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A Meta-analytic Study on Executive Function Performance in Children/Adolescents with OCD

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Título: Un Estudio Meta-analítico sobre el Rendimiento en Funciones Ejecutivas en Niños/Adolescentes con TOC.
Resumen: *Introducción:* El objetivo general de este estudio fue llevar a cabo un estudio meta-analítico con el fin de examinar el rendimiento de las funciones ejecutivas en niños/adolescentes con trastorno obsesivo-compulsivo (TOC). *Método:* Se llevó a cabo una búsqueda exhaustiva de la literatura desde 1984 hasta septiembre de 2021, seleccionando un total de 20 estudios publicados que comparaban los resultados en funciones ejecutivas entre un grupo de niños y/o adolescentes con TOC y un grupo de control sano. *Resultados:* Los resultados mostraron que la puntuación total en la escala de calidad de los estudios osciló entre los 3 y los 8.5 puntos (en una escala de 0 a 9), con una media de 6.6. Los tamaños del efecto en las distintas funciones ejecutivas fueron: Inhibición (d_+ = -0.221), Flexibilidad cognitiva (d_+ = -0.418), toma de decisiones (d_+ = -0.169) y planificación (d_+ = -0.319), indicando un menor rendimiento en los grupos con TOC frente a los grupos de control sano. Los resultados fueron clínicamente significativos en todos los dominios excepto en Toma de decisiones. El sesgo de publicación sólo se pudo llevar a cabo en flexibilidad e inhibición de respuesta. *Conclusiones:* Los pacientes con TOC presentaron peor rendimiento ejecutivo que los controles sanos en todas las funciones ejecutivas, destacando flexibilidad cognitiva y planificación. No obstante, los resultados deben interpretarse con cautela debido al pequeño tamaño muestral.
Palabras clave: Trastorno obsesivo-compulsivo. Funciones ejecutivas. Niños. Adolescentes.

Abstract: *Background:* The main objective of this work was to carry out a meta-analytical study to examine performance in executive functions in children/adolescents with obsessive-compulsive disorder (OCD). *Method:* A comprehensive literature search from 1984 to September 2021 was conducted, selecting a total of 20 published studies comparing executive function outcomes among a group of children and/or adolescents with OCD and a healthy control group. *Results:* Results showed that the total score on the quality scale of studies ranged between 3 and 8.5 points (on a scale of 0 to 9), with a mean of 6.6. The effect sizes in the different executive functions were as follows: Inhibition ($d+$ = -0.221), Cognitive flexibility ($d+$ = -0.418), Decision making ($d+$ = -0.169) and Planning ($d+$ = -0.319), indicating a lower performance in the OCD groups compared to the healthy control groups. Results were clinically significant in all domains except decision making. Publication bias could only be carried out in flexibility and response inhibition. *Conclusions:* OCD patients presented worse executive performance than healthy controls in all functions, highlighting cognitive flexibility and planning. However, results should be interpreted with caution due to the small sample size.
Keywords: Obsessive-compulsive disorder. Executive function. Children; Adolescents.

Introduction

Obsessive-compulsive disorder (OCD) is characterized by obsessions (recurrent and intrusive thoughts) and/or compulsions (repetitive behaviors or mental acts) having distress and high levels of anxiety (American Psychiatric Association, 2013). Epidemiological studies have shown that OCD is relatively prevalent in children and adolescents, yielding similar rates -around 2% (Canals et al., 2012). Neuropsychology research has attempted to determine the degree of correspondence between neuroimaging data and neuropsychological test results, in order to identify a clinical endophenotype and predict and improve treatment outcomes (Subirà et al., 2016).

Executive function (EF) and the relationship between its different subdomains either as independent entities, or as part of a whole, has been the subject of debate. EF could be described as a set of high level control mechanisms whose main purpose is regulation of cognition, behavior and emotions to meet individual goals and aims (Miyake & Friedman, 2012). Some authors consider working memory, cognitive flexibility (CF) and inhibitory response (IR) as the main mechanisms responsible for executive control (Diamond, 2013).

Chevalier & Blaye (2008) considered CF to be the ability to change mental representation based on incoming information and to keep representation intact when changes are irrelevant. IR is the mental process responsible for intentional and voluntary control, or the ability to prevent inappropriate information from interfering with responses or response patterns in progress, and to suppress previously relevant information which is not useful (Carlson & Wang, 2007). IR is not considered a unitary function, as it includes motor (behavioral) IR and cognitive IR. WM is defined as maintaining or manipulating information across a short delay when that information is not available in the environment and involves both short-term storage of information and simultaneous manipulation of mental content (Harvey et al., 2004). Planning is the ability to identify and organize steps and elements necessary to carry out an intention (Soprano, 2003; Tsukiura et al., 2001). Decision making (DM) is defined as the ability to choose after analyzing both rational and emotional information (Bechara et al., 2000).

Several meta-analyses have attempted to assess neuropsychological deficits in adult patients with OCD. Thus, Abramovitz et al. (2013) presented the results of a meta-

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analytic study on different neuropsychological domains and subdomains supporting the existence of differences between OCD patients and healthy individuals in sustained attention, nonverbal memory, executive function, WM, etc., although effect sizes ranged from medium to moderate. Likewise, they reported that results found in Response Inhibition showed a smaller overall effect size than expected. Shin et al. (2014) reported smaller effect sizes in visuospatial memory, verbal memory, executive function, verbal fluency, and processing speed, with effect sizes of 0.7 and 0.3. Snyder et al. (2015) highlighted that effect sizes in IR were medium-medium low while medium in CF. Abramovitch et al. (2019) found that poorer performance of OCD patients in neuropsychological tests was related to response severity close to a mean effect size on CF tasks.

