

A Meta-Regression Analysis of the Relationship Between ADHD Symptomatology and Caffeinated Beverage Consumption: Age, Gender, Geographic Location and Beverage Types as Moderators

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Overview

1. Introduction

- a. Existing research on stimulant use in ADHD
- b. Theoretical basis for current meta-analysis
- c. Research questions

2. Methodology

- a. Literature Search
- b. Data Analysis Strategy

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4. Discussion

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- b. Future Directions

Attention-deficit/Hyperactivity Disorder (ADHD)

Neurodevelopmental disorder

Challenges with:

- Attentional control
- Impulsivity
- Hyperactivity

Global prevalence between 2% and 7%

Background: ADHD and Stimulant Use

Stimulant prescription medications for ADHD

- Effective but not without side effects (Meszaros, 2009; Nanda, 2023)

Is there a significant association between ADHD symptoms and other non-prescription stimulant drugs?

- Turns out, there is a significant association/prevalence
 - Cigarette smoking (Kollins, 2005)
 - Cocaine (Oliva, 2021)
 - Sugary beverages (Farsad-Naeimi, 2020)

Background: Self Medication of ADHD Symptoms With Caffeine?

Theoretical basis for self medication:

- Avoiding prescription stimulant medication side effects
- Higher prevalence of other non-prescription stimulants
- Alleviation of ADHD symptoms in animal models (Vazquez, 2022)

First, the association between ADHD symptoms and caffeinated beverage consumption should be investigated

Research Questions

What is the association between ADHD symptomatology and caffeinated beverage consumption?

What might be moderating this potential association?

- Moderators to explore
 - Age
 - Gender
 - Geographic Region
 - Type of Caffeinated Beverage

Methodology: Literature Search

Databases: ERIC, Medline, ProQuest, PsycInfo, PubMed

Search Terms: ADHD (or related terms) AND Caffeine (or related terms)

658 studies identified, 413 remaining after duplicate removal using EndNote

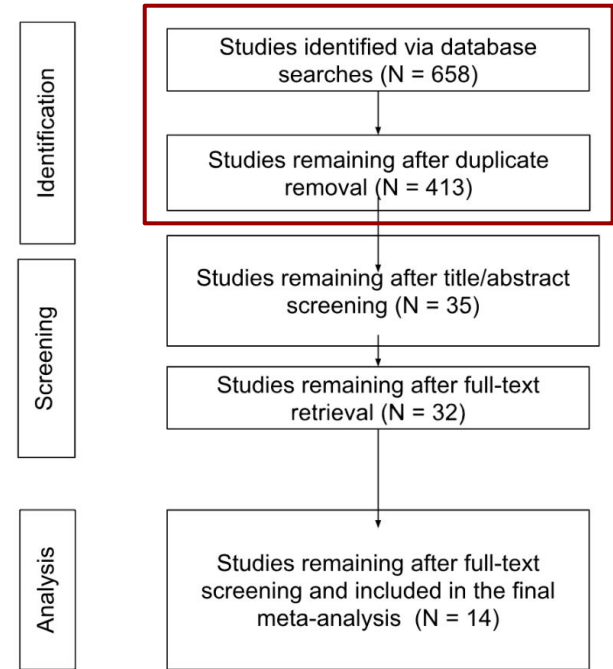


Figure 1. Flow diagram of study selection process.

Methodology: Title/Abstract Screening

Inclusion Criteria: English, Human Subjects, Cross-Sectional, Measure of Caffeinated Beverage Consumption, Measure of ADHD Symptomatology

