Use of Meta-Analyses in Nutrition Research and Policy:
Best Practices of Conducting Meta-Analysis
The Second in the Series

Best practices of meta-analysis in nutrition research: A case study of food marketing evidence synthesis to inform policy guidelines

Prof Emma Boyland (PhD), University of Liverpool, UK

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Best practice in conducting meta-analysis

Screening data for potential data errors

Evaluation of risk of bias of study design

Evaluation of study results, including precision and consistency of estimates, and the potential for publication bias

Interpreting the results of meta-analysis, including statistical heterogeneity

Best practices of meta-analysis in nutrition research: A case study of food marketing evidence synthesis to inform policy guidelines

Part 1: Screening data for potential data errors

Prof Emma Boyland (PhD), University of Liverpool, UK

Disclosures and acknowledgements

Disclosures

- No industry funding
- Author of multiple systematic reviews and meta-analyses including:

Boyland E, Nolan S, Kelly B, Tudur-Smith C, Jones A, Halford JCG & Robinson E. (2016). Advertising as a cue to consume: a systematic review and meta-analysis of the effects of acute exposure to unhealthy food and nonalcoholic beverage advertising on intake in children and adults

> 600 citations, part of AJCN highly cited collection

- Lead on SR and meta-analyses to underpin new WHO global guidelines on food marketing.

Acknowledgements

- This presentation includes content from publications developed with colleagues:

Boyland E, McGale L, Maden M, Hounsome J, Boland A & Jones A. (2022). Systematic review of the effect of policies to restrict the marketing of foods and non-alcoholic beverages to which children are exposed. Obesity Reviews.

Boyland E, McGale L, Maden M, Hounsome J, Boland A, Angus K & Jones A. (2022). Association of food and nonalcoholic beverage marketing with children and adolescents' eating behaviors and health: a systematic review and meta-analysis. JAMA Pediatrics.

- Other content guided by latest online version of Cochrane Handbook: www.training.cochrane.org/handbook.

Prevention is better than cure…best practice in data extraction

- Discussion and
- Examin
- Ext
- D
-

NASEM question

Extraction errors from the primary studies that are included in published meta-analyses are common. What are best practices to avoid/identify these types of errors?

Data extra					
• Date • Initials of extractor • Article identifier	• Fu			• Aggregation • Timing	• included mmary (e.g., mean ± SD) • Estimates and precision (e.g., odds ratio, 95% CI)

Studies (not reports) are the unit of interest

- **Linked studies – avoid data duplication**
  - Comprehensive search may identify multiple reports of the same study.
  - Authors can:
    - Extract data then link reports
    - Link reports before they extract data – can be challenging to identify
  - Review authors must choose and justify which report to use as a source for study results.

Linked reports may not:

- Share common authors
- Reference each other
- Report identical details of sample/design etc

Useful criteria
(use as many as possible)

- Location/setting
- Intervention details (e.g., stimulus)
- Sample size, baseline data
- Date, study duration

➢ **Correspond with authors**

Linked data:
Worked example from nutrition-relevant case study

PEDIATRIC ORIGINAL ARTICLE

Food advertising, children's food choices and obesity: interplay of cognitive defences and product evaluation: an experimental study

L Tarabashkina, P Quester and R Crouch

MATERIALS AND METHODS

Study design and sample

To examine factors influencing children's food choices in a controlled, yet non-laboratory and realistic environment that excludes parents' and peers' influences, this research was conducted in the form of a randomised experiment at an annual agricultural event which is traditionally visited by families representative of the South Australian population in 2011. Families typically come to this event for a relatively long period of time and it was expected that they would be more inclined to take part in this study

Table 2. Sample characteristics and food choices

Demographic characteristics	*Experimental group*	*Control group*
7–8 years (%)	17.1	22.9
9–10 years (%)	35.4	29.6
11–12 years (%)	35.4	33.5
13 years (%)	12.0	14.0

When persuasive intent and product's healthiness make a difference for young consumers

Liudmila Tarabashkina, Pascale Quester, Olga Tarabashkina and Michael Proksch

Method

Design

The data for this study were collected at an annual agricultural event traditionally visited by families representative of the South Australian population. Parents and their children aged 7-13 years passing by the researchers' stand were invited to take part in the study. Children under 7 years were excluded to make sure the participants could distinguish advertisements from programs and could process advertisements (Carter

