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# A meta-analysis update on the effectiveness of early self-control improvement programs to improve self-control and reduce delinquency

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**Abstract**
*Objective* To update Piquero et al.'s (Justice Quarterly 27:803–834, 2010) meta-analysis on early self-control improvement programs.
*Methods* Screening of eligible studies was carried out for the period between January 2010 and September 2015. An additional seven studies were identified, which were added to the original database of 34 studies, totaling an overall sample of 41 eligible studies. A random effects model was used to obtain an overall mean effect size estimate. Additional analyses were performed to assess publication bias and moderation.
*Results* Overall average, positive, and significant effect sizes were observed for improving self-control (0.32) and reducing delinquency (0.27). There was evidence of publication bias for the self-control improvement outcomes, as well as some evidence of moderation for both self-control improvement and delinquency outcomes.
*Conclusions* Early self-control improvement programs are an effective evidence-based strategy for improving self-control and reducing delinquency.

**Keywords** Self-control · Impulsivity · Crime · Delinquency · Prevention · Meta-analysis

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## Introduction

Whether termed self-control, impulsivity, or temperament, persons who lack impulse control are at risk for a wide range of problem behaviors and adverse outcomes throughout the life course, including poor educational outcomes, relationship quality, employment prospects, health, and especially involvement in deviant, antisocial, and criminal activity (Moffitt et al. 2011). So routinely identified, there should be little surprise that self-control has been a key component of various theoretical frameworks in both criminology (DeLisi and Vaughn 2014; Gottfredson and Hirschi 1990 ) and psychology (Baumeister et al. 1994; Moffitt 1993), and most recently in the business/management field (Vohs and Faber 2007).

Given the importance of self-control to decision-making and behavior, several programs have been developed to improve self-control and reduce delinquency. Although varying to some degree or another, these efforts focus on improving one's impulse control and strengthening their resolve against impulsive acts. Also, these programs aim to improve the decision-making styles of persons such that they place less emphasis on immediate gratification and more emphasis on the long-term consequences of their behavior.

In 2010, based on a search from 1975 to 2009, we published a meta-analysis of 34 high-quality evaluations of self-control improvement programs for improving self-control and reducing delinquency/crime, the results of which showed that, as a whole, the programs improved child/adolescent self-control and reduced delinquency. Additionally, the effects held across several moderators and groupings, as well as by outcome source (Piquero et al. 2010, p. 803). In the meta-analysis reported in this paper, we include an additional seven studies uncovered by our recent search between January 2010 and September 2015 and provide an update to our previous work.

## Methods

### Criteria for inclusion and exclusion of studies

Studies that investigated the effects of self-control improvement programs on child behavior problems such as conduct problems, antisocial behavior, and delinquency were included. Following the more general systematic reviews (Piquero et al. 2009, 2010), studies were only included if they had a randomized controlled trial design with post-test measures of self-control and/or child behavior problems for the experimental and control participants. The preliminary eligibility criteria were as follows: 1. Types of studies: randomized controlled experimental designs; 2. Types of participants: children aged 10 years and under or the mean age of the sample was no greater than age 10 years at the beginning of the intervention. Studies with mentally and/or physically handicapped subjects were excluded; 3. Type of intervention: self-control improvement was a major component of the intervention; 4. Types of outcomes: inclusion of at least one

child-based outcome measure of self-control and/or at least one child-based behavioral outcome measure of general problem behaviors, including antisocial behavior and delinquency; 5. Sufficient data: availability of adequate post-test data for calculating an effect size if one was not provided (i.e., means and standard deviations, *t*-tests, *F*-tests, *p*-values, etc.); 6. No time frame restrictions; 7. No geographic restrictions; 8. Published and unpublished reports were included; 9. Qualitative studies were not included; and 10. Studies needed to be available in English.

A full and detailed description of additional meta-analytic methods regarding search strategy, criteria for the determination of independent findings, etc. can be found in the original Piquero et al. (2010) meta-analysis. Adopting their exact same meta-analytic methods, the intention of the current study was: (1) to build upon these earlier results by updating the search of relevant studies through September 2015 and (2) to incorporate these newly identified studies into Piquero et al.'s (2010) meta-analysis database and re-analyze the data. As such, the current study offers the most up-to-date meta-analysis that exists evaluating the effectiveness of self-control improvement programs initiated before the age of 10 years on improving self-control and/or reducing delinquency.