After title/abstract screening, 35 studies remained

Screening Pair	Cohen's Kappa Interrater Reliability
1	0.50
2	0.81

Table 1. Interrater reliability for title/abstract screening

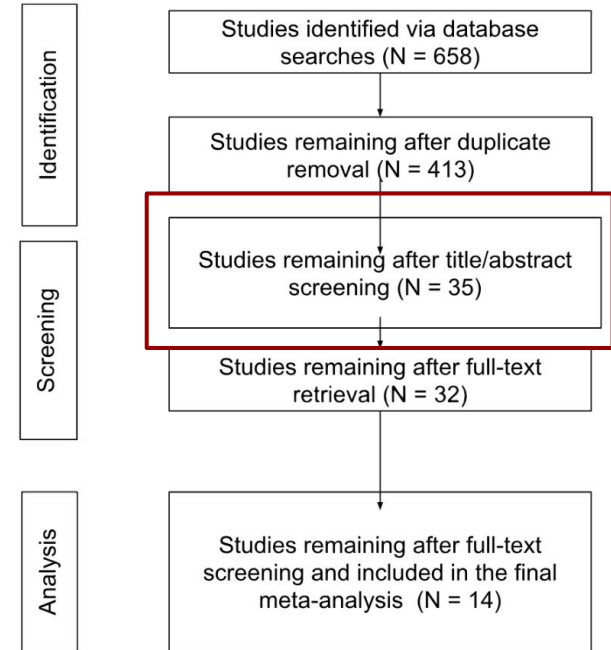


Figure 1. Flow diagram of study selection process.

Methodology: Full Text Screening

32 of the 35 full text articles were retrievable

After screening at the full-text level using the previously outlined inclusion criteria, 14 studies remained

Effect sizes and moderators of interested were coded from full text

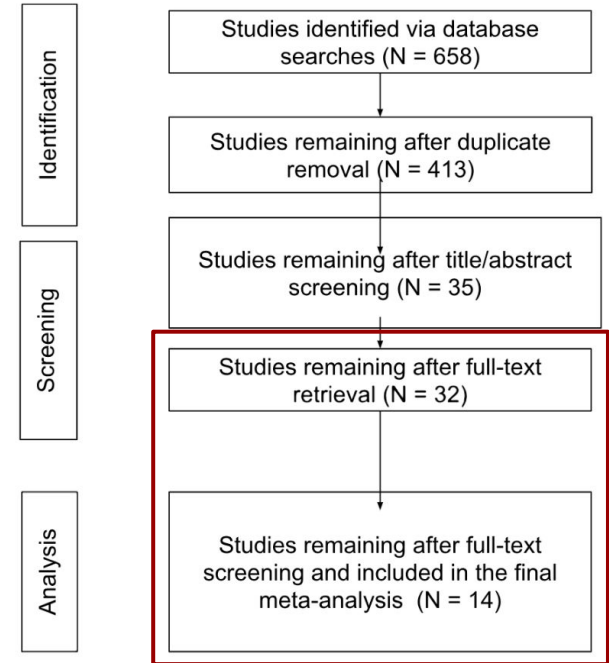


Figure 1. Flow diagram of study selection process.

Methodology: Analysis

Random-effects model used

- Does not assume that all studies have a common effect size

Conducted meta-analysis using the metafor package in R

Conversion of all effect sizes to correlation coefficients

Moderator variables:

- Mean participant age (continuous)
- Proportion of male participants (continuous)
- US-based study (dummy variable)
- Type of caffeinated beverage (separate dummy variables)
 - Total caffeine
 - Coffee
 - Energy Drinks

Included Studies

Author	Fisher's Z Effect Size	Sample Size	Mean Participant Age (Years)	Proportion of Male Participants	Beverage Type*	Country of Study
James et al., 2002	0.13	1828	15.5	1.00	E, C	Other
James et al., 2002	0.18	1842	15.5	0.00	E, C	Other
Schwartz et al., 2002	0.07	1649	16.5	0.33	E	United States
Narine et al., 2002	0.05	72	15.0	0.55	E	United States
Narine et al., 2002	0.03	69	42.9	0.33	E	United States
Cipollone et al., 2002	0.09	18913	13.0	0.14	E	United States
Cipollone et al., 2002	0.05	18913	14.0	0.48	O	United States
Cipollone et al., 2002	0.09	18913	13.0	0.51	O	United States
Agoston et al., 2002	0.02	2259	15.0	0.33	T, E, C	Other
Cusick et al., 2002	0.13	302	42.9	0.14	T	United States
Cusick et al., 2002	0.22	302	12.4	0.55	T	United States
Cusick et al., 2002	0.16	302	28.7	0.88	T	United States
Rios-Hernandez et al., 2002	0.27	120	28.7	0.88	T	Other
Salvat et al., 2002	0.24	200	28.7	0.88	O	Other
Bae et al., 2002	0.12	511	23.2	0.63	T	Other
Martin et al., 2002	0.23	132	8.3	0.72	T	United States
Galimov, 2002	0.05	5478	34.0	0.49	E	Other
Chamberlain et al., 2002	0.21	126	9.3	0.57	T	United States
Walker et al., 2002	0.22	448	22.9	0.50	T, C	United States
Farber et al., 2002	0.04	7245	15.0	0.61	T	United States

