**Review**

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# Relationship Between Types of Aggression and Executive Functions: A Meta-Analysis Study

## Saldırganlık Türleri ile Yürütücü İşlevler Arasındaki İlişki: Meta-Analiz Çalışması

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**ABSTRACT**

This meta-analysis systematically reviewed original research examining the relationship between executive function (EF) and different forms (physical and relational) and functions (reactive and proactive) of aggression. The primary aim was to clarify how cognitive control processes, such as inhibition, working memory, and cognitive flexibility, relate to distinct patterns of aggressive behavior. A systematic literature search was conducted in Medline, Scopus, and PsycINFO, including studies that assessed EF using validated measures and reported correlation coefficients with aggression variables. After screening according to PRISMA guidelines, 24 studies involving 10,181 participants met the inclusion criteria. Random-effects models were used to calculate pooled effect sizes, taking into account variability across studies. The results showed that the strongest average correlation was found between executive function and physical aggression ($r = .14$, $p = .29$), though this association did not reach statistical significance. The weakest correlation emerged between EF and reactive aggression ($r = -.003$, $p = .97$), suggesting virtually no relationship. Similarly, correlations between EF and proactive aggression ($r = .14$, $p = .09$) and relational aggression ($r = .007$, $p = .93$) were weak and non-significant. Considerable heterogeneity was observed across all models ($I^2 > 95\%$), indicating that study differences in design, sample characteristics, and measurement tools may have influenced results. Overall, the findings reveal a complex and inconsistent pattern linking executive functioning and aggression.

**Keywords:** Executive function, aggression, meta-analysis

**ÖZ**

Bu meta-analiz, yürütücü işlev (Yİ) ile saldırganlığın farklı biçimleri (fiziksel ve ilişkisel) ve işlevleri (reaktif ve proaktif) arasındaki ilişkiyi inceleyen özgün araştırmaları sistematik olarak gözden geçirmiştir. Birincil amaç, inhibisyon, çalışma belleği ve bilişsel esneklik gibi bilişsel kontrol süreçlerinin farklı saldırganlık örüntüleriyle nasıl ilişkili olduğunu açıklığa kavuşturmaktır. Sistematik literatür taraması Medline, Scopus ve PsycINFO veri tabanlarında yürütülmüş, yürütücü işlevleri geçerli ölçümlerle değerlendiren ve saldırganlık değişkenleriyle korelasyon katsayılarını rapor eden çalışmalar dahil edilmiştir. PRISMA yönergelerine göre yapılan tarama sonrasında, 10.181 katılımcıyı içeren toplam 24 çalışma dâhil edilme kriterlerini karşılamıştır. Çalışmalar arasındaki farklılıkları dikkate almak için rassal etkiler modeli kullanılarak birleştirilmiş etki büyüklükleri hesaplanmıştır. Sonuçlar, yürütücü işlev ile fiziksel saldırganlık arasındaki ortalama korelasyonun en yüksek olduğunu göstermiştir ($r = .14$, $p = .29$); ancak bu ilişki istatistiksel olarak anlamlı bulunmamıştır. En zayıf korelasyon ise yürütücü işlev ile reaktif saldırganlık arasında ortaya çıkmıştır ($r = -.003$, $p = .97$), bu da neredeyse hiçbir ilişki olmadığını göstermektedir. Benzer şekilde, yürütücü işlev ile proaktif saldırganlık ($r = .14$, $p = .09$) ve ilişkisel saldırganlık ($r = .007$, $p = .93$) arasındaki korelasyonlar da zayıf ve anlamlı değildir. Tüm modellerde önemli düzeyde heterojenlik gözlenmiştir ($I^2 > 95\%$), bu da araştırma tasarımlarındaki, örneklem özelliklerindeki ve ölçüm araçlarındaki farklılıkların sonuçları etkilemiş olabileceğini göstermektedir. Genel olarak, bulgular yürütücü işlevler ile saldırganlık arasındaki ilişkinin karmaşık ve tutarsız bir örüntü sergilediğini ortaya koymaktadır.

**Anahtar sözcükler:** Yürütücü işlev, saldırganlık, meta-analiz

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## Introduction

Aggression is both a significant risk factor for psychopathology and a symptom of various disorders in children and adolescents. However, the developmental trajectories that contribute to this behavior remain not fully understood. Because temperamental differences emerge early in life, these characteristics may provide valuable insights into the early development of aggression and antisocial behavior. To design effective interventions for managing aggressive tendencies, it is crucial to identify the key factors associated with aggression. Moreover, different mechanisms and pathways may be involved depending on the specific type of aggression (Ostrov et al. 2022, Kyranides et al. 2024).

A large body of evidence supports the view that executive functioning (EF) is essential for understanding aggressive and antisocial behavior (Hecht & Latzman 2017). EF refers to a set of higher-order cognitive and self-regulatory processes that facilitate goal-directed behavior and adaptive responses to novel or complex situations. Core components of EF include inhibitory control (IC), working memory (WM), and cognitive flexibility (CF). These skills emerge in early childhood and continue developing into adulthood, playing vital roles in problem-solving, planning, emotion regulation, and behavior monitoring (Weyandt 2005, Topham 2022). Strong EF development is fundamental for behavioral adjustment, social-emotional competence, and learning readiness as children enter formal education (Li et al. 2023).

Deficits in EF have been identified as cognitive vulnerabilities for physical aggression. Executive dysfunction—marked by difficulties in inhibition, attention control, planning, emotion regulation, and cognitive flexibility—may hinder an individual's ability to self-monitor and adaptively regulate behavior, thereby increasing the likelihood of aggression (Rohlf et al. 2018, Cruz et al. 2020). Lower EF in early childhood has been associated with impulsivity, reactive behavior, social adaptation difficulties, and externalizing problems (Caporaso et al. 2021). While inhibitory control has been found to predict physical and reactive aggression, its relationship to relational aggression remains less explored (Patwardhan et al. 2021a, Di 2024).