There are few studies focused on the evaluation of executive functions in children and adolescents with OCD. In a meta-analysis by Abramowitz et al. (2015) on 11 neuropsychological studies in pediatric OCD it was reported that pediatric OCD might not be associated with difficulties in executive function, although empirical studies had large limitations (small number of studies, different evaluation tests, comorbidity in samples, etc.).

Results of studies in the pediatric population have been discrepant. Some research has found that children/adolescents with OCD have performance problems in CF tasks (Ornstein et al., 2010; Shin et al., 2008; Taner et al., 2011) while others report they function similarly to healthy controls (Geller et al., 2017). Other studies indicate that CF in children and adolescents with OCD is modulated by the WM (Wolff et al., 2017). Ornstein et al. (2010) reported worse results in Planning and CF but not in IR and WM tasks, while Waters & Farrell (2014) indicated that children with OCD presented more failures in IR.

Study aim

Given these discrepancies, the overall aim of this study was to conduct a meta-analytic study to examine executive function performance in children/adolescents with OCD versus a healthy control group. The specific objectives were: 1) to know the descriptive characteristics of the studies; 2) to analyze its methodological quality; 3) to evaluate the difference in the performance of executive functions (decision making, problem solving, response inhibition and cognitive flexibility) in the OCD group compared to the healthy control group in the pediatric population.

Method

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA 2020, Page et al., 2021) guidelines.

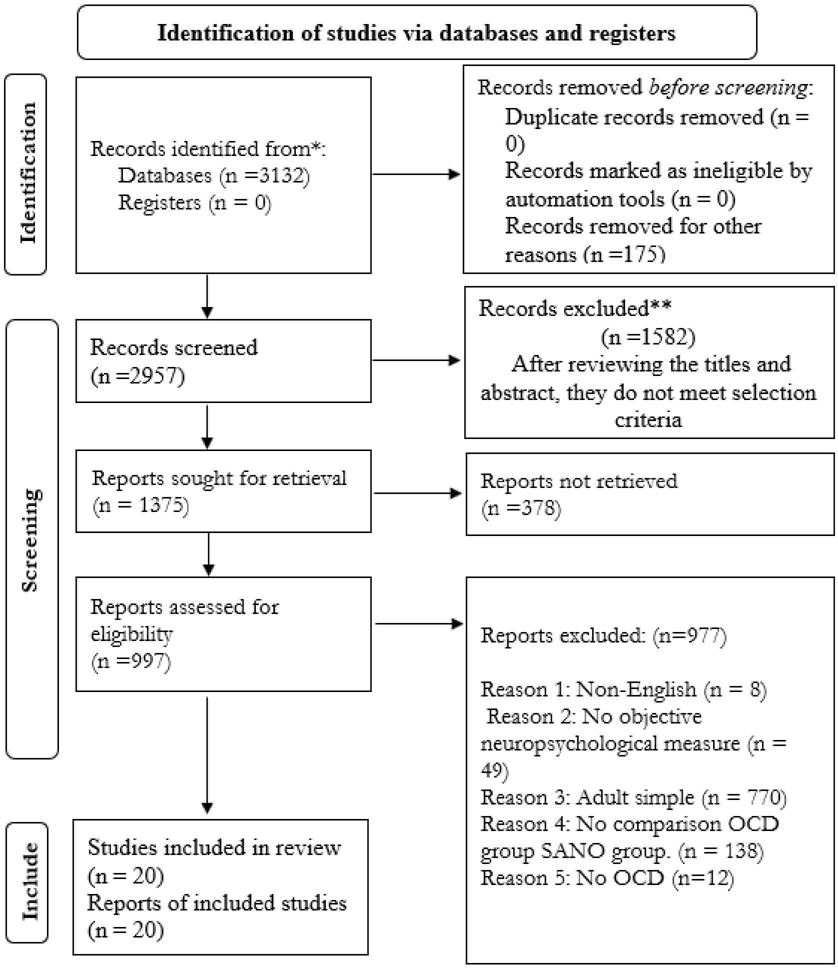
Selection Criteria

For inclusion in this research, studies had to fulfill the following criteria based on PICOS statement (Moher et al., 2009): a) studies must exclusively include children and adolescents with OCD, excluding those that include other clinical diagnoses (PANDAS, ADHD, Tourette's, etc.) versus a healthy control group; b) they must include the evaluation of the EF and other neuropsychological variables; c) the sample size in the posttest must comprise more than four participants; therefore, single-case designs were excluded; e) statistical data reported in the study must allow us to compute effect sizes, and f) the study must be written in English or Spanish.

Search strategy

Several literature search procedures were used to locate studies which met our selection criteria. Several electronic databases were first consulted: Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, and PsycINFO. The following keywords were combined, in English and Spanish in the electronic searches: ([obsessive-compulsive] or [OCD]) and [(child* or adolesc* or pediatric) and ([neuropsych] or [neurocog] or [executive function] or [processing speed] or [visuospatial] or [decisión making] or [response inhibition] or [planning] or [st-shifting)] which should be in the title or abstract. Second, the references of some meta-analyses and systematic reviews were consulted (Abramovitch et al., 2013; 2015; 2019; Bragdon et al., 2018; Shin et al., 2014; Snyder et al., 2015). Third, the references of the located studies were also reviewed. Finally, emails were sent to 10 experts in this area to locate unpublished studies. A literature flow chart of the search process is shown in Figure 1. The search strategy produced a total of 3132 references. Twenty articles met the selection criteria.

