The causal impact of school-meal programmes in developed economies: a meta-analysis

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Introduction

- School-meal programmes can serve as a vital component of the social safety net, tackling **malnutrition** while also enhancing **educational engagement**, **attendance**, **academic achievement**, **health**, **socialisation**, and **positive behaviour** (Guio, 2023).
- Research on school-meal programmes reveals **mixed results**: some studies show positive impacts, while others indicate limited, inconsistent, or even negative effects.
- Given the **policy** and **budget** relevance of school-meal programmes around the world, a comprehensive meta-analysis is essential to accurately assess their effectiveness and inform decision-making.
- This paper is the **first meta-analysis** to examine the overall causal effects of school meal-programmes on children's behavioural, health, and educational outcomes in **developed countries**, while addressing potential **publication bias** and taking into account **heterogeneity**.

Literature review

- Previous literature has encountered **two main hurdles** when attempting to evaluate the **causal impact of school-meal programmes** on child well-being:
  - the design of such programmes has often lacked the necessary quasi-experimental variation needed to credibly estimate their causal impact;
  - data that links school-meal participation and children outcomes has been rarely available to researchers (Schwartz and Rothbart, 2020).
- Even though, recent methodological advancements, more data availability and policy reforms are currently contributing to the growth of this body of literature.
- In this paper, we focus on two key aspects: i) the **design** and **characteristics** of the school-meal programmes; and, ii) the **outcomes** under analysis, including **domains**, **timing**, and **heterogeneous** effects.

Literature review: design and characteristics

- Some countries offer universal free meals, while others restrict them to disadvantaged schools or base them on income eligibility.
  - Evidence on the impact of **means-tested** programmes is limited and inconclusive (Schanzenbach, 2009; Frisvold, 2015).
  - Studies on **universal free** school meals reveal increased participation and diverse effects on behaviour, health, and education (Davis et al., 2023; Holford and Rabe, 2022).
- School-meal programmes also differ in the type of meals provided, with some offering **breakfast**, others **lunch**, and some covering both Millimet et al. (2010).
- Food delivery methods include **canteen service** or **classroom delivery**.
  - classroom delivery generally increases participation and positively impacts educational achievement and behaviour, though some studies find negligible effects on health and academic performance (Cuadros-Meñaca et al., 2023; Imberman and Kugler, 2014; Abouk and Adams, 2022).
- **Nutritional** quality is vital, as it directly affects the value of the replaced meals (Anderson et al., 2018; Belot and James, 2011).

Literature review: outcomes, timing and heterogeneous effects

- Research on school-meal programmes mainly examines their impact on children's **behaviour**, **health**, and **education**.
  - **Behaviour**: reduced **physical fights** at school (Altindag et al., 2020; Norwood, 2020), **suspensions** (Gordon and Ruffini, 2021; Radsky et al., 2022; Kho, 2018); and, **disciplinary infractions** (Cuadros-Meñaca et al., 2023).
  - **Health**: research has focused on assessing the prevalence of **obesity**, **general health status**, and **nutritional outcomes**, with mixed results (Gundersen et al., 2012; Schanzenbach, 2009).
  - **Education**: research shows mixed results, with some studies reporting positive impacts on **academic achievement**, while others find no significant effects, and most indicate null effects on **school attendance** (Abouk and Adams, 2022; Cuadros-Menaça et al., 2022; Gordanier et al., 2020; Corcoran et al., 2016; Belot and James, 2011).