Although CF has been studied less frequently, it is believed to support children's ability to adjust their responses to social cues, aligning with the Social Information Processing (SIP) model, which posits that flexible thinking leads to more context-appropriate behavior and may reduce aggression (Patwardhan et al. 2021a). Because EF develops unevenly across childhood, age-related differences may account for inconsistencies in previous findings. Moreover, aggression is influenced not only by EF components such as IC but also by emotional processes, necessitating an integrative framework to fully understand aggression in children (Caporaso et al. 2021).

EF does not operate in isolation but interacts dynamically with emotional and cognitive mechanisms. "Hot" EF refers to emotion regulation in affectively charged contexts, whereas "cold" EF pertains to abstract, decontextualized cognitive tasks. This distinction underscores the importance of evaluating EF alongside emotion regulation when examining aggression, particularly in preschool-aged children (Zelazo & Carlson 2020, Patwardhan et al. 2021a).

Aggression—defined as intentional behavior aimed at harming another individual (Anderson Bushman 2002)—is often viewed as a response to perceived threat. Multiple psychosocial and intergenerational factors predispose individuals to later aggression and violence. These include prenatal risks (e.g., fetal alcohol exposure), childhood adversities (e.g., maltreatment, parental absence), and environmental stressors (e.g., poverty, peer influence), along with individual differences in temperament, personality, and neurocognitive function (Bergeron & Valliant 2001, Broomhall 2005, Hancock et al. 2010, Friedman et al. 2018, Humenik et al. 2020).

Two widely studied forms of aggression are physical aggression (e.g., hitting, pushing) and relational aggression (e.g., social exclusion, spreading rumors) (Ersan 2020). While younger children are more likely to exhibit overt physical aggression, relational aggression tends to emerge and become more prominent as children's social cognition develops (Crick & Grotpeter 1995, Little et al. 2003). Another common approach categorizes aggression based on its function—namely, reactive and proactive aggression (Martín-Ramírez 2010, Moya-Albiol & Romero-Martínez 2020, Li et al. 2023).

Reactive aggression is typically impulsive and emotionally driven ("hot-blooded"), occurring in response to perceived provocation or threat. In contrast, proactive aggression is deliberate and goal-oriented ("cold-blooded"), reflecting a calculated attempt to gain reward or dominance (Vitaro et al. 2006, Mullin & Hinshaw 2007, Romero-Martínez et al. 2022). Although these two types of aggression are modestly correlated, they differ in emotional profiles, theoretical models, and developmental trajectories. Reactive aggression aligns with frustration–aggression theory and poor affect regulation, whereas proactive aggression corresponds to social learning theory and strategic behavior (Poulin & Boivin 2000, White et al. 2013).

Proactive aggression is often associated with advanced social-cognitive skills and lower anxiety, while reactive aggression correlates more strongly with emotion dysregulation, anger reactivity, and hostile attribution biases (Hubbard et al. 2001, Schippell et al. 2003). Proactive aggression involves fewer emotion-processing deficits than reactive aggression, which has been linked to impairments in conflict resolution and attention regulation (Dodge et al. 1997).

EF may play distinct roles across these aggression subtypes. Some findings suggest that higher EF is related to proactive (planned) aggression, whereas lower EF—particularly in inhibition and organization—is more strongly tied to reactive aggression (Ellis et al. 2009, Poland et al. 2016, Hecht & Latzman 2018). Children with weak EF may resort to impulsive, emotionally reactive aggression when frustrated, while those with stronger planning skills may use aggression more strategically.

The relationship between EF and relational aggression remains debated. Although relational aggression is often assumed to require higher-level cognitive processing (e.g., theory of mind, planning), findings are mixed. Some studies show that children with poor EF also engage in relational aggression, possibly due to overlapping risk factors such as attention deficits (Diamantopoulou et al. 2007, McQuade et al. 2013). Conversely, others suggest that higher EF may facilitate more subtle and manipulative social behaviors (Björkqvist et al. 1992, Renouf et al. 2010).

Studies that examine both physical and relational aggression have identified differing EF correlates depending on age and gender. For example, reactive aggression has been associated with weaker inhibition and planning abilities in children (Giancola et al. 1996, Thomson & Centifanti 2018), whereas proactive aggression appears linked to goal-directed thinking and lower impulsivity (Poland et al. 2016).

Overall, variability in EF–aggression findings across subtypes, contexts, and developmental stages underscores the need for further research. Classifying aggression by both form (physical vs. relational) and function (reactive vs. proactive) provides a clearer framework for understanding the cognitive and emotional mechanisms underlying aggressive behavior (Rohlf et al. 2018). Therefore, the present study aims to examine the relationship between executive functions (EF) and different forms (physical and relational) and functions (reactive and proactive) of aggression in children and adolescents through a meta-analytic approach. By systematically analyzing existing studies, this research seeks to determine whether deficits in executive functions—particularly in inhibition, working memory, and cognitive flexibility—are differentially associated with these subtypes of aggression.

## Method

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were employed to investigate the study selection process.

### Screening Strategy and Information Sources

A systematic search was conducted in three major psychology and health-related databases—Scopus, Medline, and PsycINFO—which were selected for their extensive coverage of peer-reviewed literature in psychology, psychiatry, and behavioral sciences. Although other databases such as Web of Science, Google Scholar, ERIC, and SciLit were considered, these were not included due to overlaps in indexing, limitations in filtering by study design or effect sizes, and the focus on high-quality, indexed sources. The search in each database covered the period from [January 2000 to December 2024]. The research included the publications that were publicized in scientific journals in English language.

As a key word "executive functioning" was included in the title or abstract in relation with the following terms: "executive function" OR "agression" OR "proactive aggression" OR "reactive aggression" OR "physical aggression" OR "relational aggression" OR "aggressive behavior" OR "aggresiveness" OR "forms of aggression" OR "subtypes of aggression" OR "functions of aggression". Duplicates were eliminated when the searching was completed in all databases, and the research selection procedure started.