Figure 1
PRISMA 2020 Flow Diagram (Page et al., 2021).



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Variables recorded from studies

The coded variables in each study were: mean age (years), percentage of women, diagnosis time in OCD group, mean Verbal IQ, quality of the study adapted from the NOS scale (adequate definition of cases, adequate representativeness of cases, adequate selection of controls, adequate definition of controls, matching of cases and controls in age, matching of cases and controls in IQ and at least one other variable, evaluator blinding, comparable loss rates, instruments validated, measurement methods), total sample size, comorbidity, drug consumption, country and continent where study was conducted, and year of publication.

Computation of effect sizes

The main purpose of this meta-analysis was to search for neuropsychological variables of the OCD group-control group. The effect size index was the standardized mean difference, defined as the difference between the paediatric OCD and control means divided by a pooled standard deviation. Hedges' correction for small sample sizes was also applied to each effect size: $d = c(m)[(M_{OCD} - M_{Control})/S]$, with d being Hedges' standardized mean difference, M_{OCD} and $M_{Control}$ the OCD and control means, S a pooled estimate of the standard deviation of the two groups, and $c(m)$ a correction factor for small sample sizes (Botella & Sánchez-Meca, 2015). Negative effect sizes indicated a poorer performance for the OCD group in comparison with the control group, and viceversa. Separate d indices were calculated for each executive function or neuropsychological outcome reported in the studies. For reliability assessment of effect size calculations, the same random sample of studies used in the coding reliability study was subjected to a double process of effect size calculations, obtaining excellent inter-coder reliability, with intra-class correlations over 0.90.

Statistical Analysis

Separate meta-analyses were carried out with the effect sizes for each outcome measure. Random-effects models were assumed in order to accommodate variability exhibited by the effect sizes (Borenstein & Hedges, 2019). To assess heterogeneity of effect sizes, the *Q* statistic and the I^2 index were calculated. I^2 indices around 25%, 50%, and 75% were interpreted as reflecting low, moderate, and large heterogeneity, respectively (Higgins et al., 2003). For each outcome measure, a weighted mean effect size with its confidence interval was calculated. To assess publication bias on the CF and RI, a funnel plot was constructed, the Egger test was calculated, and the trim-and-fill method for imputing missing effect sizes was applied (Rothstein et al., 2005). The moderator analysis was required to meet two conditions. First, the meta-analysis had to include at least 15 studies. Second, there had to be heterogeneity (I^2 > 25%). The IR meta-analysis met the first condition but not the second. Accordingly, moderator analysis was not performed. Statistical analyses were conducted with the statistical program *Comprehensive Meta-analysis 3.3*, CMA 3.3 (Borenstein et al., 2014).

Results

Study characteristics

The sample size of the 20 studies comprised 1450 participants (minimum = 19, maximum = 263, mean = 72), 685 groups with OCD (minimum = 10, and maximum = 102), with a mean sample size of 34 participants. The remaining 765 participants were part of the control groups (minimum = 9, maximum = 161), with a mean sample size of 38 participants. Table 1 presents a description of the characteristics of a quantitative nature.

Table 1
Descriptive characteristics of the methodological and participant quantitative variables.

Moderator variable	*k*	*Mín.*	*Máx.*	*Mean*	*Mdn*
Participants:					
OCD: Mean age (years)	19	9.5	14.3	12.9	13.8
OCD: % women	15	35.3%	80%	53.8%	49%
OCD: diagnosis (years)	12	0.6	7.8	3.7	3.1
OCD: Mean verbal IQ Verbal	10	95.3	112.9	103.9	102.1
OCD: Mean CY-BOCS	12	16.1	27.7	22.1	21.5
Control: Mean age (years)	18	10.1	14.5	12.8	13.1
Control: % women	15	13%	70%	46.1%	49%
Control: Mean IQ Verbal	10	94.5	117.6	106.8	108
Methodological:					
Quality score	20	3	8.5	6.6	6.8
OCD group: sample size	20	10	102	34	24
Control group: simple size	20	9	161	38	24
Total simple size	20	19	263	73	47

k = number of studies. Min and Max = minimum and maximum values. Mdn = median value.

For other participant variables, clinical participants (80%) were found to have no comorbid conditions and 55% were drug free. As for context variables, 73.7% of studies were performed in universities, with the rest in a hospital context. Studies were conducted between 1999 and 2020, with 65% published between 2009 and 2018.

Methodological quality of studies

Assessment of the methodological quality of studies was through an adaptation of the NOS scale. Table 2 shows scores obtained by every study in each of the 9 items of the quality scale. Items 3 (100%, adequate selection of controls), 2 (95%, adequate representativeness of cases) and 1 (90%, adequate definition of cases) were those most completed by studies. The total score on the quality scale ranged between 3 and 8.5 points (on a scale of 0 to 9), with a mean of 6.6.

Table 2
Assessment of the methodological quality of the studies with NOS scale.