Table I Sample characteristics

	N	*(%)*
Children		
Females	90	51
Males	85	[illegible]
7-8 years	30	17
9-10 years	62	35
11-13 years	83	47

"Thank you for your email. Yes, the data are linked"

Multiple studies in a single report: Worked example from nutrition-relevant case study

1

The Influence of Brand Equity Characters on Children's Food Preferences and Choices

Lauren Sophie McGale, MSc, Jason Christian Grovenor Halford, PhD, Joanne Alison Harrold, PhD, and Emma Jane Boyland, PhD

Study design We recruited 209 children 4-8 years of age from schools and childcare centers in the UK. In a mixed-measures design, the children were asked to rate their taste preferences and preferred snack choice for 3 matched food pairs, presented either with or without a brand equity character displayed on packaging. Study 1 addressed congruent food–character associations and study 2 addressed incongruent associations. Participants were also asked to rate their recognition and liking of characters used. Wilcoxon signed-rank tests and χ^2 analyses were used where appropriate.

Two separate studies with similar experimental designs (but slightly different stimuli)

2

Mealtime exposure to food advertisements while watching television increases food intake in overweight and obese girls but has a paradoxical effect in boys

G. Harvey Anderson, Shokoufeh Khodabandeh, Barkha Patel, Bohdan L. Luhovyy, Nick Bellissimo, and Rebecca C. Mollard

Protocol

Two experiments were conducted: experiment 1 in boys and experiment 2 in girls. Both experiments followed a within-subject repeated measures design. All participants attended 4 sessions that were scheduled once per week for 4 weeks. The 4 treatment

Same RCT repeated with male and female samples separately

3

Does a 'protective' message reduce the impact of an advergame promoting unhealthy foods to children? An experimental study in Spain and The Netherlands

Frans Folkvord [a, b, *], Francisco Lupiáñez-Villanueva [b], Cristiano Codagnone [b, c], Francesco Bogliacino [d], Giuseppe Veltri [e], George Gaskell [f]

about advertising targeting children. This study examined whether incorporating a 'protective' message in an advergame promoting energy-dense snacks would reduce children's snack intake. A randomized between-subject design was conducted in the Netherlands ($N = 215$) and Spain ($N = 382$) with an advergame promoting either energy-dense snacks or nonfood products. The results showed that playing an advergame promoting energy-dense snacks increased caloric intake in both countries, irrespective of

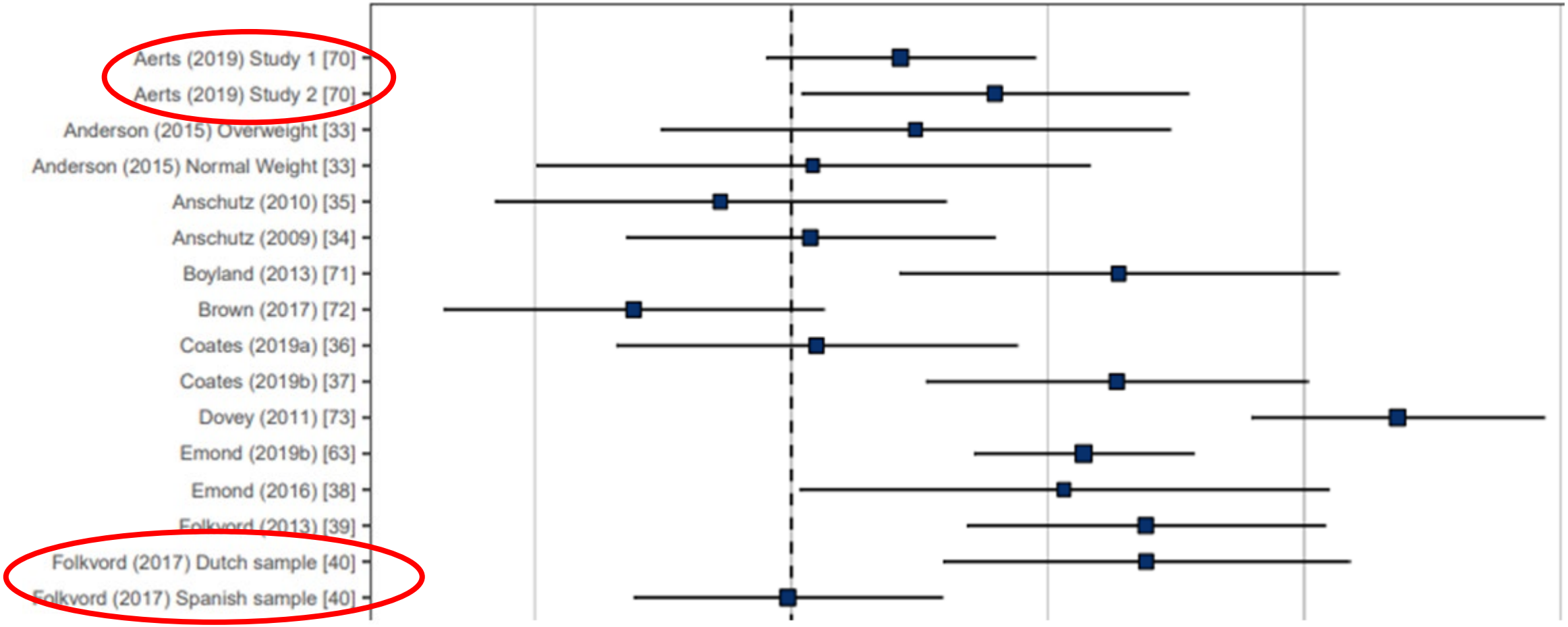
Same RCT repeated with samples in the Netherlands and Spain separately