Literature review: outcomes, timing and heterogeneous effects

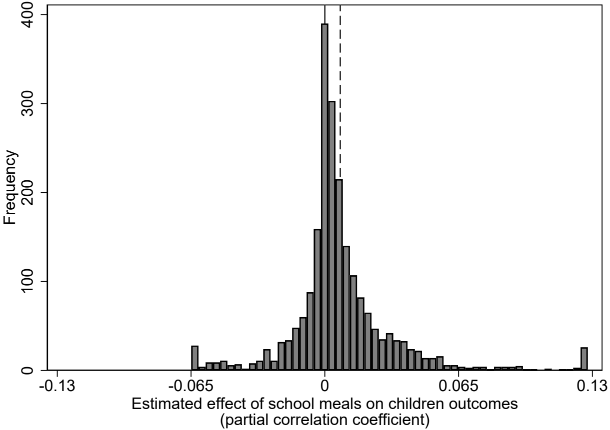
- Most studies focus on **short-term** effects.
  - Few studies on the **long-term** effects document increased educational attainment, improved health, and higher lifetime income (Lundborg et al., 2022; Bütikofer et al., 2018; Hinrichs, 2010).
- The effectiveness of school-meal programmes may vary based on **students' characteristics**, including **gender**, **grade**, **age**, and **socio-economic status** (Davis, 2023; Kim, 2021; Davis et al., 2019; Kho, 2018).

Data

- Our search was performed using the terms ('school meal*' OR 'school breakfast*' OR 'school lunch*') AND ('programme' OR 'program') AND ('impact') AND ('child*') AND ('outcome*') AND ('causal') in Google Scholar (Irsova et al., 2024).
- We impose four inclusion criteria:
  - **behaviour**, **health**, and **education**;
  - **experimental** and **quasi-experimental**;
  - **developed countries**;
  - standard error or a measure that allows its reconstruction.
- The final sample includes **2214** estimates from **46** studies. PRISMA
- We standardise effect sizes using **partial correlation coefficients (PCCs)**.
  - PCC < 0.07 no effect; $0.07 \geq$ PCC < 0.175 small effect; $0.175 \geq$ PCC $<$ 0.338 moderate effect; PCC ≥ 0.338 large effect (Doucouliagos, 2011).

Data

Figure: Distribution of the effect sizes



Note: The solid line is set at zero, while the dashed line represents the sample mean (0.008).

Histogram of heterogeneity

Data

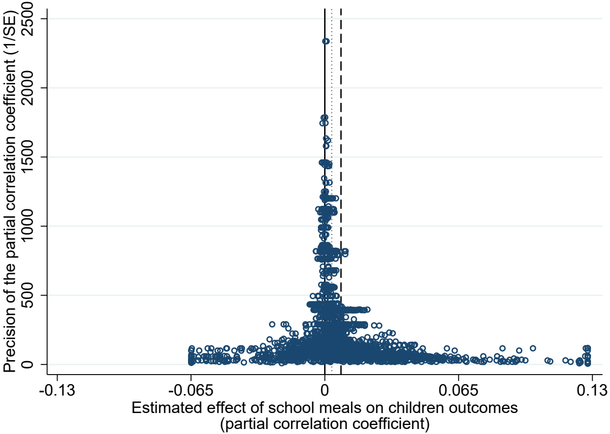
Table: Summary statistics for different subsets of studies

	Observations	Unweighted Mean	Unweighted 95% conf. int.		Weighted Mean	Weighted 95% conf. int.	
	(1)	(2)	(3)		(4)	(5)	
Domain							
Outcome: Behaviour	208	0.007	0.005	0.009	0.004	0.001	0.006
Outcome: Health	788	0.007	0.005	0.009	0.008	0.005	0.010
Outcome: Education	1218	0.008	0.007	0.009	0.010	0.009	0.012
Programme characteristics							
Lunch	904	0.007	0.005	0.008	0.004	0.003	0.006
Breakfast	768	0.012	0.010	0.014	0.016	0.013	0.018
Breakfast and lunch	542	0.003	0.001	0.004	0.005	0.003	0.007
Universal	1405	0.005	0.004	0.007	0.007	0.006	0.008
Means-tested	809	0.011	0.009	0.013	0.012	0.009	0.014
Student characteristics							
Secondary school	842	0.011	0.009	0.012	0.012	0.010	0.014
Primary school	1992	0.007	0.006	0.008	0.007	0.006	0.008
Kindergarten	210	0.000	-0.002	0.003	0.003	0.001	0.005
Female	119	0.005	0.001	0.009	0.010	0.005	0.016
Male	123	0.006	0.003	0.009	0.007	0.003	0.012
Caucasian	86	0.009	0.006	0.013	0.010	0.006	0.013
Minority	145	0.007	0.003	0.010	0.007	0.004	0.010
Advantaged	203	0.004	0.000	0.008	-0.001	-0.005	0.003
Disadvantaged	240	0.008	0.005	0.012	0.014	0.010	0.018
All students	1334	0.008	0.007	0.009	0.008	0.007	0.010
All estimates	2214	0.008	0.006	0.009	0.008	0.007	0.009