## Literature search

A systematic and exhaustive search of the relevant literature from January 2010 to September 2015 initially revealed 21 studies that appeared to meet the search criteria. Upon reviewing these studies to determine if they indeed conformed to the specific inclusion criteria, were written in English, and were not duplicate studies, our number of relevant studies was reduced to nine. An additional two studies were discarded as they did not provide enough data in order to permit the calculation of an effect size. Ultimately, our final sample of relevant studies that met the criteria previously defined by Piquero et al. was seven studies. After combining these seven studies with Piquero et al.'s database of 34 studies, this resulted in a database of 41 randomized, controlled trials of self-control improvement programs, generating 53 effect sizes for self-control and 36 effect sizes for delinquency. A full description of these 41 studies is provided in the Appendix.

## Types of interventions

We briefly elaborate here on the broad categories of types of interventions that were identified in this review. Interventions characterized as social skills development programs typically focus on skills for emotional understanding and communication, friendship skills, self-control skills, and social problem solving skills (Conduct Problems Prevention Research Group, CPPRG 1999; Tremblay et al. 1991). These self-control improvement sessions can also revolve around themes such as "look and listen", "following rules", "what to do when I am angry", "what to do when they do not want to play with me", and "how to react to teasing" (Tremblay et al. 1991, p. 154). Programs classified as cognitive coping strategies interventions often involve psychoeducational

tasks (Reid and Borkowski 1987) and/or "cognitive self-instructional training where children are taught to covertly emit verbalizations that will cue or guide their non-verbal behavior" (Jackson and Calhoun 1982, p. 7). A third category of self-control improvement programs is video tape training/role playing interventions. In this type of program, children typically are shown videos where the children in the video are either performing appropriate or inappropriate behavior. Following the video tape training, the children's own behavior and self-control is observed. At times, these interventions also utilize didactic lectures, experiential activities (e.g., role playing), and viewing videos of child-centered play sessions to improve self-control (Baggerly 1999).

Immediate/delayed rewards clinical interventions can best be characterized by Mischel and Baker (1975). This type of intervention takes place in an experimental room that is divided by a wooden barrier where there are toys/games on one side and a table and chair with a desk bell on the other side. The experimenter would teach the child how to ring the bell and would demonstrate to them that, when the experimenter left the room, ringing the bell would make them return. Following this instruction, the experimenter would "transform the reward objects that face him [the child] during the delay period in ways that either permit or prevent effective delay of gratification" (Mischel and Baker 1975, p. 259). The final intervention type was relaxation training. Lakes and Hoyt's (2004) study was the most identifiable of this intervention type. Specifically, these self-control improvement sessions focus on meditation and deep breathing techniques in an effort to teach youths how to regulate their own behavior.

### Effect size calculations

All of the effect size calculations in the current study were calculated as Cohen's *d* (Cohen 1988) standardized mean difference effect sizes. However, when studies did not provide a Cohen's *d* effect size estimate, we transformed the data that were provided in the form of *t*-values, *F*-values, *p*-values, correlations, odds ratios, etc. into Cohen's *d* effect sizes (see Lipsey and Wilson 2001 for the relevant formulas). In addition, following prior meta-analytic research (Piquero et al. 2009, 2015) and to be consistent with Piquero et al.'s (2010) original meta-analysis of self-control improvement programs, we applied the Hedges and Olkin (1985) adjustment of Cohen's *d* (e.g., Hedges *g*) and used inverse variance weights. All of the meta-analytic results that follow were estimated using Comprehensive Meta-Analysis (CMA) software, version 2 (Borenstein et al. 2005).