Best practice for reporting inclusion of multiple studies in meta-analysis

JAMA Pediatrics | Original Investigation

Association of Food and Nonalcoholic Beverage Marketing With Children and Adolescents' Eating Behaviors and Health
A Systematic Review and Meta-analysis

Emma Boyland, PhD; Lauren McGale, PhD; Michelle Maden, PhD; Juliet Hounsome, PhD; Angela Boland, PhD; Kathryn Angus; Andrew Jones, PhD



Multiple outcomes within a study

How this might arise

- multiple outcomes measured within a domain.

  (eg 'TV viewing time' and 'online time' in a 'media use' domain);

- multiple methods to measure the outcome.

  (eg self-reported, clinician-rated, or via tools/instruments, as well as their subscales);

- multiple time points measured within a time frame.

All provide a measure but are not completely interchangeable, some more relevant than others, and are statistically dependent

Best practice actions

- Use decision rules to select the most relevant.
  - May be based on clinical (content validity), methodological (reliability of measure), or theoretical considerations.
- Use a meta-analysis method that models or accounts for dependency.

Multiplicity of outcomes: Use of decision rules
Worked example from nutrition-relevant case study

TABLE 4

Adjusted means and SDs of food intake (in kcal) controlled for sex, hunger, and age, by condition and food intake[1]

	Total intake[2]	Total energy-dense snack intake[3]	Total fruit intake[4]	Jelly cola bottle intake[5]	Milk-chocolate candy shell intake[6]	Banana intake[7]	Apple intake[8]
Energy-dense snacks (n = 69)	$202^{a} \pm 111$	$170^{a} \pm 107$	$32^{a} \pm 27$	$89^{a} \pm 85$	$80^{a} \pm 81$	$16^{a} \pm 20$	$17^{a} \pm 16$
Fruit (n = 67)	$183^{b} \pm 117$	$150^{b} \pm 116$	$33^{b} \pm 28$	$78^{b} \pm 74$	$72^{b} \pm 80$	$18^{b} \pm 22$	$15^{b} \pm 14$
Nonfood (n = 65)	$130^{c} \pm 83$	$106^{c} \pm 83$	$24^{c} \pm 24$	$60^{c} \pm 53$	$45^{c} \pm 58$	$14^{c} \pm 20$	$10^{c} \pm 10$
Control (n = 69)	$106^{d} \pm 75$	$80^{d} \pm 71$	$29^{d} \pm 29$	$39^{d} \pm 39$	$40^{d} \pm 46$	$16^{d} \pm 22$	$11^{d} \pm 12$

The following hierarchy was specified to select one outcome per domain in a review examining the effects of food marketing on food intake (Boyland et al 2022):