Note: In Columns (4) and (5), we weight each observation by the inverse number of estimates reported per study.

Publication bias

Figure: Funnel plot



Note: The solid line represents zero, the dotted line indicates the median (0.003), and the dashed line represents the sample mean (0.008).

Publication bias

- We use ten methods for testing publication bias. Methodologies
- Most of them are based on the following equation (Stanley and Doucouligos, 2012):

$$PCC_{ij} = \alpha + \gamma SE(PCC_{ij}) + \epsilon_{ij} \quad (1)$$

where $PCCij$ is the i-th partial correlation coefficient from the j-th study, $SE(PCCij)$ represents the corresponding standard errors, and ϵ_{ij} is the error term. γ provides information on the existence, direction, and magnitude of publication bias and α is the effect beyond bias.

  - $|\widehat{\gamma}| < 1$ 'little to modest' selectivity; $1 \geq |\widehat{\gamma}| < 2$ 'substantial' selectivity $|\widehat{\gamma}| \geq 2$ 'severe' selectivity (Doucouliagos and Stanley, 2013).

Publication bias

Table: Publication bias tests

	Panel A: Linear models				
	OLS	FE	MAIVE	wNOBS	WLS
	(1)	(2)	(3)	(4)	(5)
Publication bias	0.5367**	0.7479***	0.5455**	0.5161	0.5891***
	(0.2184)	(0.2159)	(0.2204)	(0.3518)	(0.1640)
Effect beyond bias	0.0014	-0.0010	0.0013	0.0021	0.0008
	(0.0018)	(0.0024)	(0.0018)	(0.0056)	(0.0006)
Observations	2214	2214	2214	2214	2214
	Panel B: Non-linear models				
	WAAP	STEM	EK	AK	p-uniform*
	(6)	(7)	(8)	(9)	(10)
Publication bias			0.7029***		L=25.8636***
			(0.0000)		(p=0.0000)
Effect beyond bias	0.0006*	0.0000	0.0004***	0.0004***	0.00690***
	(0.0003)	(0.0021)	(0.0001)	(0.0000)	(0.0014)
Observations	2214	2214	2214	2214	2214

Note: Standard errors clustered at the study level. *** significant at 1%, ** at 5% and * at 10%.

- There is a slight indication of publication bias in favour of positive estimates. The effect beyond bias is imprecisely estimated suggesting that, overall, school-meal programmes in developed countries have **negligible** effects on children outcomes.

Publication bias across domains: behaviour

Table: Publication bias tests for the behaviour domain

	Panel A: Linear models				
	OLS	FE	MAIVE	wNOBS	WLS
	(1)	(2)	(3)	(4)	(5)
Publication bias	0.3185	0.4816	0.3201	0.2505	0.6099
	(0.3776)	(0.3712)	(0.3775)	(0.4091)	(0.4555)
Effect beyond bias	0.0045	0.0033	0.0045	0.0059	0.0024**
	(0.0031)	(0.0027)	(0.0030)	(0.0055)	(0.0010)
Observations	208	208	208	208	208
	Panel B: Non-linear models				
	WAAP	STEM	EK	AK	p-uniform*
	(6)	(7)	(8)	(9)	(10)
Publication bias			1.0778***		L=4.2088**
			(0.1779)		(p=0.0402)
Effect beyond bias	0.0015***	0.0019	0.0008*	.	0.0090**
	(0.0002)	(0.0016)	(0.0004)	(.)	(0.0044)
Observations	208	208	208	208	208

Note: Standard errors clustered at the study level. *** significant at 1%, ** at 5% and * at 10%.