### Eligibility Criteria and Study Selection

The following inclusion criteria was implemented for this meta analysis: (a) use of a standardized and validated measure of executive function such as uch as the Behavior Rating Inventory of Executive Function (BRIEF) (b) research that validated cross-sectional or longitudinal method, (c) reseach which provide correlation coefficient. The exclusion criteria was (a) studies with qualitative nature (b) studies which are not included in academic publication such as thesis or dissertations, (c) systematic reviews and meta-analysis, (d) research which is not in English language, (e) studies for which there is not a full text (f) studies which did not provide correlation coefficients

The data extraction involved the author, publication year, sample size, age of the participants, measurement tool of executive function and Pearson's r correlation.

### Statistical Analysis

The statistical analyses were conducted using the Metafor package (version 4.2.2) in the R programming language (Viechtbauer, 2010). The effect size metric used for all analyses was the Pearson correlation coefficient (r) representing the association between executive function and different types of aggression.To satisfy the assumptions of normality and stabilize variance, Pearson's r values were transformed into Fisher's z-scores before meta-analysis. These z-scores allow for more accurate estimation of pooled effect sizes and confidence intervals, especially when correlations are near the boundaries of -1 or +1 (Welz et al., 2022). After analysis, the Fisher's z-values were converted back to Pearson's r for ease of interpretation. Positive values indicate a positive association between EF and aggression, while negative values indicate an inverse relationship.

A random-effects model was used for all analyses to account for expected heterogeneity across studies. This model was chosen because the included studies varied widely in terms of sample characteristics (e.g., age range, country), study design (e.g., cross-sectional vs. longitudinal), and measurement instruments for both executive function and aggression. Unlike fixed-effects models, the random-effects model assumes that the true effect size may differ from one study to another and incorporates between-study variance ($\tau^2$) into the estimation. This approach provides more conservative and generalizable estimates (DerSimonian & Kacker, 2007; Borenstein et al., 2009). Heterogeneity was assessed using Q statistics, $\tau^2$ (tau-squared), and $I^2$ statistics (Higgins & Thompson, 2002). To examine potential publication bias, Egger's regression test and rank correlation test were performed. Outlier and influence diagnostics included studentized residuals and Cook's distances. Raw data and diagnostic plots are available upon request for transparency.

## Results

A total of 2208 studies were screened and the amount of articles which sources found were as follows: 1401 in Scopus, 476 in Medline, and 331 in PsycINFO. After further evaluation of the studies and exclusion, 118 studies were eligible for this study (Figure. 1). Furthermore, taking into account the criteria, 24 studies were comprised in this analysis. A total of 94 reports were excluded for the following reasons: 83 due to ineligible study design (e.g., qualitative studies or reviews) and 21 due to missing correlation coefficients.

### Studies and Their Characteristics

The analysis comprised of 24 studies and the majority of the studies were cross-sectional, longitudinal and correlational. The majority of the studies are carried out in the USA, followed by United Kingdom, China, Sweden, Germany, France, Hong Kong, Scotland, New Zealand, Turkey, Australia. The 21 studies were conducted in school environment, two in online platform, one in kindergarden, one in a university, and one which is conducted in a website by national respondents. The sample size of the participants taken for all studies were 10,181. The average age for physical aggression was 15.11, for relational aggression 11.68, for proactive aggression 14.54 and for reactive aggression was 15.05. Different tools were employed to evaluate executive function and aggression which revealed valuable information.

