaire for Children; MCQ-C30: Metacognitions Questionnaire for Children - 30 Item version; MKF-K: Metacognition questionnaire for children; MWQ: Meta-Worry Questionnaire; WW-II: Why Worry-II; POS: Positive beliefs about worry; NEG: Negative beliefs about worry.

Correlations between POS and NEG were reported as significant in 12[30,51,52,55,64-69,76,77,81] out of 19 studies, whereas that finding applied to only one of two subgroups in Studies 1 and 2 of Benedetto *et al*[49] and a study by Reinholdt-Dunne *et al*[79]. Meta-analysis demonstrated a small to medium effect size.

These mixed results partly support the metacognitive model as well, but NEG seem to have a generally more stable effect on worry and anxiety than POS. POS correlations were quite smaller (small to medium effect sizes) while NEG correlations were large. This is not surprising since NEG revealed medium to large correlations with anxiety and worry in adults, while POS result in small to medium correlations with anxiety and worry[83,85,86]. Meta-analysis revealed a smaller effect for the correlation between POS and NEG (small to medium), while correlations for NEG with anxiety and worry are large - evidence that concurs with studies from adult research[83,85,86]. To evaluate conclusively the causal claims of the metacognitive model for children, longitudinal studies are needed. However, most of the studies we included applied a cross-sectional design that precludes such conclusions. Only 10 studies compared clinical to non-clinical samples. Future studies should compare POS, NEG, and meta-worry in clinical and non-clinical samples to validate further the metacognitive model of GAD in childhood and youth. For more information about the specific influence of NEG and meta-worry in the development of GAD, patients presenting different anxiety disorders should be compared also, since the results here are far from clear. In total, the overall situation that this systematic review and meta-analysis portrays indicates that NEG play an especially relevant role in worry and anxiety in children and adolescents, and that there is ample evidence from studies that supports the applicability of the metacognitive model of GAD in childhood and youth.

At what age do children report POS, NEG, and meta-worry, and does age play a role in the relationships with worry and anxiety?

Fourteen studies in total included samples of children aged 7 years and upwards. None of those studies investigated the age of onset of metacognition about worry explicitly. To explore how well children understand questionnaire items, White and Hudson[30] added a response option for not-understanding in the MCQ-CR, and their results support an improvement in how well items are understood from the age 7 to 12 years. Nevertheless, at least 75% of 7- to eight-year-olds understood every MCQ-CR

item. Only one study investigated even younger children[70]. The authors posed open-ended questions verbally to assess POS and NEG in 6-year-olds and concluded that these children are capable of understanding and can describe beliefs about worry, as more than half of the 6- to 10-year-olds stated POS, and almost 8 out of 10 children stated NEG. Response frequencies did not differ with age. Although children are less capable of introspection at 5 years of age than 7- or 8-year-olds[33,35], this result implicates that the metacognitive abilities needed to perceive and describe when worry arises and what feelings and thoughts are associated with it are already developed by the age of 6 years. It thus seems possible that we are underestimating the metacognitive ability of young children[36]. This could also be because POS and NEG are usually surveyed using questionnaires.

Most of the included studies revealed no significant associations between the participants' age and NEG[24,27,30,54,76,79,82] or POS[24,27,30,72,76,77,79,81,82]. Two studies even demonstrated negative correlations between age and NEG[77,81]. We cannot therefore assume any increase in POS and NEG with rising age. However, one study[54] did show a positive correlation between POS and age. We analyzed mean age as a covariate in meta-regressions as a potential source of variance, but the results were not significant, thus we cannot assume that mean age is a relevant source of variance. Because of the rather small number of included studies in meta-regressions (range: $k = 11-16$) and the substantial heterogeneity as demonstrated by Q - and I^2 -statistics, there might be insufficient power to demonstrate mean age's moderating effect[87]. Our results therefore do not allow us to assume that mean age has a zero-effect on correlations between POS and NEG with each other, worry, and anxiety. Nevertheless, our overall results suggest that POS and NEG do not vary much with age and that the metacognitive model of GAD can be applied to a broad age range of seven to 18 years.