Publication bias across domains: health

Table: Publication bias tests for the health domain

	Panel A: Linear models				
	OLS	FE	MAIVE	wNOBS	WLS
	(1)	(2)	(3)	(4)	(5)
Publication bias	0.7699***	1.0708***	0.7898***	0.9176***	0.5667**
	(0.1604)	(0.2723)	(0.1680)	(0.1850)	(0.2591)
Effect beyond bias	-0.0031	-0.0070*	-0.0033	-0.0065	-0.0004
	(0.0030)	(0.0036)	(0.0030)	(0.0063)	(0.0020)
Observations	788	788	788	788	788
	Panel B: Non-linear models				
	WAAP	STEM	EK	AK	p-uniform*
	(6)	(7)	(8)	(9)	(10)
Publication bias			0.4064***		L=6.8553***
			(0.1206)		(p=0.0088)
Effect beyond bias	.	0.0005	0.0004	0.0000	0.0071***
	(.)	(0.0004)	(0.0004)	(0.0001)	(0.0027)
Observations	788	788	788	788	788

Note: Standard errors clustered at the study level. *** significant at 1%, ** at 5% and * at 10%.

- Selectivity concerns are most pronounced in the health dimension.

Publication bias across domains: education

Table: Publication bias tests for the education domain

	Panel A: Linear models				
	OLS	FE	MAIVE	wNOBS	WLS
	(1)	(2)	(3)	(4)	(5)
Publication bias	0.4260	0.5634	0.4280	0.2553	0.6423***
	(0.4116)	(0.4067)	(0.4125)	(0.7033)	(0.2287)
Effect beyond bias	0.0033	0.0018	0.0033	0.0075	0.0010
	(0.0029)	(0.0044)	(0.0029)	(0.0106)	(0.0007)
Observations	1218	1218	1218	1218	1218
	Panel B: Non-linear models				
	WAAP	STEM	EK	AK	p-uniform*
	(6)	(7)	(8)	(9)	(10)
Publication bias			0.8771***		L=15.0910
			(0.0656)		(p=0.0001)
Effect beyond bias	0.0006**	0.0000	0.0003**	0.0025***	0.0065***
	(0.0003)	(0.0015)	(0.0001)	(0.0006)	(0.0017)
Observations	1218	1218	1218	1218	1218

Note: Standard errors clustered at the study level. *** significant at 1%, ** at 5% and * at 10%.

- In the case of education, the effects beyond bias are statistically significant in most non-linear models, yet they are not economically meaningful. More heterogeneity

Heterogeneity

- We collect **51** variables that capture the context in which each estimate was obtained, and run the following **meta-regression**:

$$PCC_{ij} = \gamma_0 + \gamma_1 SE(PCC_{ij}) + \gamma_2 X_{ij} + \epsilon_{ij} \quad (2)$$

  X_{ij} represents the set of variables that capture heterogeneity between studies.

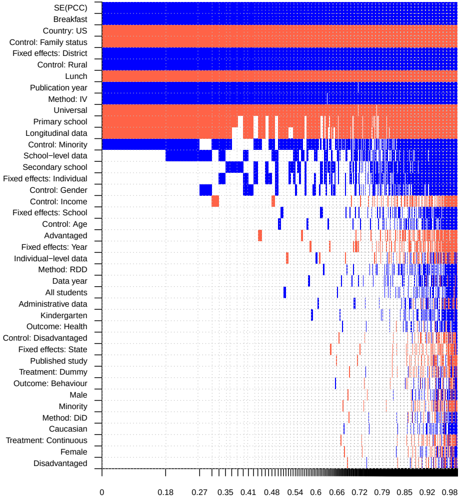
  - **Data characteristics**: outcome; type of treatment; and characteristics of the database.
  - **Programme and student characteristics**: whether the program provides breakfast, lunch, or both; its universality or means-testing; the educational stage; socio-demographic characteristics; and location.
  - **Estimation characteristics**: methodology; controls; and fixed effects.
  - **Publication characteristics**: whether it is published in an academic journal or as a WP; publication year; IF; and number of citations received.