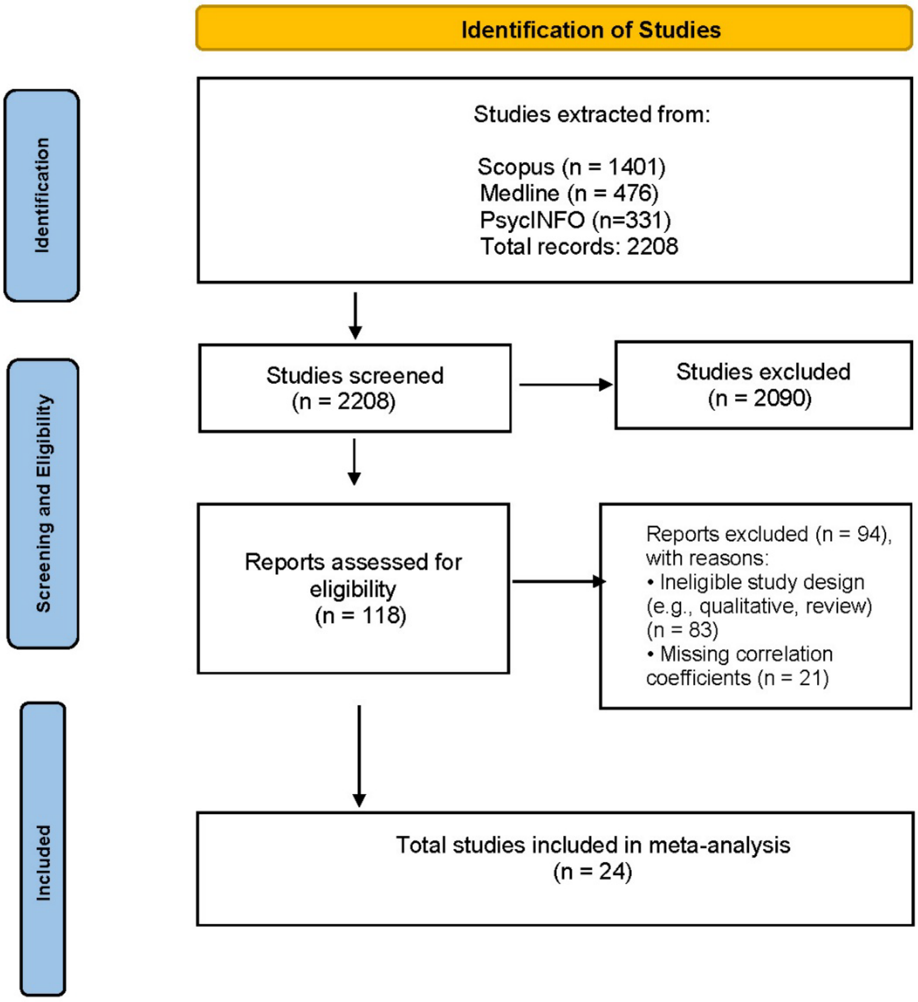


**Figure 1. PRISMA flow chart**

## Executive Function and Physical Aggression

A total of 11 studies were included in the analysis. The observed Fisher r-to-z transformed correlation coefficients ranged from -0.5230 to 0.8872, with 55% of the estimates being negative. Using a random-effects model, the estimated average Fisher r-to-z transformed correlation coefficient was 0.1423 (95% CI: -0.1206 to 0.4052). This indicates that the average effect was not significantly different from zero ($z = 1.0608$, $p = 0.2888$) (Figure 2).

The Q-test suggested substantial heterogeneity among the true outcomes ($Q(10) = 1123.3278$, $p < 0.0001$, $tau^2 = 0.1911$, $I^2 = 98.3399\%$). The 95% prediction interval for the true outcomes ranged from -0.7540 to 1.0386, meaning that while the estimated average effect is positive, some studies may still show a negative effect.

An analysis of studentized residuals found no studies exceeding the threshold of ±2.8376, suggesting no outliers within this model. Similarly, Cook's distances indicated that none of the studies had an excessive influence on the results. Finally, both the rank correlation test and the regression test found no evidence of funnel plot asymmetry (p = 0.7612 and p = 0.9884, respectively).

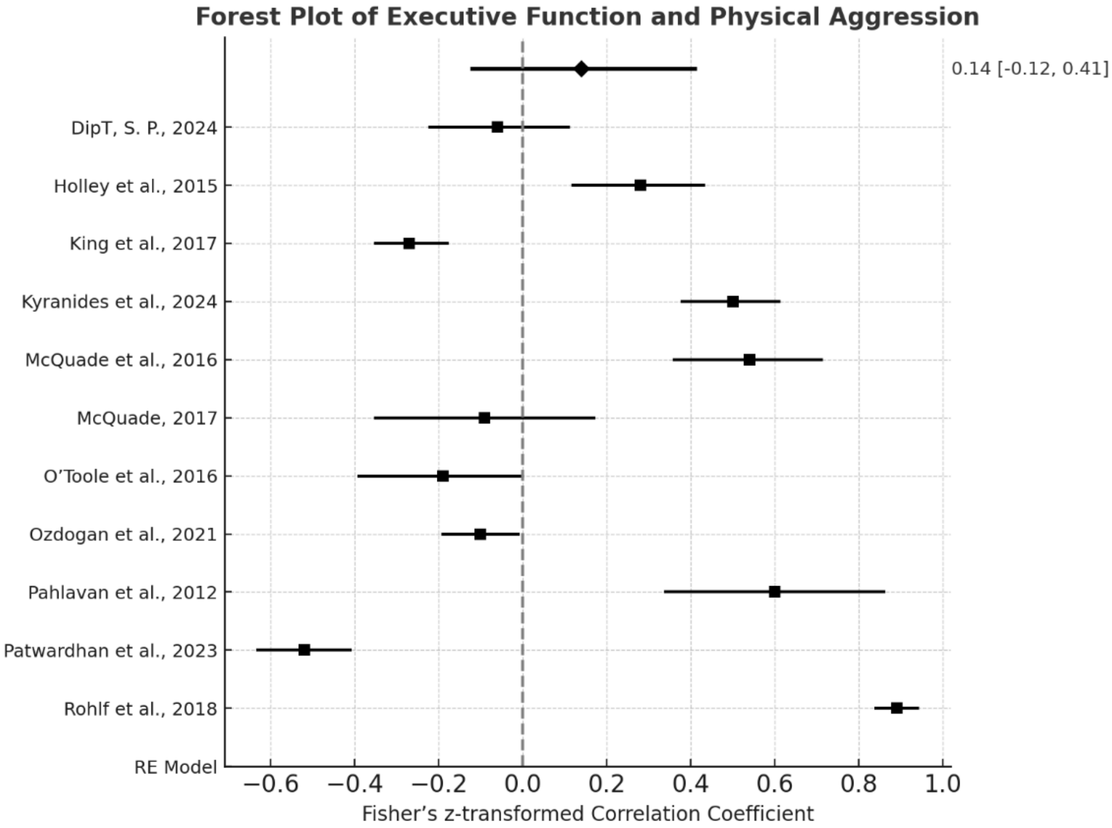


**Figure 2. Forest plot showing the effect sizes and 95% confidence intervals for the relationship between executive function and physical aggression.**

Squares represent individual study effect sizes, horizontal lines indicate 95% confidence intervals, and the diamond shows the pooled random-effects estimate.

## Executive Function and Relational Aggression

A total of 10 studies were analyzed. The observed Fisher r-to-z transformed correlation coefficients ranged from -0.3884 to 0.5901, with 60% of the estimates being negative. Using a random-effects model, the estimated average Fisher r-to-z transformed correlation coefficient was 0.0074 (95% CI: -0.1720 to 0.1867), indicating no significant difference from zero (z = 0.0803, p = 0.9360) (Figure 3).

The Q-test suggested considerable heterogeneity among the true outcomes (Q(9) = 475.4170, p < 0.0001, $tau^2$ = 0.0778, $I^2$ = 95.8571%). The 95% prediction interval for the true outcomes ranged from -0.5680 to 0.5827, meaning that although the estimated average effect is positive, some studies may still report negative effects.