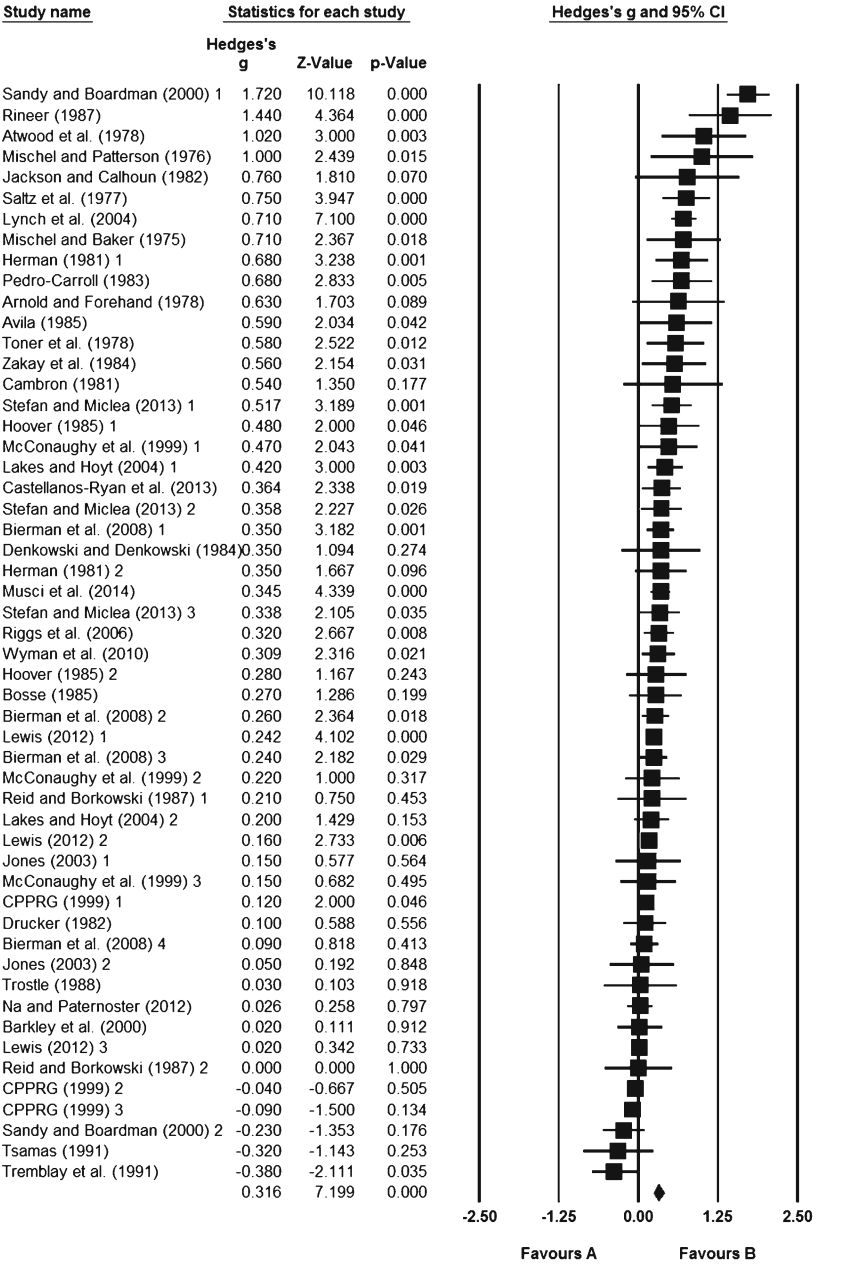
## Results

### Self-control effect sizes

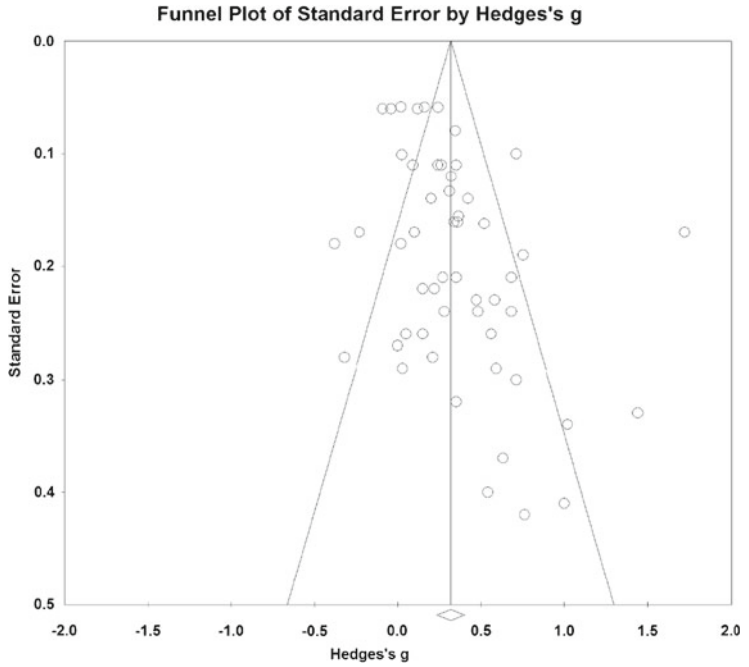
Figure 1 provides a graphical display of a forest plot that illustrates the 53 self-control effect sizes, along with their corresponding *z*-test of statistical significance. These effect sizes are