Estudio	I1	I2	I3	I4	I5	I6	I7	I8	I9	T
Andres et al. (2006)	1	1	1	1	1	1	0	1	1	8
Andres et al. (2008)	1	1	1	1	1	0	0	1	1	7
Barua et al. (2020)	1	1	1	0	1	0	0	1	1	6
Batistuzzo et al. (2015)	1	1	1	1	1	1	1	1	1	8.5
Baykal et al. (2014)	1	0	1	0	0	0	0	1	1	4
Beers et al. (1999)	1	1	1	1	0	0	0	1	1	6
Carrasco et al. (2013)	1	1	1	1	1	0	1	1	0	7
Erhan et al. (2017)	0	1	1	1	0	0	0	0	0	3
Geller et al. (2017)	1	1	1	1	1	1	0	1	1	8
Hanna et al. (2013)	1	1	1	1	1	0	0	1	1	6.5
Hanna et al. (2016)	1	1	1	1	1	0	0	1	0	6
Hybel et al. (2017)	1	1	1	1	0	0	0	1	1	6
Kodaira et al. (2012)	1	1	1	1	1	1	0	1	1	8
Negreiros et al. (2019)	1	1	1	1	0	0	1	1	1	7
Ornstein et al. (2010)	1	1	1	1	1	1	0	1	1	8
Ota et al. (2013)	1	1	1	1	1	1	0	1	1	8
Rubia et al. (2010)	1	1	1	0	1	1	0	0	0	5
Shin et at. (2008)	1	1	1	1	1	1	0	1	1	8
Taner et al. (2011)	1	1	1	1	1	0	0	0	1	6
Woolley et al. (2008)	0	1	1	1	1	1	0	0	1	5.5
Totales (%)	90	95	100	85	75	45	15	80	80	6.6[a]

I1: Adequate definition of cases. I2: Adequate representativeness of the cases. I3: Appropriate selection of controls. I4: Adequate definition of controls. I5: Matching of cases and controls in age. I6: Matching cases and controls in IQ and at least one other variable. I7: Evaluator masking. I8: Comparable loss rates. I9: Validated measurement instruments. T: Total quality score. [a] Mean of the total scores.

In order to verify the extent to which the OCD and control groups were matched within the studies in the most relevant sociodemographic characteristics, meta-analytical syntheses of several of these were performed. The age variable revealed no heterogeneity [*Q* (17) = 13.75, p = .685, I^2 = 0%], groups with OCD and CG being equal. The same occurred with the gender variable [*Q* (14) = 17.48, p = .231, I^2 = 19.9%]. Figure 2 presents a forest plot with these mean differences in age.

Figure 2
Forest plot of the differences between the mean ages of the OCD and control groups. Mean differences with a positive sign indicate a higher mean age in the group with OCD than in the control group; and vice versa.

Study name	Difference in means	Lower limit	Upper limit
Andrés et al. (2007)	0,030	-1,263	1,323
Andrés et al. (2008)	0,400	-1,171	1,971
Barua et al. (2020)	0,100	-0,706	0,906
Beers et al. (1999)	0,590	-1,204	2,384
Carrasco et al. (2013)	0,100	-0,952	1,152
Erhan et al. (2017)	-0,460	-1,376	0,456
Geller et al. (2017)	-0,220	-0,973	0,533
Hanna et al. (2013)	0,000	-1,021	1,021
Hanna et al. (2016)	-0,100	-1,030	0,830
Hybel et al. (2017)	-0,040	-0,967	0,887
Kodaira et al. (2012)	0,140	-0,910	1,190
Negreiros et al. (2019)	1,200	0,280	2,120
Ornstein et al. (2010)	0,130	-1,385	1,645
Ota et al. (2013)	0,160	-1,286	1,606
Rubia et al. (2010)	-0,200	-1,204	0,804
Shin et at. (2008)	1,950	0,293	3,607
Taner et al. (2011)	0,300	-1,405	2,005
Woolley et al. (2008)	-0,200	-1,505	1,105
	0,110	-0,146	0,366

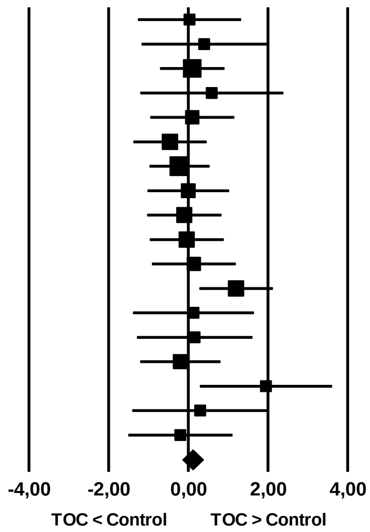
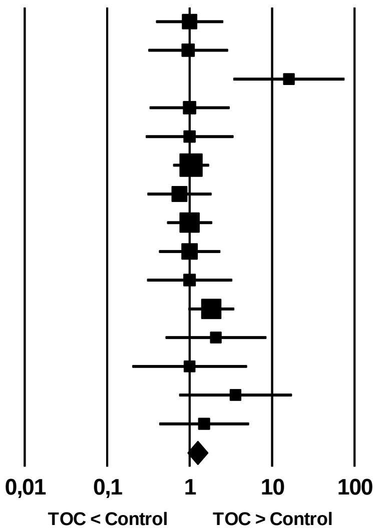


Figure 3 presents a forest plot with the odds ratios (ORs) of these studies by gender. Odds ratios greater than 1 indicate a higher percentage of women in the OCD group than in the control group; and vice versa.