Analysis of studentized residuals identified one study (Rohlf et al., 2018) with a value exceeding ±2.8070, suggesting it could be a potential outlier within this model. However, Cook's distances indicated that none of the studies exerted an excessive influence on the results. Lastly, both the rank correlation test and the regression test found no evidence of funnel plot asymmetry (p = 1.0000 and p = 0.2307, respectively).

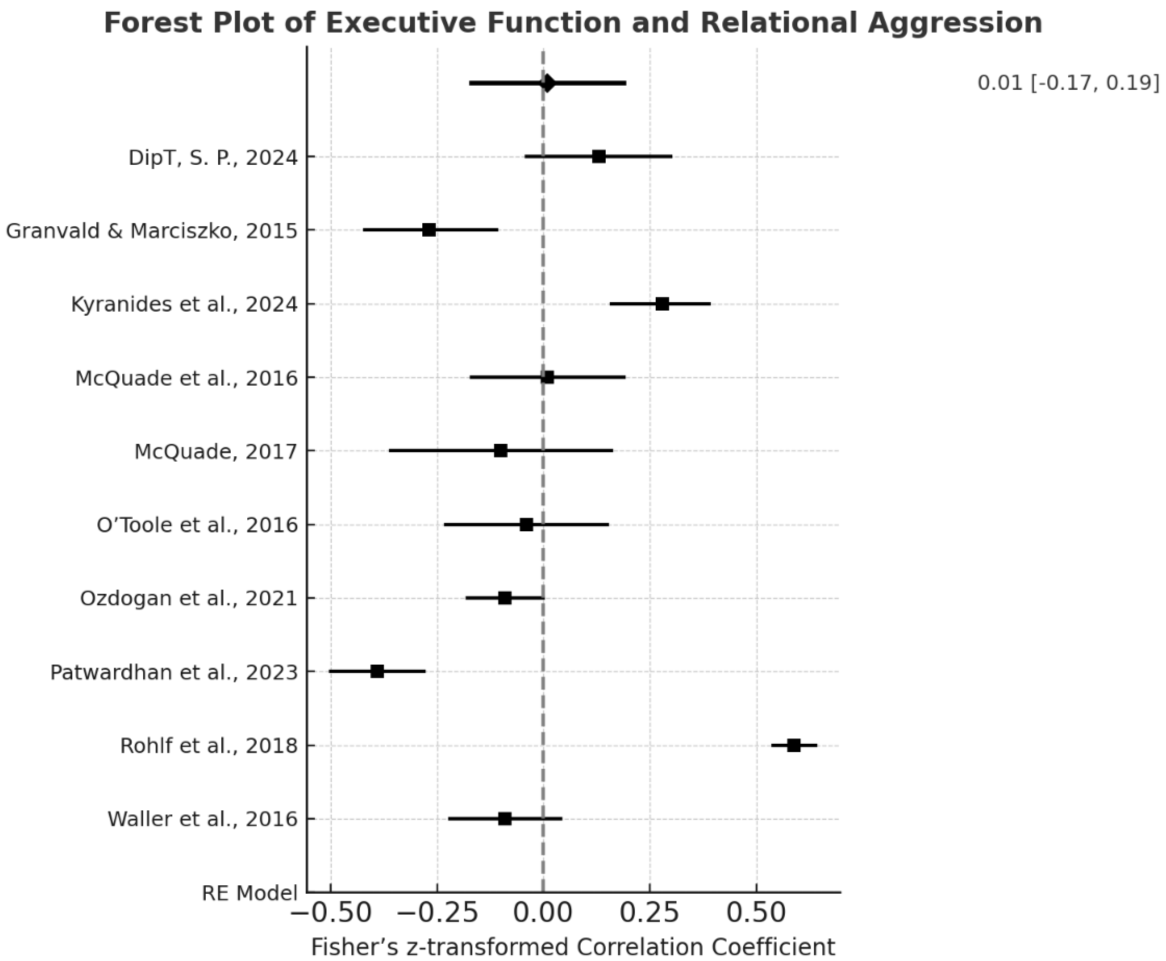


**Figure 3. Forest plot showing the effect sizes and 95% confidence intervals for the relationship between executive function and relational aggression.**

Each square corresponds to a single study, with horizontal lines indicating 95% confidence intervals, while the diamond represents the overall pooled effect size.

## Executive Function and Proactive Aggression

A total of 16 studies were analyzed. The observed Fisher r-to-z transformed correlation coefficients ranged from -0.3884 to 0.8291, with 62% of the estimates being positive. Using a random-effects model, the estimated average Fisher r-to-z transformed correlation coefficient was 0.1370 (95% CI: -0.0253 to 0.2993), indicating no significant difference from zero (z = 1.6542, p = 0.0981) (Figure 4). .

The Q-test suggested substantial heterogeneity among the true outcomes (Q (15) = 390.7148, p < 0.0001, $tau^2$ = 0.1038, $I^2$ = 97.9237%). The 95% prediction interval for the true outcomes ranged from -0.5151 to 0.7891, meaning that although the estimated average effect is positive, some studies may report negative effects.

An analysis of studentized residuals showed that no studies exceeded the threshold of ±2.9552, suggesting no outliers in this model. Similarly, Cook's distances indicated that none of the studies had an undue influence on the results. Lastly, both the rank correlation test and the regression test found no evidence of funnel plot asymmetry (p = 0.4986 and p = 0.0613, respectively).