**Fig. 1** Forest plot of the distribution of self-control effect sizes sorted by magnitude ($N = 53$ effect sizes). ▶ Note: studies that contributed multiple effect sizes are denoted with a '1', '2', or '3', respectively, following the study name and year, depending on how many effect sizes were provided

# Meta Analysis




## Meta Analysis



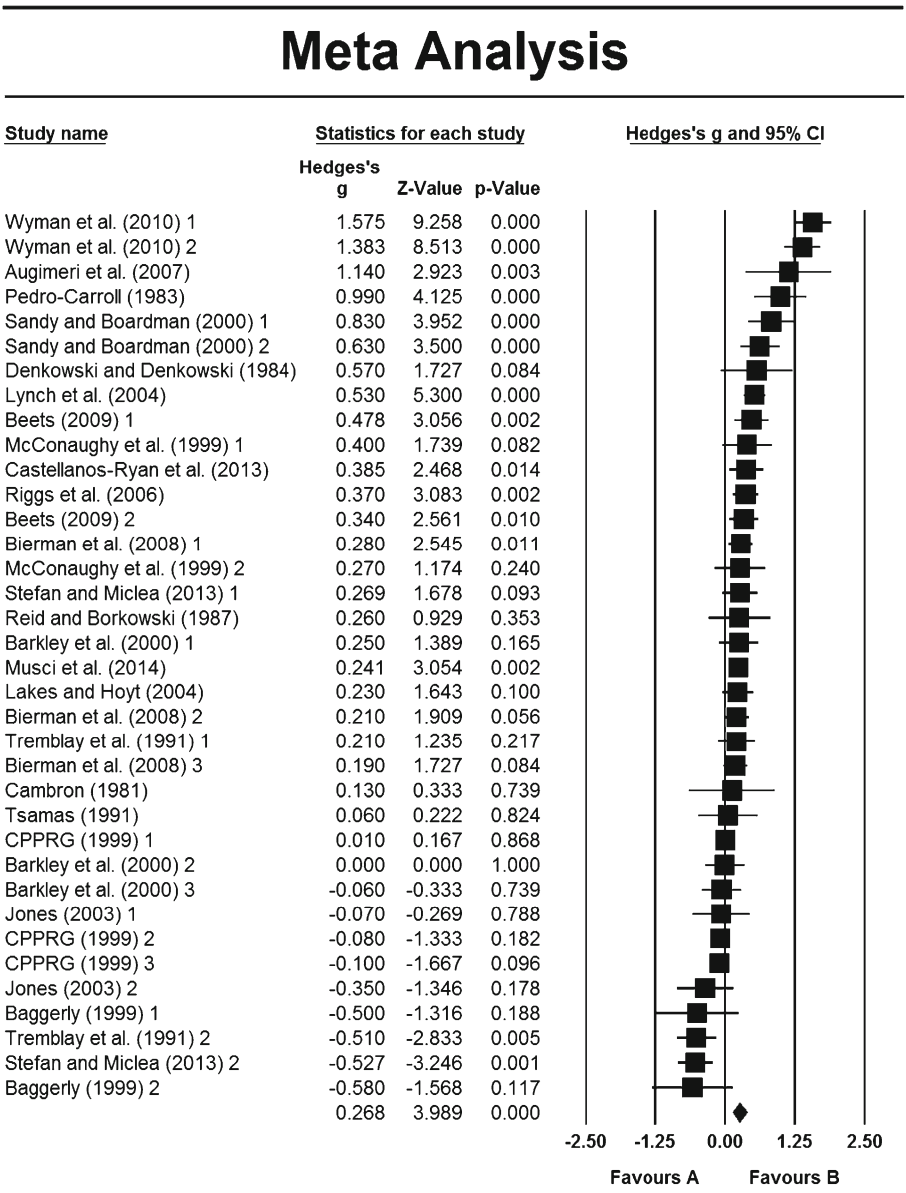

Note: Kendall's tau statistic = 0.20, $z$ =2.11, $p < 0.05$; Egger's regression intercept = 1.81, standard error = 0.52, $t$= 3.47, $p < 0.0001$