*Beverage Type: T=Total Caffeine, E=Energy Drinks, C=Coffee, O=Other

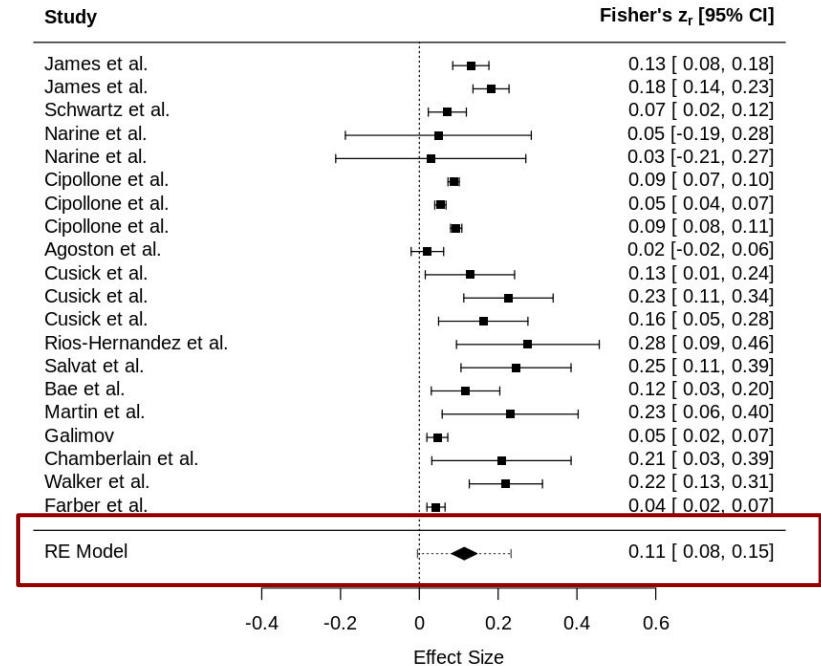
Results: Random-Effects Model

Fisher's Z (Effect Size):

0.1141

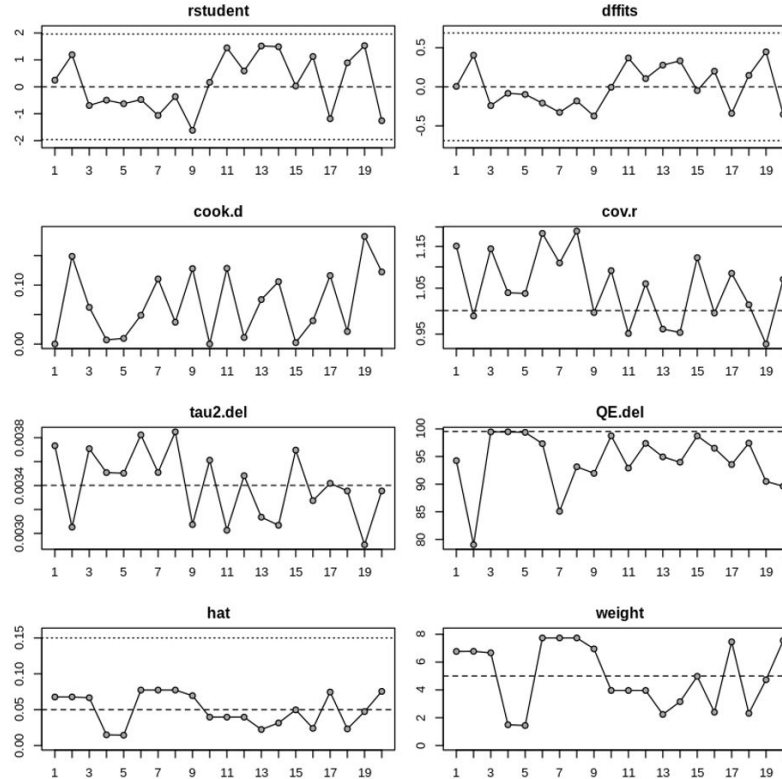
95% CI: [0.08, 0.15]