Heterogeneity

- Incorporating all variables in a multiple meta-regression (MRA) can reduce precision due to **collinearity** and introduce **uncertainty** about which explanatory variables to select.
- We use **Bayesian Model Averaging (BMA)** to handle model uncertainty (Raftery et al., 1997; Hoeting et al., 1999), as done in previous meta-analyses (Yang et al., 2024; Opatrny et al., 2023; Kroupova et al., 2021).
- Studies conducted in the US, controlling for family status, lunch programmes, and universal programmes are negative causal predictors of children outcomes. In contrast, publication bias ($SE(PCC)$), breakfast programmes, the inclusion of district fixed effects, controlling for rural status, and publication year are positive causal predictors of children outcomes.

Heterogeneity

Figure: Model inclusion in Bayesian Model Averaging (BMA)



Note: We use the Unit Information Prior (UIP) and the dilution model prior (George, 2010)

Conclusions

- After adjusting for publication bias and heterogeneity, estimates of the causal impact of school-meal programmes on children's behavioural and health outcomes range from null to modest.
- Non-linear models show statistically significant improvements in academic performance, though these gains are not economically substantial.
- Is the investment in school-meal programmes justified?
    - We lack evidence on the impact of completely removing school meals.
    - Benefits may extend beyond immediate outcomes and include medium- to long-term effects.
    - They may also influence household finances, parental employment, work-family balance, and social skills through socialisation — dimensions that remain largely unexplored in the literature.
    - Effectiveness may vary with programme quality.

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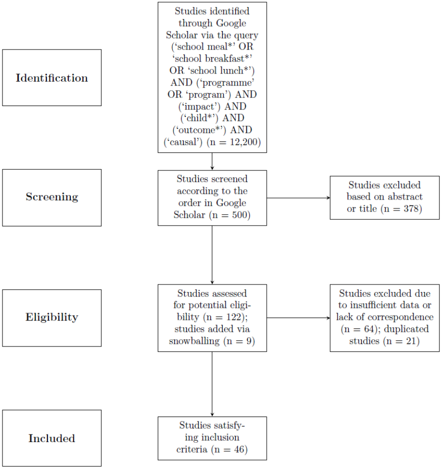
Appendix: PRISMA

Figure: PRISMA flow diagram



Note: Asterisks allow searches to include variations of a keyword.

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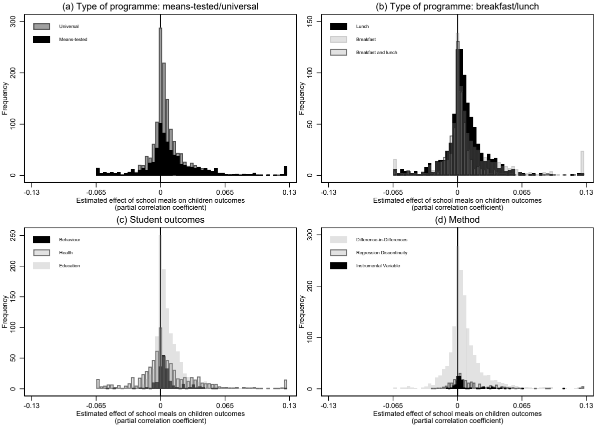
Appendix: Effects sizes by heterogeneity

Figure: Distribution of the effects sizes by aspects of heterogeneity among primary studies



Note: The solid line is set at zero.

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Appendix: Methods for testing publication bias

- 1) **PET-PEESE (OLS)**: it regresses the estimate on its standard error.

$$PCC_{ij} = \alpha + \gamma SE(PCC_{ij}) + \epsilon_{ij} \tag{3}$$

  where $PCCij$ is the i-th partial correlation coefficient from the j-th study, $SE(PCCij)$ represents the corresponding standard errors, and ϵ_{ij} is the error term. γ provides information on the existence, direction, and magnitude of publication bias and α captures the mean effect size corrected for publication bias (Card and Krueger, 1995; Egger et al., 1997; Stanley, 2005; Stanley and Doucouligos, 2012).