**Fig. 2** Funnel plot examining publication bias for self-control effect sizes

organized in descending order with the largest positive effect size located in the first row, and the corresponding 95 % confidence intervals for the effect sizes are also plotted in Fig. 1. As illustrated, the majority of the effect sizes were positive (48 out of 53) and statistically significant at the $p < 0.05$ level (30 of 53), and only one of these statistically significant effect sizes was a negative value (Tremblay et al. 1991). More importantly, the overall mean effect size (with random effects) for the 53 effect sizes was 0.32 ($z = 7.20$, $p < 0.001$), which was positive and statistically significant, indicating that self-control improvement programs can effectively improve self-control.[1]

In order to be consistent with Piquero et al.'s (2010) original meta-analysis and other meta-analyses in the criminological literature (Piquero et al. 2009, 2015), we included non-published studies as well. As a result of this decision, it was necessary for us to perform additional analyses to investigate the potential influence of publication bias on our obtained effect sizes. The results of these publication bias analyses are presented graphically in a funnel plot (Fig. 2) and associated Kendall's and Egger's test statistics are displayed below the funnel plot. Specifically, upon analyzing the funnel plot and reviewing the Kendall's ($z = 2.11$, $p < 0.05$) and Egger's ($t = 3.47$, $p < 0.001$) test statistics, there appeared to be evidence to suggest that publication bias existed to some degree, as the smaller studies tended to cluster

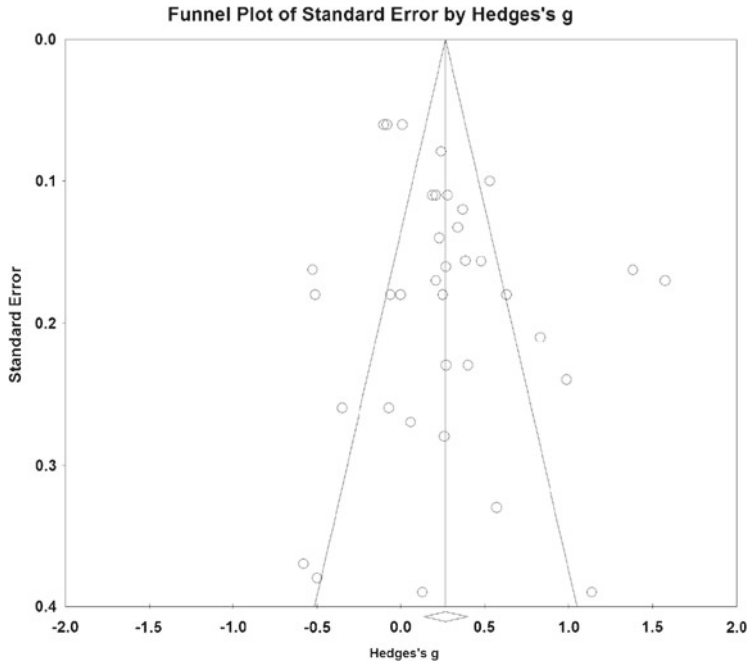
[1] The mean effect size for the ten effect sizes derived from the seven studies identified during the new search period of January 2010 to September 2015 was 0.23 ($z = 4.665$, $p < 0.001$).




## Meta Analysis

**Fig. 3** Forest plot of the distribution of delinquency effect sizes sorted by magnitude ($N = 36$ effect sizes). Note: studies that contributed multiple effect sizes are denoted with a '1', '2', or '3', respectively, following the study name and year, depending on how many effect sizes were provided

to the right of the funnel plot, that is, smaller studies had a higher likelihood of being published if they yielded larger effects.




Note: Kendall's tau statistic =0.01, $z = 0.10$, $p = 0.92$; Egger's regression intercept = 1.77, standard error = 0.92, $t = 1.92$, $p = 0.06$

**Fig. 4** Funnel plot examining publication bias for delinquency effect sizes

## Delinquency effect sizes

Comparatively, Fig. 3 graphically displays the forest plot with the effect size distribution for the 36 delinquency effect sizes, along with their corresponding *z*-test of statistical significance and 95 % confidence interval. The majority of the effect sizes were positive (27 out of 36) and 16 of the 36 effect sizes were statistically significant at the $p < 0.05$ level, only two of which were negative value effect sizes.[2] The overall mean effect size (with random effects) for the 36 effect sizes was 0.27 ($z = 3.99$, $p < 0.001$), suggesting that self-control improvement programs can effectively reduce delinquency. Corresponding publication bias analyses can be found in the funnel plot (Fig. 4), with associated Kendall's and Egger's test statistics reported below the funnel plot. These results failed to reveal evidence of publication bias at the $p < 0.05$ level for the delinquency effect size estimates.