I^2 (Heterogeneity): 92.07%



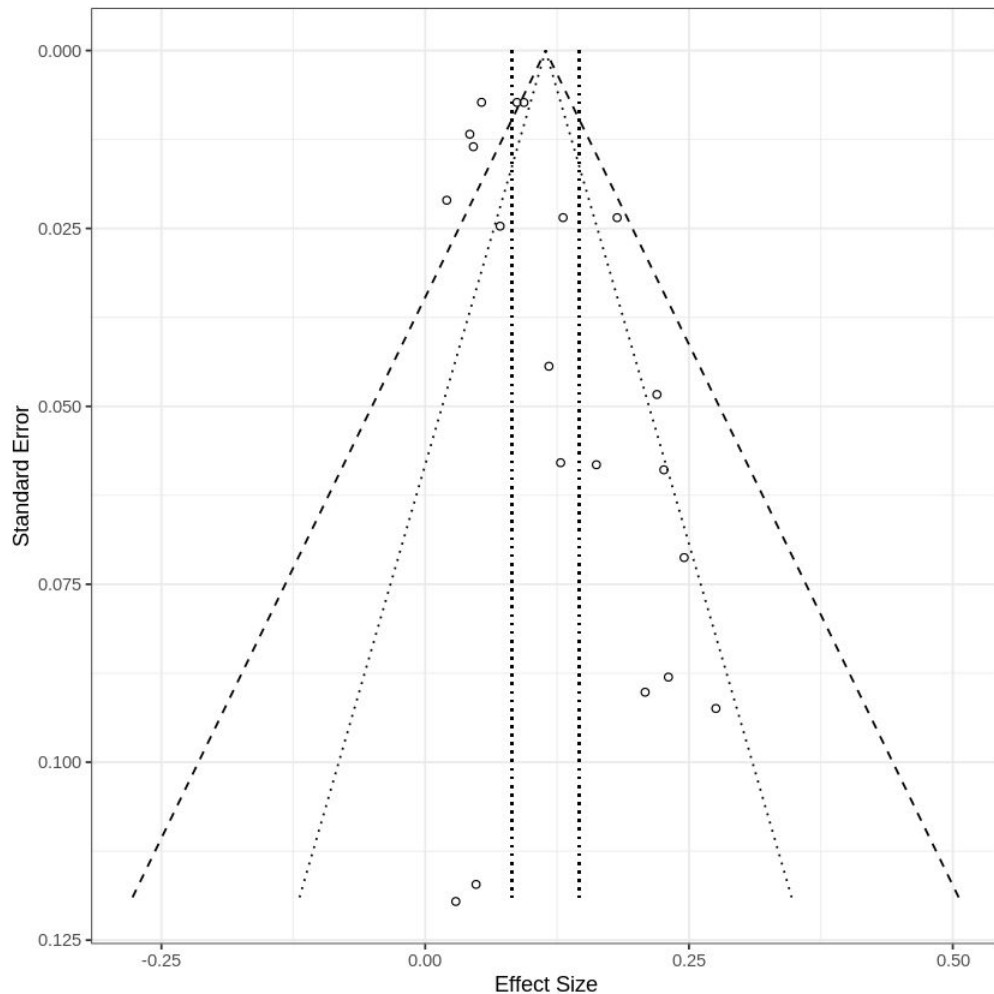
Assessing for Influential Studies

No studies were shown be particularly influential on the pooled effect size



Assessing for Publication Bias

Evidence of possible small study publication bias



Moderating Variables

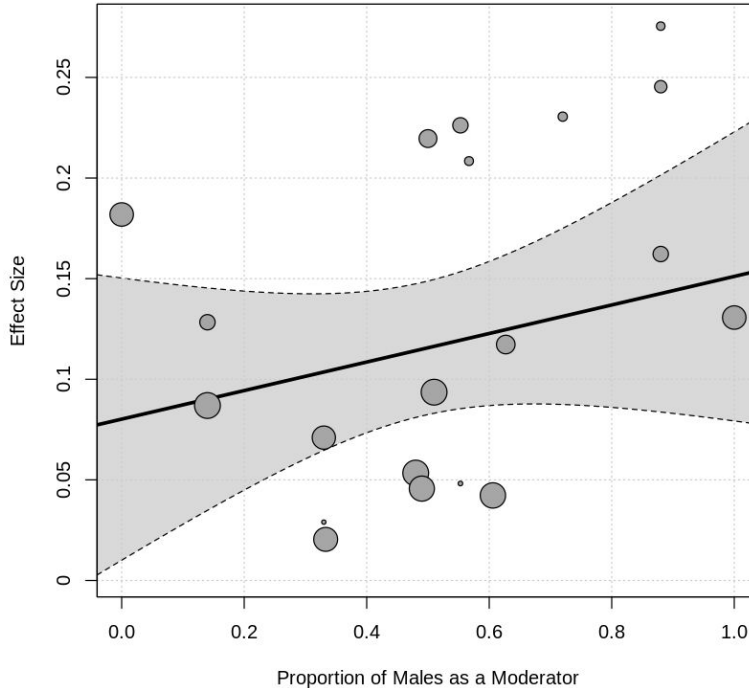
Moderating Variable	Coefficient	p-value
Age	0.0003	0.8673
Gender	0.0790	0.2679
Geographic Location	-0.0086	0.8059
Total Caffeine Intake	0.0368	0.2811
Coffee Consumption	0.0219	0.5655
Energy Drink Consumption	-0.0541	0.1089

Table 2. Meta-Regression Results

Gender as a Moderator

Male participants tended to report a larger effect size

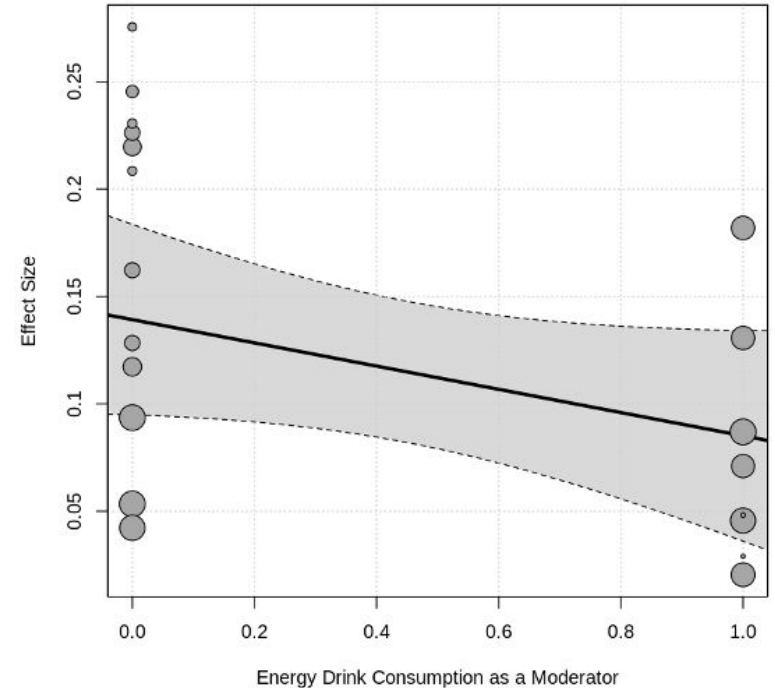
Statistically insignificant ($p=0.2679$)



Energy Drink Consumption as a Moderator

Studies specifically assessing energy drink consumption reported a smaller effect size

Statistically insignificant ($p=0.1089$)



Discussion

A statistically significant overall effect size between ADHD symptomatology and caffeinated beverage consumption (Fisher's Z: 0.11 [0.08, 0.15])

No particularly influential studies on overall effect size

No significant moderators discovered

- Greater number of studies with larger sample sizes may change this

Limitations

Cross-sectional studies do not provide directionality of relationship

Relatively large between-study heterogeneity ($I^2 = 92.07\%$)

Evidence for small study publication bias (small sample size studies not reporting insignificant results)