- 2) **FE**: study fixed effects are incorporated to account for unobserved heterogeneity at the study level.
- 3) **Meta-Analysis Instrumental Variable Estimator (MAIVE)**: this method uses the inverse of the square root of the sample size as an instrument for the reported standard error (Irsova et al., 2023).
- 4) **wNOBS**: each observation is weighted by the inverse number of estimates reported per study (Krueger, 2003).
- 5) **WLS**: it assigns greater weight to more precise estimates by using the inverse of the standard error (Stanley, 2005).

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Appendix: Methods for testing publication bias

- 6) **Weighted Average of Adequately Powered (WAAP)**: excludes estimates with power under 80% (Ioannidis et al., 2017).
- 7) **STEM**: the number of included estimates in this method is determined by a bias-variance trade-off balancing. As n increases, bias rises (due to the inclusion of imprecise estimates), but variance decreases (as more studies are included) (Furukawa, 2021).
- 8) **Endogenous Kink (EK)**: it determines a threshold for the standard error below which publication bias is unlikely, then fits a piecewise linear regression of the estimates on their standard errors with a break at this threshold (Bom and Rachinger, 2019).
- 9) **AK**: it calculates the probability of publication based on the likelihood of an estimate falling into intervals defined by critical t-statistic values. The model then weights each estimate by its publication probability, giving more weight to estimates with a lower chance of being published (Andrews and Kasy, 2019).
- 10) **p-uniform***: it corrects the effect size estimate by using the distribution of significant p-values, assigning different weights to estimates based on their likelihood of publication (Aert and van Assen, 2020).

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Publication bias: disadvantaged

Table: Publication bias tests for disadvantaged children

	Panel A: Linear models				
	OLS	FE	MAIVE	wNOBS	WLS
	(1)	(2)	(3)	(4)	(5)
Publication bias	0.3702	1.8512***	0.3706	0.1925	0.6184
	(0.4735)	(0.1969)	(0.4745)	(0.4760)	(0.4111)
Effect beyond bias	0.0034	-0.0166***	0.0034	0.0077	0.0000
	(0.0060)	(0.0026)	(0.0060)	(0.0083)	(0.0017)
Observations	240	240	240	240	240
	Panel B: Non-linear models				
	WAAP	STEM	EK	AK	p-uniform*
	(6)	(7)	(8)	(9)	(10)
Publication bias			0.7827***		L=2.7498*
			(0.1343)		(p=0.09727)
Effect beyond bias	.	-0.0005	-0.0009*	-0.0004	0.0087
	(.)	(0.0024)	(0.0004)	(0.0003)	(0.0053)
Observations	240	240	240	240	240

Note: Standard errors clustered at the study level. *** significant at 1%, ** at 5% and * at 10%.

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Publication bias: advantaged

Table: Publication bias tests for advantaged children

	Panel A: Linear models				
	OLS	FE	MAIVE	wNOBS	WLS
	(1)	(2)	(3)	(4)	(5)
Publication bias	0.3170	0.2634	0.3182	0.4643	0.2684
	(0.2410)	(0.7066)	(0.2419)	(0.3797)	(0.3364)
Effect beyond bias	-0.0009	0.0000	-0.0009	-0.0046	-0.0001
	(0.0041)	(0.0117)	(0.0041)	(0.0119)	(0.0011)
Observations	203	203	203	203	203
	Panel B: Non-linear models				
	WAAP	STEM	EK	AK	p-uniform*
	(6)	(7)	(8)	(9)	(10)
Publication bias			0.2285*		L=1.2550
			(0.1249)		(p=0.2626)
Effect beyond bias	.	0.0008	0.0002	0.0004*	0.0070
	(.)	(0.0026)	(0.0005)	(0.0002)	(0.0063)
Observations	203	203	203	203	203

Note: Standard errors clustered at the study level. *** significant at 1%, ** at 5% and * at 10%.

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