- The outcome closest to the key indicator for resulting policy (ie reduced unhealthy food intake)
- The outcome that provided the largest-scale measure (eg total amount of unhealthy food consumed selected ahead of amount of single item consumed)
- Amount consumed of first unhealthy item listed (as described by authors)

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Part 2: Evaluation of risk of bias in study design

Prof Emma Boyland (PhD), University of Liverpool, UK

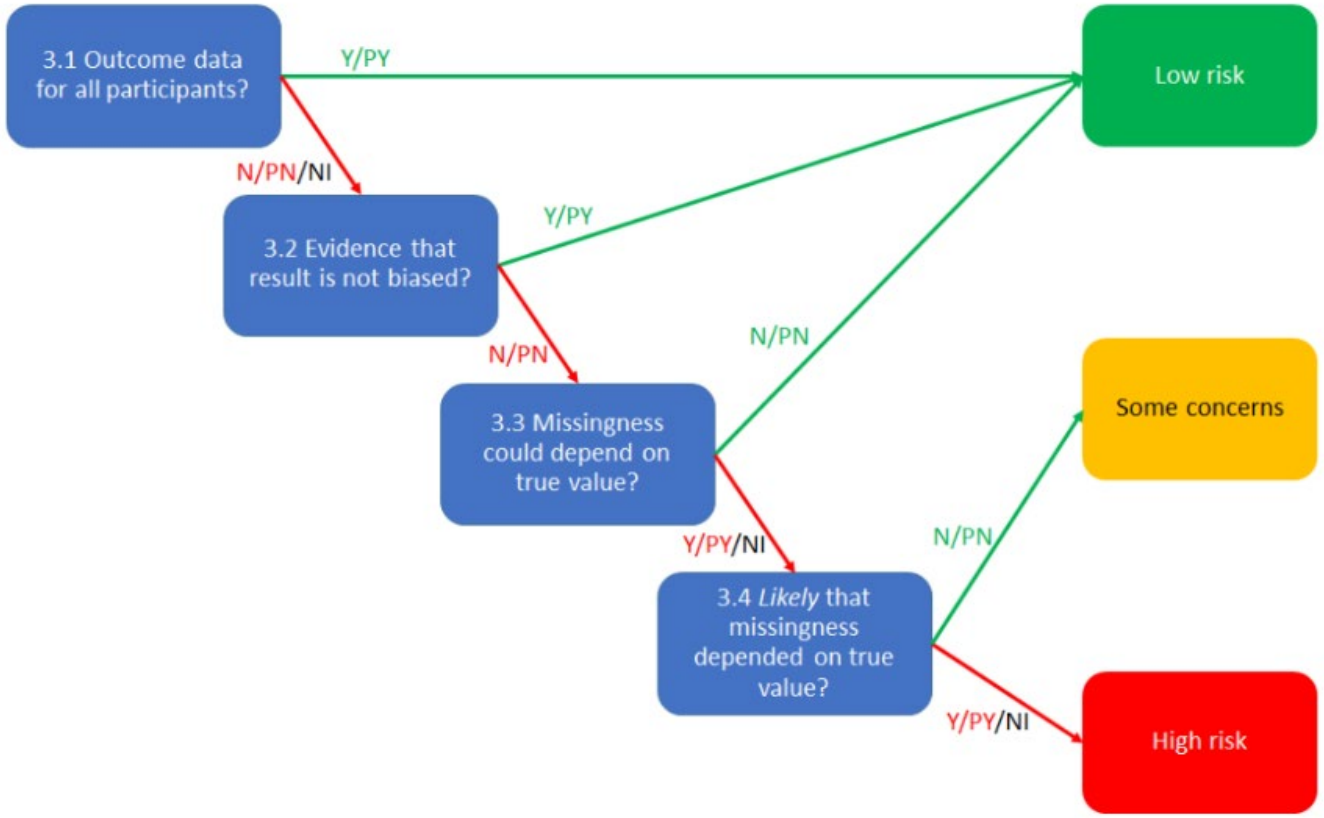
Considering and evaluating bias

"Systematic error, or deviation from the truth, in results"

- Sources of bias
  - (1) study authors, (2) research constraints, (3) review authors
- Authors of meta-analyses should seek to minimize bias
- Bias can lead to over or underestimation of effect
- Bias can vary in magnitude
  - Small: trivial
  - Substantial: apparent finding is entirely due to bias
- Use robust tools relevant to the study design
  - eg Cochrane tools: RoB2 for RCTs, ROBINS-1 for non-randomized studies