## Moderator analyses

Similar to Piquero et al.'s (2010) original meta-analysis, we observed heterogeneity in the self-control effect sizes ($Q = 256.02$, $p < 0.001$) and in the delinquency effect sizes

[2] The mean effect size for the eight effect sizes derived from the seven studies identified during the new search period of January 2010 to September 2015 was 0.51 ($z = 2.502$, $p < 0.001$).

**Table 1** Self-control weighted effect sizes, confidence intervals, *z*-tests, and *Q*-statistics of moderators (with random effects)

| Variables | *n* | ES | *z*-Test | *Q*-statistic | *Q* between groups |
|---|---|---|---|---|---|
| Published | | | | | 0.46 |
| Yes | 37 | 0.21 | 9.94*** | 216.25*** | |
| No | 16 | 0.19 | 6.19*** | 42.31*** | |
| USA study | | | | | 1.59 |
| Yes | 47 | 0.20 | 10.98*** | 240.03*** | |
| No | 6 | 0.29 | 4.09*** | 17.39** | |
| Population type | | | | | 14.41*** |
| High-risk, low-income | 33 | 0.17 | 8.39*** | 204.13*** | |
| Universal | 20 | 0.32 | 8.93*** | 40.48** | |
| Gender composition (mostly male) | | | | | 17.97*** |
| Yes | 27 | 0.12 | 4.75*** | 83.66*** | |
| No | 26 | 0.27 | 11.46*** | 157.39*** | |
| Race composition (mostly white) | | | | | 15.01*** |
| Yes | 31 | 0.30 | 9.65*** | 58.10*** | |
| No | 22 | 0.16 | 7.60*** | 185.91*** | |
| Attrition problems | | | | | 2.47 |
| Yes | 17 | 0.23 | 8.94*** | 118.73*** | |
| No | 36 | 0.18 | 7.63*** | 137.81*** | |
| Treatment setting | | | | | 2.55 |
| School | 46 | 0.20 | 11.23*** | 250.24*** | |
| Clinic | 7 | 0.37 | 3.50*** | 6.23 | |

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

($Q = 279.12$, $p < 0.001$). As a result, we performed a series of categorical and continuous variable moderator analyses to determine what factors may play a role in moderating the effect size estimates. Table 1 presents the categorical ANOVA moderator analyses (with random effects) for the self-control effect sizes, and these results demonstrated that studies/programs with a high-risk, low-income population (mean effect size = 0.17, $z = 8.39$, $p < 0.001$) had significantly smaller self-control effect sizes, on average, as well as studies/programs that had a mostly male (mean effect size = 0.12, $z = 4.75$, $p < 0.001$) and mostly non-white (mean effect size = 0.16, $z = 8.39$, $p < 0.001$) population. With respect to the delinquency outcome moderator analyses shown in Table 2, studies/programs that were based in the USA had significantly higher delinquency effect sizes (mean effect size = 0.18, $z = 8.08$, $p < 0.001$), on average, whereas significantly lower delinquency effect sizes were obtained from studies/programs that relied on a mostly male population (mean effect size = 0.11, $z = 4.32$, $p < 0.001$).

Tables 3 and 4 provide the results from the continuous moderator analyses estimated from a series of bivariate meta-analytic regression models relying on a random effects model and using a maximum likelihood function. These meta-analytic regression results

**Table 2** Delinquency weighted effect sizes, confidence intervals, *z*-tests, and *Q*-statistics of moderators (with random effects)

| Variables | *n* | ES | *z*-Test | *Q*-statistic | *Q* between groups |
|---|---|---|---|---|---|
| Published | | | | | 1.02 |
| Yes | 29 | 0.18 | 7.87*** | 255.16*** | |
| No | 7 | 0.06 | 0.55 | 22.98*** | |
| USA study | | | | | 4.23* |
| Yes | 30 | 0.18 | 8.08*** | 237.50*** | |
| No | 6 | 0.03 | 0.39 | 37.39** | |
| Population type | | | | | 0.55 |
| High-risk, low-income | 29 | 0.16 | 6.70*** | 254.39*** | |
| Universal | 7 | 0.20 | 4.10*** | 24.23*** | |
| Gender composition (mostly male) | | | | | 16.77*** |
| Yes | 24 | 0.11 | 4.32*** | 210.03*** | |
| No | 12 | 0.31 | 7.71*** | 52.32*** | |
| Race composition (mostly white) | | | | | 0.03 |
| Yes | 23 | 0.16 | 4.58*** | 74.47*** | |
| No | 13 | 0.17 | 6.34*** | 204.63*** | |
| Attrition problems | | | | | 1.47 |
| Yes | 8 | 0.23 | 4.46*** | 35.28*** | |
| No | 28 | 0.16 | 6.54*** | 242.38*** | |
| Treatment setting | | | | | 0.03 |
| School | 32 | 0.17 | 7.77*** | 266.61*** | |
| Clinic | 4 | 0.14 | 0.97 | 12.48** | |