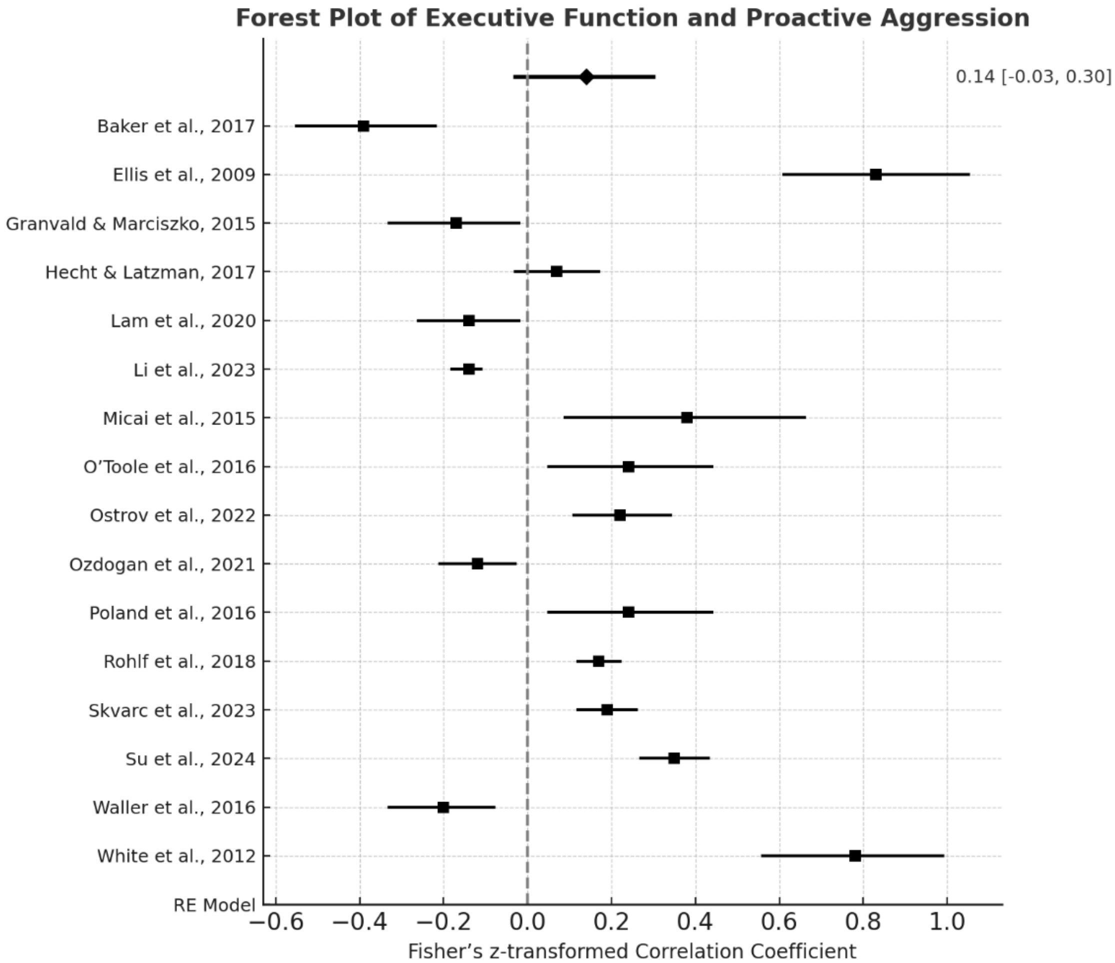


**Figure 4. Forest plot showing the effect sizes and 95% confidence intervals for the relationship between executive function and proactive aggression.**

Individual study results are displayed as squares with 95% confidence intervals, and the pooled random-effects estimate is shown as a diamond.

## Executive Function and Reactive Aggression

A total of 11 studies were analyzed. The observed Fisher r-to-z transformed correlation coefficients ranged from -0.4236 to 0.4722, with 55% of the estimates being negative. Using a random-effects model, the estimated average Fisher r-to-z transformed correlation coefficient was -0.0029 (95% CI: -0.1553 to 0.1496), indicating no significant difference from zero ($z = -0.0367$, $p = 0.9707$) (Figure 5).

The Q-test suggested considerable heterogeneity among the true outcomes ($Q(10) = 952.8978$, $p < 0.0001$, $tau^2 = 0.0626$, $I^2 = 97.4922\%$). The 95% prediction interval for the true outcomes ranged from -0.5164 to 0.5107, meaning that while the estimated average effect is negative, some studies may report positive effects.

An analysis of studentized residuals showed no studies exceeding the threshold of ±2.8376, suggesting no outliers in this model. However, Cook's distances indicated that one study (Rohlf et al., 2018) may have had an undue influence on the results. Lastly, both the rank correlation test and the regression test found no evidence of funnel plot asymmetry ($p = 0.2183$ and $p = 0.9104$, respectively).