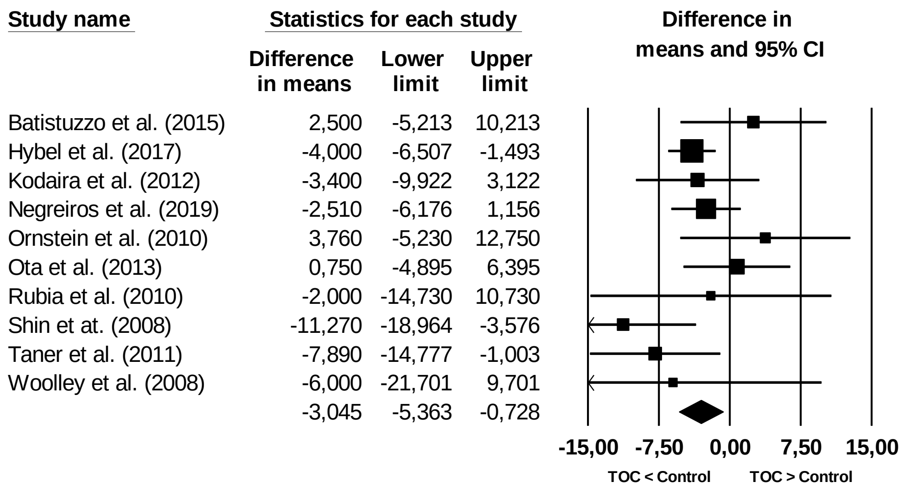
Figure 3
Forest plot of the odds ratios between the proportions of women in the OCD and control groups.

Study name	Odds ratio	Lower limit	Upper limit
Andrés et al. (2007)	1,000	0,392	2,553
Andrés et al. (2008)	0,960	0,316	2,922
Barua et al. (2020)	16,000	3,398	75,345
Batistuzzo et al. (2015)	1,000	0,327	3,055
Beers et al. (1999)	1,000	0,295	3,393
Geller et al. (2017)	1,042	0,632	1,718
Hanna et al. (2013)	0,754	0,309	1,842
Hanna et al. (2016)	1,000	0,534	1,874
Hybel et al. (2017)	1,000	0,425	2,352
Kodaira et al. (2012)	1,000	0,306	3,273
Negreiros et al. (2019)	1,833	0,968	3,471
Ornstein et al. (2010)	2,086	0,511	8,509
Ota et al. (2013)	1,000	0,202	4,955
Shin et at. (2008)	3,604	0,748	17,349
Taner et al. (2011)	1,500	0,429	5,248
	1,244	0,943	1,642



Regarding the Verbal IQ the 20 studies, 10 reported the mean Verbal IQ, observing a lower Verbal IQ in the OCD group compared to the CG. This mean difference was statistically significant (95% *CI*: -5.363, -0.728). Regarding heterogeneity, it did not reach statistical significance [$Q(9) = 12.97$, $p = .164$], although the I^2 index showed low to moderate heterogeneity ($I^2 = 30.6\%$). Figure 4 presents a forest plot with these mean differences.

Figure 4
Forest plot of the differences between the mean Verbal IQs of the OCD and control groups. Mean differences with a positive sign indicate a higher mean Verbal IQ in the OCD group than in the control group; and vice versa.



Distribution of effect sizes and heterogeneity

Separate meta-analyses were performed for each executive function. Table 3 shows the mean effects obtained with each outcome variable, together with a 95% confidence interval and the heterogeneity assessment tests (*Q* statistic, I^2 index and inter-study standard deviation, τ).

Table 3
Effects sizes in EF.

Variables	k	d_+	IC al 95% Li	IC al 95% Ls	Q	I^2	τ
Inhibition	15	-0.220	-0.332	-0.108	12.53	0	0
CF	12	-0.418	-0.694	-0.142	43.50***	74.7	0.407
DM	3	-0.169	-0.414	0.076	2.29	12.7	0.080
Planning	7	-0.319	-0.500	-0.138	0.55	0	0

k = number of studies. d_+ = average standardized mean change. LL and UL = lower and upper limits of the 95% confidence interval for d_+. +. Q = Cochran's heterogeneity Q statistic. I^2 = heterogeneity index. τ = tipic deviation inter-study. *$p < .05$. **$p < .01$. ***$p < .001$.

Four executive functions were assessed: RI, CF, DM and planning. Figure 5 presents a forest plot in RI. The mean effect was negative ($d_+ = -0.221$) and statistically significant (95% *CI*: -0.335, -0.108) compared to OCD groups. According to Cohen's (1988) criteria, the magnitude of difference in inhibition between OCD and control groups was of low relevance (close to 0.20), but clinically significant. Heterogeneity statistics revealed no variability between study effect sizes ($I^2 = 0$). Figure 6 presents a forest plot of effect sizes in CF. The average in cognitive flexibility were lower in the OCD groups ($d_+ = -0.418$) and statistically significant. The magnitude between moderate and low (between 0.20 and 0.50) and clinically significant. Heterogeneity statistics revealed the presence of high variability between effect sizes ($I^2 = 74.7\%$). Effect sizes achieved in decision making were negative ($d_+ =$ -0.000, -0.169), indicating a certain tendency to a lower performance in the group with OCD but did not reach clinical significance. The average of the effect sizes in planning was negative, indicating a worse performance in groups with OCD ($d_+ = -0.319$), but clinically significant.