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

demonstrate that all four continuous variables were statistically significant moderators of the self-control effect sizes and three of the four of these same continuous variables were also statistically significant moderators of the delinquency effect sizes. Specifically, there

**Table 3** Moderator correlations with self-control effect sizes (derived from bivariate meta-analysis regression with random effects)

| Variables | b | se | *z*-Test |
|---|---|---|---|
| Publication year | −0.0039 | 0.0019 | −2.10* |
| Total sample size | −0.0003 | 0.0001 | −6.70*** |
| Age at intervention | −0.0034 | 0.0105 | −0.32 |
| Duration of intervention | −0.0116 | 0.0041 | −2.86** |

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

**Table 4** Moderator correlations with delinquency effect sizes (derived from bivariate meta-analysis regression with random effects)

| Variables | b | se | *z*-Test |
|---|---|---|---|
| Publication year | 0.0175 | 0.0034 | 5.23*** |
| Total sample size | −0.0002 | 0.0001 | −4.19*** |
| Age at intervention | 0.1189 | 0.0183 | 6.52*** |
| Duration of intervention | −0.0326 | 0.0054 | −6.02*** |

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

was a significant inverse relationship between year of publication (b = −0.0039, se = −0.0019, $p < 0.05$), total sample size (b = −0.0003, se = 0.0001, $p < 0.001$), and the duration of the intervention (in months) (b = −0.0016, se = 0.0041, $p < 0.01$) and the self-control effect sizes. In contrast, there was a positive and statistically significant relationship between the year of publication (b = 0.0175, se = 0.0034, $p < 0.001$) and the age of the youth at the time of the intervention (b = 0.1189, se = 0.0183, $p < 0.001$) and the obtained delinquency effect sizes, whereas a statistically significant inverse relationship was observed for the total sample size (b = −0.0002, se = 0.0001, $p < 0.001$) and the duration of the intervention (b = −0.0326, se = 0.0054, $p < 0.001$) and the delinquency effect sizes.[3]

## Discussion

The purpose of this paper was to update the meta-analysis conducted by Piquero et al. (2010) that evaluated the effectiveness of self-control programs aimed at improving self-control and reducing delinquency. Our updated search, from January 2010 to September 2015, yielded seven additional methodologically rigorous studies that were added to the existing database of 34 studies, yielding a total sample size of 41 studies that comprise the current update.

The main finding emerging from this updated meta-analysis was a confirmation of our previous conclusion. That is, self-control programs improve a child/adolescent's self-control and also reduce delinquency. The overall mean effect size in the current update was 0.32 for improving self-control and 0.27 for reducing delinquency, which compares to our previous estimates of 0.35 and 0.19 for improving self-control and reducing delinquency, respectively. Other analyses provided some indication of publication bias for the self-control improvement outcomes but not for the delinquency outcomes. Also, we detected some moderating effects for self-control improvement (publication year, total sample size, duration of intervention) and delinquency reduction

[3] Meta-analytic regression models (with random effects and using a maximum likelihood function) incorporating all of the statistically significant categorical and continuous moderator variables simultaneously were estimated for the self-control and delinquency effect sizes, separately. However, as none of the moderators emerged as statistically significant predictors of the mean effect size in either model, we opted to not present the results of these two full regression models.

(publication year, total sample size, age at intervention, duration of intervention). In this vein, some of these notable moderating effects suggest that interventions with smaller samples yield higher effect sizes, as do interventions that are brief rather than long term. As such, self-control improvement programs may benefit from taking more smaller scale approaches that are also briefer in duration, as, perhaps, certain components of self-control improvement interventions specifically or these types of programs in general do not perform better when scaled up and/or there may be decay effects over time for lengthier self-control improvement interventions. Nevertheless, the evidence is strong that self-control modification programs can improve self-control and reduce delinquency among children and adolescents and should be considered alongside other evidence-based strategies that seek to improve children and adolescents—and ultimately in their transition to adulthood.