Applying critical appraisal tools: RoB2

Domain	Examples
1. Risk arising from the randomization process	Was the allocation sequence random? Are there baseline differences suggesting issues with randomization?
2. Risk of bias due to deviation from the intended intervention	Were participants aware of their assigned intervention? Were researchers aware of assignments?
3. Risk of bias due to missing outcome data	Were data available for all (or nearly all) randomized participants?
4. Risk of bias in measurement of the outcome	Was the method of measuring the outcome inappropriate (eg very poor validity)?
5. Risk of bias in selection of the reported result	Was reporting in line with a preregistered protocol and analysis plan? Is the result likely to have been selected from multiple possible results?



	D1	D2	D3	D4	D5	Overall
Anderson 2015 (1)	!	!	+	+	+	!
Anderson 2015 (2)	!	!	+	+	+	!
Arendt 2015	!	+	+	+	+	!
Bialkova 2016	!	!	+	+	+	!
Boyland 2015	!	!	+	+	+	!
Bragg 2019	+	+	+	+	+	+
Buchanan 2017	!	!	+	+	+	!
Coates 2019a	+	+	+	+	+	+
Coates 2019b	!	!	+	+	!	!
Dixon 2017	!	+	+	+	+	!
Dixon 2018	!	+	+	+	+	!
Dixon 2020	!	!	+	+	+	!
Dovey 2017	+	+	+	+	+	+
Emond 2016	!	!	+	+	+	!
Folkvord 2017	!	+	+	+	+	!
Gilbert-Diamond 2017	!	+	+	+	+	!
Gregori 2017a	!	+	+	+	+	!
Harris 2017	+	!	+	+	+	!
Heard 2016	!	!	+	+	+	!
Kearney 2020	+	!	+	+	+	!
Lazard 2018 (1)	!	!	+	+	+	!
Lazard 2018 (2)	!	!	+	+	+	!
Lorenzoni 2017a	!	!	+	+	+	!
Masterson 2019	!	+	+	+	+	!
Matthes 2015	!	+	+	+	+	!
McDarby 2018	!	+	+	+	+	!
McGale 2016 (1)	!	+	+	+	+	!
McGale 2016 (2)	!	+	+	+	+	!
Naderer 2018b	!	!	+	+	+	!
Neyens 2015	+	!	+	+	+	!
Neyens 2017	!	+	+	+	!	!
Norman 2018	+	+	+	+	+	+
Ogle 2017	!	+	+	+	!	!
Ponce-Blandon 2020	!	+	+	+	+	!
Putnam 2018	!	!	+	+	!	!
Redondo 2020	!	+	+	+	+	!
Smith 2020	!	+	+	+	+	!
Talati 2018	!	!	+	+	+	!
Tarabashkina 2016	+	+	+	+	+	+
Werle 2016	+	!	+	+	!	!

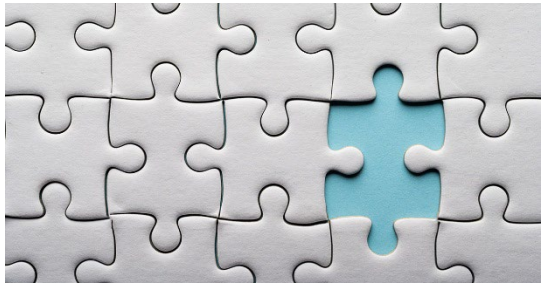
Challenges in assessing risk of bias: Examples from nutrition-relevant case study

1 Reporting guidelines: experimental studies

- Randomized controlled trials – CONSORT
- Systematic reviews – PRISMA
- Observational studies – STROBE
- Case reports – CARE
- Qualitative research – COREQ
- Pre-clinical animal studies – ARRIVE

2 Higher risk profiles due to lack of disclosure

- Randomization procedure?
- Result selection?



3 Research design constraints

4 Lack of relevant tool for study type

Systematic review of the effect of policies to restrict the marketing of foods and non-alcoholic beverages to which children are exposed

Emma Boyland[1] | Lauren McGale[1,2] | Michelle Maden[3] | Juliet Hounsome[3] | Angela Boland[3] | Andrew Jones[1]