Figure 5
Forest Plot displaying the standardized mean changes for the RI. Hedges' g coincides with the d index reported in the text.

Study name	Std diff in means	Lower limit	Upper limit
Andres et al. (2008)	-0,680	-1,250	-0,110
Ota et al. (2013)	0,126	-0,675	0,927
Taner et al. (2011)	-0,701	-1,340	-0,062
Ornstein et al. (2010)	-0,234	-0,895	0,427
Andres et al. (2006)	-0,502	-0,978	-0,026
Beers et al. (1999)	-0,016	-0,621	0,589
Geller et al. (2017)	-0,039	-0,287	0,209
Baykal et al. (2014)	-0,587	-1,066	-0,108
Carrasco et al. (2013)	-0,297	-0,738	0,144
Hanna et al. (2016)	-0,203	-0,514	0,108
Hybel et al. (2017)	-0,210	-0,603	0,183
Negreiros et al. (2019)	-0,118	-0,423	0,187
Rubia et al. (2010)	-0,178	-0,938	0,582
Woolley et al. (2008)	-0,456	-1,368	0,456
Hanna et al. (2013)	-0,101	-0,545	0,343
	-0,221	-0,335	-0,108

Std diff in means and 95% CI

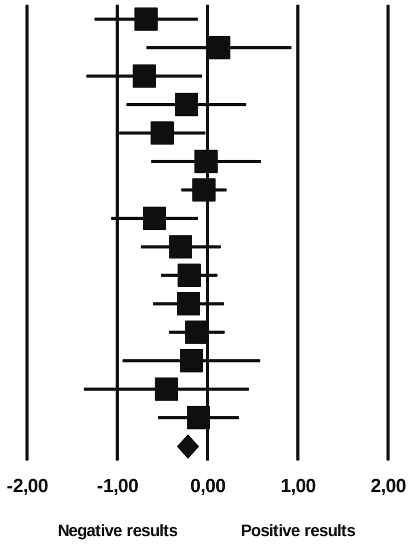
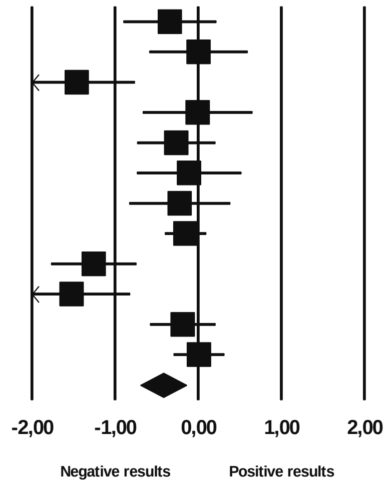


Figure 6
Forest Plot displaying the standardized mean changes for the CF. Hedges' g coincides with the d index reported in the text.

Study name	Std diff in means	Lower limit	Upper limit
Andres et al. (2008)	-0,340	-0,898	0,218
Kodaira et al. (2012)	0,005	-0,586	0,596
Taner et al. (2011)	-1,460	-2,157	-0,763
Ornstein et al. (2010)	-0,006	-0,665	0,653
Andres et al. (2006)	-0,263	-0,734	0,208
Shin et at. (2008)	-0,109	-0,736	0,518
Beers et al. (1999)	-0,222	-0,829	0,385
Geller et al. (2017)	-0,152	-0,400	0,096
Baykal et al. (2014)	-1,256	-1,769	-0,743
Barua et al. (2020)	-1,523	-2,227	-0,819
Hybel et al. (2017)	-0,185	-0,578	0,208
Negreiros et al. (2019)	0,010	-0,295	0,315
	-0,418	-0,694	-0,142

Std diff in means and 95% CI



Analysis of publication bias

To assess publication bias as a threat against the average effect sizes for RI and CF, funnel plots were constructed (Figure 7 and 8). Ten studies are required for accurate results. The funnel plot for the effect sizes of the RI variable showed asymmetry. The application of the Egger test yielded a marginally significant result [b_0 = -1.12, t (12) = 1.76, p = .103], indicating some suspicion of publication bias. Trim-and-fill imputed 5 additional effect sizes, resulting in an adjusted mean effect d_{aj} = -0.134 (95% CI: -0.267, 0.0003), indicating a clear effect of publication bias. As for the CF variable, Figure 8 presents a funnel plot of said meta-analysis. Egger's test reached statistical significance [b_0 = -2.76, $t(10)$ = 1.87, p = .091]. T*rim-and-fill* did not impute any additional effects.

Figure 7
Funnel plot of RI variable. Hedges' g coincides with the d index reported in the text.