Which methods are currently applicable to assess POS, NEG, and meta-worry in childhood and youth?

The studies included in this review indicate that MCQ-family of questionnaires are the ones most widely used in research and clinical practice to measure metacognitive beliefs in childhood and youth. We identified six derivatives of the MCQ in this review. The MCQ-C, applied in 22 studies, was most frequently administered in children and adolescents aged 7 to 18 years. For youth between 11 and 17 years, the MCQ - Adolescent Version was used in nine studies. MCQ-C₃₀ was also used in 7- to 17-year-olds in eight studies. Since each study we included originated from a single research group, we may have overestimated the frequency of use. The MCQ-30, designed for adults, was administered by three study groups in adolescents between 15 and 18 years of age without any adaptations for that age group. Other MCQ-derivates were only used in one study each. The MCQ-CR was especially designed to be better understandable for 7- and 8-year-olds[30] but was not distributed further. One study used the German questionnaire Metakognitionsfragebogen für Kinder[68]. To measure exclusively POS, Why Worry-II was used without pretesting or adaptation in a sample of 7- to 18 year-olds[71].

One study posed open-questions to assess verbally POS and NEG in children from the age of 6 to 10 years but detected no age-related differences in POS or NEG[70]. Such interview approaches represent an alternative method when surveying young children who may not yet be able to read well enough. To define the onset of POS and NEG more specifically, future research should also attempt to replicate the results of Wilson and Hughes[70] with a larger sample and perhaps include even younger children. An interview-format was also applied in the dissertation of Bacow[88], the MCQ-C author who designed the "Evaluations of Worries and Thoughts Interview for Children" (EWTI-C) to survey worry and associated beliefs. While the MCQ-C's results were covered in the paper of Bacow *et al*[28], no EWTI-C data have been published yet. Interestingly, when measured with the EWTI-C, POS and NEG did not correlate with worry at all, and participants with anxiety disorder reported more NEG, but not POS, than non-clinical controls[88]. This indicates a need for valid and reliable methods to measure metacognition in childhood and youth. More recently, thanks to the availability of the MCQ-CR and MCQ-C₃₀, two promising adaptations of the MCQ have been added and should be further investigated. Although meta-worry plays an important role in the metacognitive model, only one study investigated this construct using the meta-worry questionnaire with children aged 11 years[73]. This questionnaire has not yet been validated or adapted for children and adolescents. We need to improve and modify suitable instruments for measuring meta-worry, and it deserves more attention in future research.

Limitations

Some limitations need to be considered: First, the results we extracted are mainly cross-sectional and thus preclude any causal conclusions. Longitudinal studies are needed to support the metacognitive model's causal assumptions despite the overall relationship trends the cross-sectional data from this review has revealed so far.

Second, the broad heterogeneity revealed across the various meta-analyses we conducted should be considered a limitation. The amount of genuine variance not attributable to chance was medium to large, as the heterogeneity values indicate ($I^2 = 67\%$ and 95%). Mean age was assessed as a covariate by meta-regression to see whether age plays a role in relationships between POS and NEG with worry and anxiety, but it did not explain variance. Other sources of variance might include differences in assessment methods for POS, NEG, anxiety and worry, sample types (clinical *vs* non-clinical), percentage of comorbid disorders in clinical samples, and gender distribution. Additional meta-regressions for these potential covariates could help to explain the amount of variance among the included studies.

Third, some studies covered a broad age range[28,51,69,78,79], limiting specific interpretations of potential developmental patterns specific to different age groups. We chose mean age as a covariate for meta-regression, but the ages of all participants might not have been accurately represented. Our results can thus only reflect the mean age of the samples and must be interpreted with caution for aggregation bias[89].

Fourth, only studies with clinical samples were included if they exclusively assessed patients with DSM-5[40] listed anxiety disorders, but three studies[27,28,52] contained clinical subgroups with post-traumatic stress disorder or OCD, as they had been included in anxiety disorders in the DSM's earlier fourth edition[90]. Moreover, 60% of non-clinical participants in one study presented subclinical anxiety symptoms[28].