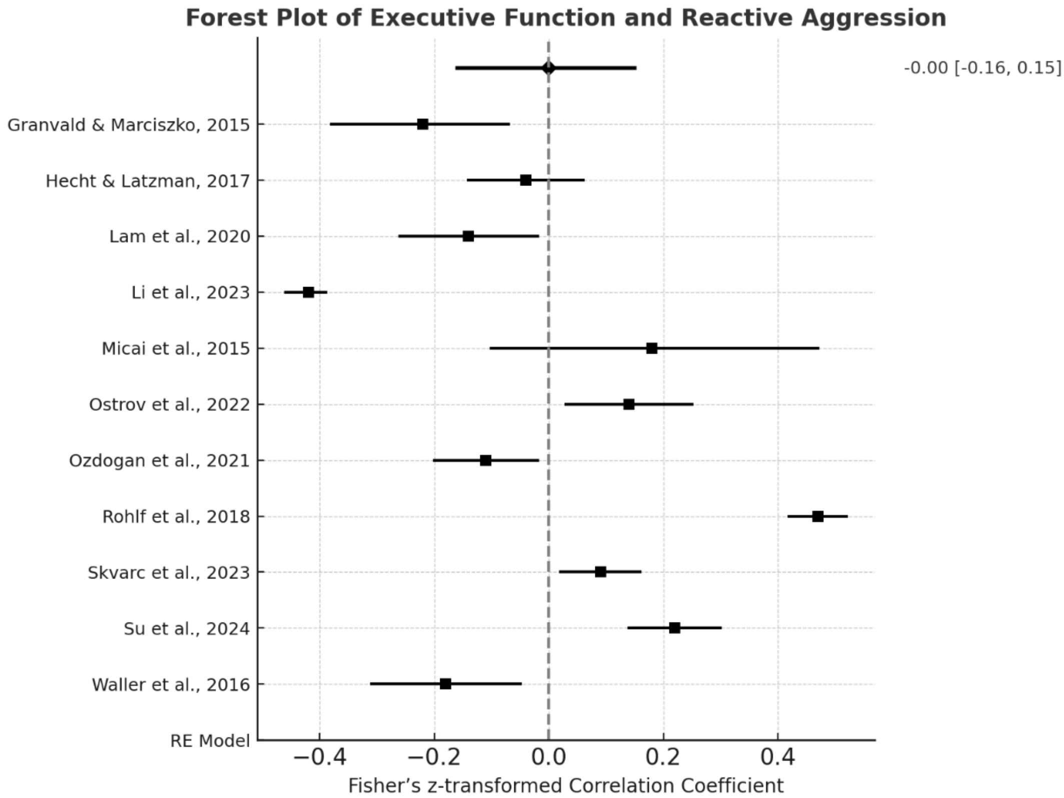


**Figure 5. Forest plot showing the effect sizes and 95% confidence intervals for the relationship between executive function and reactive aggression.**

Squares illustrate effect sizes for each study, lines show 95% confidence intervals, and the diamond represents the pooled random-effects estimate.

## Discussion

This meta-analysis examined the relationship between executive function (EF) and different forms (physical and relational) and functions (reactive and proactive) of aggression in children and adolescents. Based on previous literature, it was hypothesized that EF deficits—particularly in inhibitory control, working memory, and cognitive flexibility—would be most strongly associated with physical and reactive aggression, and less predictive of relational and proactive aggression. Although EF is widely recognized as essential for self-regulation and goal-directed behavior, the present findings revealed generally weak and non-significant associations across aggression subtypes. However, the substantial heterogeneity observed ($I^2$ > 95%) suggests that these relationships may be moderated by developmental, cognitive, and contextual factors. Physical aggression, typically overt and impulsive, was expected to correlate negatively with EF—especially inhibitory control. Across 11 studies, the estimated average correlation was modestly positive (r = .14), though not statistically significant. Notably, 55% of the effect sizes were negative, partially supporting the hypothesis that stronger EF may reduce physical aggression.

These mixed results likely reflect the influence of moderators such as age and gender. EF, particularly inhibitory control, continues to mature during early childhood (Utendale et al. 2011), and its role in suppressing aggressive impulses may be more pronounced at younger ages. Additional influences—such as emotional dysregulation, impulsivity, and environmental stressors—may mediate or even override EF's protective effects (Anderson & Bushman 2002, Séguin 2009). Previous research indicates that poor inhibition contributes to physical aggression in both emotionally neutral and affect-laden contexts (Zelazo et al. 2005), while neurobiological mechanisms (e.g., prefrontal dysfunction) may further shape this relationship. Overall, EF appears to represent one component of a broader cognitive-emotional system influencing physical aggression.

Relational aggression is socially manipulative, involving behaviors such as exclusion, rumor spreading, or subtle emotional harm. It was hypothesized to be less directly linked to EF or even positively associated with certain subcomponents such as cognitive flexibility and planning. The results supported this view: across 10 studies, the average effect size was near zero (r = .007), and 60% of studies reported negative correlations.

This weak and inconsistent pattern aligns with theories suggesting that relational aggression may be more strategic than impulsive and therefore not necessarily rooted in EF deficits (Crick & Dodge, 1994, Ostrov & Houston 2008). Indeed, relational aggression has been associated with higher social intelligence, theory of mind, and working memory (Andreou 2006, Renouf et al. 2010, McQuade et al. 2013). Girls and older children—who more frequently use relational aggression—may engage in socially calculated behaviors requiring intact EF (Björkqvist et al. 1992, Underwood et al. 2001).

Nonetheless, some evidence links relational aggression to EF deficits in specific conditions, such as among children with ADHD symptoms or in peer-victimized contexts (Diamantopoulou et al. 2007, Cooley & Fite 2016). Conflicting findings may also arise because many studies do not control for physical aggression, which overlaps conceptually and behaviorally. Developmental stage is another key factor: during preadolescence, when EF skills are still developing, relational aggression may become increasingly covert and sophisticated (Crick et al. 2007, Best & Miller 2010). Thus, EF's role in relational aggression likely varies depending on age, gender, cognitive profile, and social context.

Proactive aggression is deliberate, goal-directed, and motivated by expected rewards rather than emotional arousal. It was hypothesized that EF would be weakly or positively associated with proactive aggression. Across 16 studies, the average correlation was weak and non-significant (r = .137, p = .098), aligning with theoretical perspectives suggesting that proactive aggression may depend on intact planning, decision-making, and cognitive control (Hubbard et al. 2010).

Some scholars propose that proactive aggression involves moral disengagement and social learning processes (Bandura 1986, Dodge et al. 1997), which are not necessarily impaired by EF deficits. Children who exhibit proactive aggression may be cognitively capable but lack empathy or demonstrate callous-unemotional traits. However, EF subcomponents such as working memory, inhibition, and planning may still influence proactive aggression when interacting with factors like hostile attribution bias. Kempes et al. (2006) suggested that a strong hostile attribution bias increases the cognitive demands required for planning proactive aggression, thereby weakening the EF–aggression link under certain conditions.

These nuances indicate that while EF may not prevent proactive aggression, it can facilitate it in children with adequate cognitive control but limited moral reasoning—highlighting the importance of interventions that integrate empathy development and moral education rather than focusing solely on cognitive training.

Reactive aggression is emotionally charged, often triggered by perceived provocation, and was hypothesized to correlate most strongly and negatively with EF. However, the average correlation across 11 studies was near zero (r = –.003), contradicting expectations. Although 55% of the estimates were negative, variability across studies suggests a more complex association.