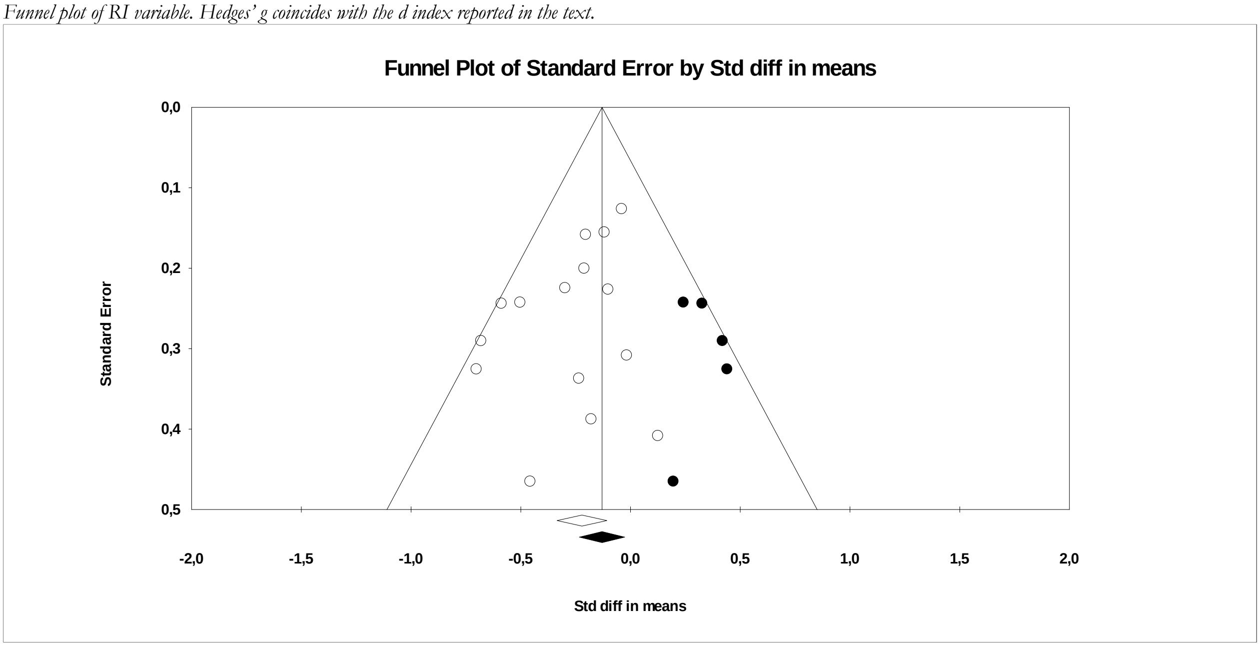
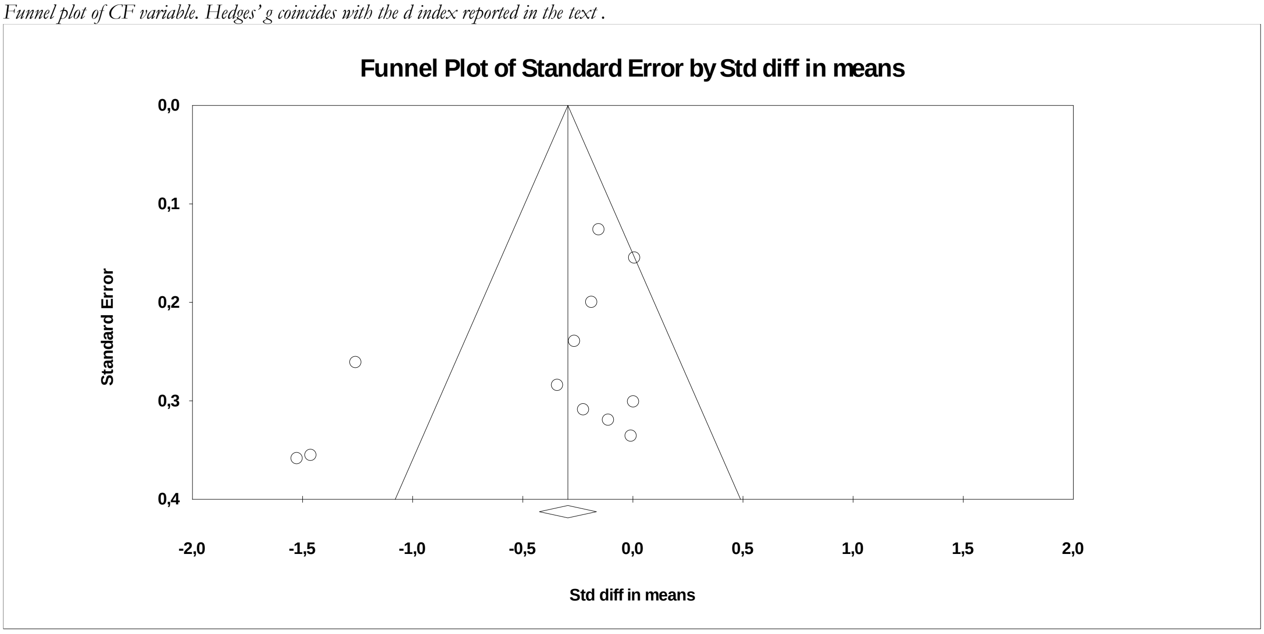


Figure 8
Funnel plot of CF variable. Hedges' g coincides with the d index reported in the text .



Discussion

There is abundant research on executive functions in adults with OCD, reaching smaller effect sizes in IR and CF. These data could be mediated by variables such as response severity (Abramovitch et al., 2019; Snyder et al., 2015). Studies in the pediatric population are fewer with somewhat inconsistent results (Geller et al., 2017; Ornstein et al., 2010; Shin et al., 2008; Taner et al., 2011). The aim of this work was to investigate performance in EF on pediatric OCD. A meta-analysis was conducted on 20 studies, of which fifteen evaluated IR, twelve CF, seven planning and three DM.