## Appendix

**Table 5** Meta-analysis studies ($n = 41$ studies)

| Author, publication date | Location | Year of intervention | Sample size ($N$) | Targeted age(s) |
|---|---|---|---|---|
| Arnold and Forehand (1978) | USA | N/R | 32 | 4–5 years old |
| Atwood et al. (1978) | New Mexico | N/R | 80 | 4th–5th grade |
| Augimeri et al. (2007) | Toronto, Ontario, Canada | 1985–1988 | 32 | Mean age 9 years old |
| Avila (1985)* | Gainesville, Florida | | 57 | 5th grade |
| Baggerly (1999)* | USA | N/R | 30 | Kindergarten |
| Barkley et al. (2000) | Worcester, Massachusetts | 1991–1996 | 119 | Mean age 5 years old |
| Beets et al. (2009) | Hawaii, USA | 2001–2006 | 1714 | 5 years old |
| Bierman et al. (2008a, b) | Pennsylvania | N/R | 356 | 4 years old |
| Bosse (1985)* | USA | N/R | 103 | 5–6 years old |
| Cambron (1981)* | Louisville, Kentucky | N/R | 30 | 7–9 years old |
| Castellanos-Ryan et al. (2013) | Montreal, Quebec | 1984 | 250 | 8 years old |
| CPPRG (1999) | North Carolina, Tennessee, Washington, and Pennsylvania central Pennsylvania | N/R | 891 | 1st graders |
| Denkowski and Denkowski (1984) | USA | N/R | 45 | 3rd–5th grade |
| Drucker (1982)* | New York | N/R | 120 | 1st–3rd grade |
| Herman (1981)* | Detroit, Michigan | N/R | 130 | 4–6 years old |
| Hoover (1985)* | Southwest USA | N/R | 70 | Mean age 8 years old |
| Jackson and Calhoun (1982) | USA | N/R | 40 | 5–6 years old |
| Jones (2003)* | Eugene, Oregon | N/R | 59 | 2–4 years old |
| Lakes and Hoyt (2004) | Mid-western USA | 2000–2001 | 207 | 5th grade |
| Larkin and Thyer (1999) | Gainesville, Georgia | N/R | 52 | Pre-K to 3rd grade |

**Table 5** (continued)

| Author, publication date | Location | Year of intervention | Sample size (*N*) | Targeted age(s) |
|---|---|---|---|---|
| Lewis (2012)* | Chicago, Illinois | 2004–2010 | 1170 | 8 years old |
| Lynch et al. (2004) | Lansing, Michigan | 1996–1997 | 399 | 4–5 years old |
| McConaughy et al. (1999) | N/R | N/R | 82 | Kindergarten |
| Mischel and Baker (1975) | USA | N/R | 60 | Mean age 4.5 years old |
| Mischel and Patterson (1976) | USA | N/R | 70 | Mean age 4.5 years old |
| Musci et al. (2014) | Baltimore, Maryland | 1993 | 677 | 6 years old |
| Na and Paternoster (2012) | Baltimore, Maryland | 1993 | 448 | 6 years old |
| Pedro-Carroll (1983)* | New York | 1982 | 75 | 3rd–6th grade |
| Porter (1982)* | USA | N/R | 34 | 1st–2nd grade |
| Reid and Borkowski (1987) | Indiana | N/R | 77 | 2nd–4th grade |
| Riggs et al. (2006) | Seattle, Washington | N/R | 329 | Mean age 8 years old |
| Rineer (1987)* | Southwestern USA | 1986–1987 | 42 | Kindergarten |
| Saltz et al. (1977) | Detroit, Michigan | 1972–1975 | 146 | 3–5 years old |
| Sandy and Boardman (2000) | New York City, New York | 1997–1999 | 404 | 2–6 years old |
| Ştefan and Miclea (2013) | Cluj-Napoca, Romania | 2009 | 204 | 4 year olds |
| Toner et al. (1978) | Madison, Wisconsin | N/R | 90 | Preschool to 3rd grade |
| Tremblay et al. (1991) | Montreal, Quebec, Canada | 1985–1987 | 249 | 7 years old |
| Trostle (1988) | Pennsylvania | N/R | 48 | 3–6 years old |
| Tsamas (1991)* | USA | 1989 | 61 | Preschool |
| Wyman et al. (2010) | USA | N/R | 226 | 7 years old |
| Zakay et al. (1984) | Tel-Aviv, Israel | N/R | 74 | Mean age 10 years old |

*N/R* Not reported

*Unpublished data

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