Reactive aggression is linked to poor emotion regulation, frustration intolerance, and heightened threat sensitivity (Dodge et al. 1997). EF deficits may reduce an individual's ability to inhibit impulsive reactions, but these effects are likely mediated by anger, temperament, and stress reactivity (Vitaro et al. 2002, Hubbard et al. 2010). Neurobiological factors, such as amygdala hyperactivity, may also contribute more directly to reactive aggression than EF dysfunction (Morgan & Lilienfeld 2000). Furthermore, distortions in cue encoding—where ambiguous social signals are interpreted as hostile—may moderate the EF–aggression relationship (Ellis et al. 2009).

The absence of a significant association between EF and reactive aggression contradicts several earlier findings reporting negative correlations, particularly those involving inhibitory control and emotion regulation (Ellis et al. 2009, White et al. 2013). One explanation may be the variability in measurement methods, EF and aggression were operationalized differently across studies, potentially limiting comparability. Additionally, the intense emotional arousal typical of reactive aggression may not be fully captured by cognitive EF tasks, especially in laboratory settings. Moderating factors—such as temperament, hostile attribution bias, or contextual stress—may also obscure direct EF–aggression links in cross-sectional designs.

Although the overall effect size was close to zero, several studies suggest that reactive aggression is more consistently associated with EF impairments than proactive aggression, particularly among children exhibiting hostile attribution bias or low emotional regulation (White et al. 2013). Thus, EF likely influences reactive aggression indirectly, in interaction with emotional and cognitive distortions.

Understanding the relationship between EF and aggression has significant clinical relevance, particularly for developing interventions across childhood and adolescence. Although this meta-analysis revealed weak associations between EF and aggression subtypes, the findings emphasize the importance of tailoring interventions to the form and function of aggression.

Given the observed links between EF deficits and physical and reactive aggression, interventions should focus on enhancing inhibitory control and emotion regulation. These deficits often manifest as impulsive outbursts in response to perceived threats. Programs such as STOP & THINK and Tools of the Mind, which target behavioral inhibition and self-monitoring, are particularly effective for young children. Because anger may mediate the EF–reactive aggression relationship, integrating anger management and affect-regulation components could further strengthen outcomes.

Proactive aggression, characterized by goal-oriented and calculated behavior, is often associated with moral reasoning deficits rather than cognitive impairments. Cognitive–behavioral approaches emphasizing empathy, moral reflection, and reward sensitivity—such as PATHS and Second Step—can redirect cognitive control toward prosocial goals.

For relational aggression, especially among socially skilled youth, interventions should address social cognition, conflict resolution, and prosocial problem-solving. Programs like I Can Problem Solve (ICPS) help children navigate peer dynamics and reduce manipulative behaviors through enhanced flexible thinking and communication.

Interventions supporting core EF components (working memory, attentional control, cognitive flexibility) are also essential. Mindfulness-based practices and neurofeedback can improve attention, stress regulation, and self-awareness, particularly when EF deficits co-occur with externalizing or internalizing symptoms. Programs should be developmentally appropriate, culturally sensitive, and involve parents and teachers to reinforce skills across settings.

The modest correlations observed in this study indicate that EF alone does not account for aggression, underscoring the need for broader models incorporating emotion regulation, social cognition, and neurobiological mechanisms. Future interventions should integrate longitudinal and multi-informant designs to refine prevention and treatment strategies.

Several limitations must be acknowledged. First, age variability across studies may have confounded results. As both EF and aggression develop dynamically across childhood and adolescence, future research should employ age-stratified longitudinal designs to clarify directionality—whether EF deficits precede aggression or vice versa. Second, several studies relied on teacher reports to distinguish between reactive and proactive aggression. Although informative, future work should include multi-informant assessments (e.g., parent, self-, and peer reports) and observational methods to enhance ecological validity. Third, the high heterogeneity across studies ($I^2$ > 95%) reflects substantial variability in design, measures, and samples. Future meta-analyses should incorporate meta-regressions or individual participant data (IPD) approaches to identify moderators such as age, gender, and cultural context. Measurement inconsistency further limits generalizability. Studies used a range of EF (e.g., Stroop, BRIEF) and aggression (e.g., CBCL, RPQ) tools. Future research should adopt standardized, validated instruments (e.g., BRIEF-2, RPQ) for comparability. Additionally, most studies were conducted in Western contexts (mainly the U.S. and U.K.), which limits cross-cultural generalizability. Including diverse cultural samples will clarify how sociocultural norms, parenting styles, and school environments shape EF–aggression relationships. Restricting inclusion to English-language publications may also have introduced language bias, excluding relevant non-English studies. Despite these limitations, this meta-analysis offers valuable insights into the cognitive processes underlying different aggression subtypes and identifies key directions for future research.

## Conclusion

This meta-analysis explored associations between executive function (EF) and distinct forms (physical, relational) and functions (reactive, proactive) of aggression in children and adolescents. Overall, correlations were weak and often non-significant, though distinct trends emerged: a) Physical aggression showed the highest, yet modest, positive correlation with EF (r = .14), suggesting limited but potentially meaningful associations, especially in early childhood, b) Relational aggression was largely unrelated to EF (r = .007), consistent with the notion that it may rely on intact or even enhanced cognitive processing., c) Proactive aggression exhibited a weak positive trend (r = .14), in line with its goal-oriented nature and possible dependence on planning., d) Reactive aggression showed no significant correlation (r = –.003), indicating the influence of emotional and contextual mediators such as anger and emotion regulation.

These findings imply that EF is not a uniform predictor of aggression but interacts with subtype characteristics and contextual moderators such as age, gender, and emotional control. Interventions should therefore be tailored to aggression subtype and EF profile—for example, inhibitory control training for physical/reactive aggression and social-cognitive programs for relational/proactive aggression.

Future studies should adopt longitudinal, cross-cultural, and multi-informant designs using standardized tools to better understand developmental trajectories and refine intervention strategies. Considering individual and contextual moderators will enable more targeted and effective approaches to preventing and treating aggression in youth.

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