Our first aim was to analyze participant characteristics. We were able to observe that the mean ages of studies did not differ significantly between the OCD and control groups, except for studies by Negreiros et al. (2019) and Shin et al. (2008). Sex was well represented, apart from one study (Barua et al., 2020). Regarding verbal IQ, three studies presented a significantly lower mean difference in Verbal IQ for the group with OCD compared to CG (Hybel et al., 2017; Shin et al., 2008; Taner et al., 2011). This, together with the fact that only 10 studies presented this information might mean that participants are not equal in this variable. All this leads to the conclusión that studies were quite equal in terms of sociodemographic characteristics, sex and age, but not in verbal IQ, which could be a variable affecting results in performance of EF.

Our second aim was to analyze the methodological quality of studies. We consider that first meta-analysis in this field reports the quality of the studies in detail, being a relevant value for research. We observed an average quality of 6.6 (scale from 0 to 9). Studies scoring highest in quality were Batistuzzo et al. (2015), Andres et al. (2006), Geller et al. (2017), Kodaira et al. (2012), Ornstein et al. (2010), Ota et al. (2013) and Shin et al. (2008). All studies fulfilled item 1 (adequate selection of control groups). However, the item on masking was only taken into account by the evaluator for 5%, which could lead to overestimation of effects, that is, to obtain more marked deficits in participants with OCD compared to controls.

Our third aim was to analyze difference in performance of EF (DM, planning, RI and CF) in the OCD group versus the healthy control group.

Of the 15 studies evaluating IR, four presented a low but clinically significant effect size in comparison to groups with OCD (Andrés et al., 2006, 2008; Baykal et al., 2014; Taner et al., 2011), although this must be analyzed with caution due to the small sample size. Nevertheless, the magnitude of the effect size found in this meta-analysis was higher than in that by Abramowitz et al. (2015) which only reached an effect size close to zero (-0.07). Compared to adult-focused meta-analyses (Abramovitch et al., 2013; Shin et al., 2014; Snyder et al., 2015) that reported a medium magnitude (0.49 to 0.55), our effect sizes were minor. This may be due to several reasons. Firstly, perhaps this domain of EF deteriorates over time, being lower in childhood and adolescence than in adulthood (Beers et al., 1999). Nonetheless, it must be remembered that differences in ETs were not found in all studies with adults (Rosa-Alcázar et al., 2020). Another possible explanation would be selection of tasks to assess IR. Abramovitch and Cooperman (2015) pointed out differences in IR according to different paradigms. Thus, studies that used the Go-No-Go and Stroop interference paradigms did not find differences between groups, it being necessary to use stop tasks, as there may be different neuronal substrates (Eagle et al., 2008).In the present meta-analysis, most studies used the Stroop and Go-No-Go task, thus in future research it would be important to use tests associated with the three paradigms within each study (Abramovitch et al., 2015).

The effect size average in CF was lower in groups with OCD (d_+ = -0.418) its magnitude moderate and low (between 0.20 and 0.50) and clinically significant. Three studies presented significantly lower mean levels of flexibility than the control groups (Barua et al., 2020; Baykal et al., 2014; Taner et al., 2011). Our results achieved worse results in CF in the OCD group than those in the meta-analysis by Abramowitz et al. (2015) whose mean ES was medium low (d = -0.26). In the meta-analysis by Snyder et al. (2015) and Shin et al. (2014) -focused on adults- effect sizes were similar to our data. The most used measure was the computerized version WCST the main signs being dysfunction, perseverative errors are the main signs of frontal dysfunction (Teubner-Rhodes et al., 2017). This version appears to be more sensitive than the classic method for identifying deficiencies in patients with OCD (Shin et al., 2014).

Results in DM reported a mean effect of -0.169, not considered relevant from a clinical viewpoint. However, only three studies reported this domain (Erhan et al., 2017; Hybel et al., 2017; Negreiros et al., 2019), with homogeneous results.

The mean effect in Planning was of low to moderate magnitude, indicating worse performance in groups with OCD (d_+ = -0.319). Effect sizes for this variable exhibited high homogeneity but only 7 studies reported this domain. This result is close to that found in the meta-analysis by Abramowitz et al. (2015) which is also under-represented in studies.

Overall, effect sizes for all domains ranged from -0.169 to -0.418, with impairment clinically significant in CF, IR, and Planning. This does not mean, as indicated by Abramowitz et al. (2015) that there are children with OCD who may perform worse on these variables, but these results should be taken in the context of the limited sample size. Notably, the small number of effect sizes precluded any meaningful statistical analyzes to examine possible moderator variables. Interestingly, subdomains that produced the smallest effect sizes (Planning, RI, and DM) also turned out to be homogeneous. Furthermore, due to the small sample size, we decided not to examine possible moderating variables.

These findings reported that results in children/adolescents with OCD are quite smaller in magnitude compared to those obtained in meta-analyses in adult patients with OCD (Abramovitch et al., 2013, 2019; Shin et al., 2014).

The current study has important implications for clinical practice with pediatric OCD patients. Firstly, this study may suggest that incorporating a CF component into treatment could enable more effective interventions. The inclusion of specific modules on flexibility might potentially enhance the effectiveness of exposure with response prevention, improving adherence to treatment, and preventing desertion (Rosa-Alcázar et al., 2020).

This research is not without limitations. Firstly, the small number of studies, and low representation in the measure of some domains, together with certain publication bias, all restrict us from generalizing our results, therefore these must be interepreted with caution. This has also prevented analyzing possible influence of moderating variables in the different domains.

Future studies particularly longitudinal studies, that examine neural and clinical neurocognitive correlates of pediatric OCD are needed to confirm our findings and to determine the extent to which our results may have clinical relevance.

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