Fifth, to measure POS and NEG, some Cronbach's alpha values for the MCQ-C[25, 27,28,52,57,64,65,72,73] and MCQ-C₃₀[60,76] fell below the recommended level of 0.70 for exploratory research as recommended by Nunnally and Bernstein[91]. Moreover, the MCQ-C does not seem to be ideally suitable for use in younger children, as 35.8% to 78.6% of children aged 7 to 8 years did not fully understand six items[52]. As the MCQ-C was used in $k = 22$ studies and the MCQ-C₃₀ in $k = 8$ studies, this factor should be considered a limitation.

Sixth, we could include only one unpublished study as gray literature[68], therefore the risk of publication bias should be considered a limiting factor.

CONCLUSION

In conclusion, the studies included in this review demonstrate that POS and NEG are measurable by administering questionnaires in children from 7 years of age upwards, and even children aged as young as 6 years can already name them verbally. Furthermore, POS and NEG do not seem to vary with age in childhood and youth. NEG shows strong overall correlations with worry and anxiety over different age groups, highlighting their relevance in the development and maintenance of anxiety disorders and confirming the metacognitive model's implications. POS' smaller effect sizes and inconsistent findings suggest that these play a subordinate role, in line with the evidence from adult studies[83,85,86]. The current research data reveal quite large heterogeneity between studies that cannot be attributed to the influence of mean age. Nor can any conclusions about the influence of meta-worry on anxiety disorders be drawn. Measurements of meta-worry in children and adolescents are thus needed, and measurements of POS and NEG for young children require further research. Longitudinal studies could enable clearer conclusions to be made on causal relationships between the metacognitive model's relevant constructs.

ARTICLE HIGHLIGHTS

Research background

The metacognitive model of generalized anxiety disorder has been applied to children and youth in different studies. Results mostly support its validity, but the roles of positive metacognitive beliefs about worry (POS), meta-worry, and age-effects do not appear to be fully clarified yet.

Research motivation

Summarizing the current research on relationships, age-effects, and measurements for POS, negative metacognitive beliefs about worry (NEG) and meta-worry in childhood and youth are both timely and worthwhile.

Research objectives

Relationships between POS, NEG, and meta-worry with each other, worry, and anxiety, and possible age-effects for these relationships were analyzed. Assessment methods POS, NEG and meta-worry for children and adolescents were examined.

Research methods

A literature search was carried out in the electronic databases PsycINFO, PubMed, PSYINDEX, and ERIC in 2017 and updated in 2020. Empirical research in German or English language on metacognition was included with child and adolescent samples diagnosed with anxiety disorders or healthy controls if POS, NEG, or meta-worry was measured. Meta-analysis for reported correlations between these metacognitions and anxiety or worry was carried out with RevMan 5.4.1, assuming random-effects models. Meta-regressions with mean age as the covariate were performed *via* the online tool MetaMar 2.7.0.

Research results

Overall, we included $k = 48$ studies in this systematic literature review and of those, $k = 24$ studies fulfilled our inclusion criteria for meta-analysis. Systematic review and meta-analysis showed that POS and NEG correlate with worry and anxiety. Mean age was not a significant covariate in meta-regressions. Only one study measured meta-worry. We identified eight questionnaires and one interview approach for assessment of metacognitive beliefs.

Research conclusions

Our overall results support the applicability of the metacognitive model of generalized anxiety disorder in childhood and youth. NEG play an especially relevant role in worry and anxiety in children and adolescents, while conclusions about meta-worry's influence cannot be drawn. Most included studies used a cross-sectional design and thus preclude causal conclusions. Metacognitive beliefs do not seem to vary with age and appear to be measurable in children from 7 years upwards.

Research perspectives

Longitudinal studies and research on the impact and measurement of meta-worry would be beneficial. Measurements applying to young children should undergo further investigation.

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