



IUNS - ICN 2025

International Congress of Nutrition

24-29 August 2025 | Paris, France

SUSTAINABLE FOOD FOR GLOBAL HEALTH

Meta-analysis of 633,317 individuals shows associations between healthy diets and mental health in 23 low- and middle-income countries

Thalia M Sparling¹ Cesar Cornejo¹ Bryan Cheng³ Lisa M. Troy² Suneetha Kadiyala¹

¹ LSHTM, ² UMass Amherst, ³ Columbia

Presented by CESAR CORNEJO
(London School of Hygiene and Tropical Medicine, LSHTM)



Background

Common mental health disorders (CMDs)

- Depression, anxiety and stress: 17.2% of life years lost to disability in 2021

Low- and Middle-Income Countries (LMIC)

- Disproportionately higher prevalence of CMDs & concomitant health burdens & Underfunding

CMDs and diet quality

Theoretical arguments:

- Healthy diets → better mental health (physiological and social arguments)
- Poor mental health → diet quality (behavioural and physiological arguments, individual and household)

Empirical evidence:

- **CMDs <---> food insecurity / unhealthy diets (interlinked / reinforcing each other)**
- **Good evidence in high-income countries**

This paper

Previous synthesis

- Mainly on depression
- No focus on LMIC settings

Knowledge gaps

- (1) No clear **evidence gaps** in LMIC
- (2) No synthesis **quantifying associations** in LMIC
- (3) No assessment **evidence robustness** in LMIC

Research Question:

What is the association between healthy diet patterns and mental health symptoms measured by validated tools in LMIC?

Main results and contributions

Mental health is **better** in individuals with **healthy diets** in LMIC

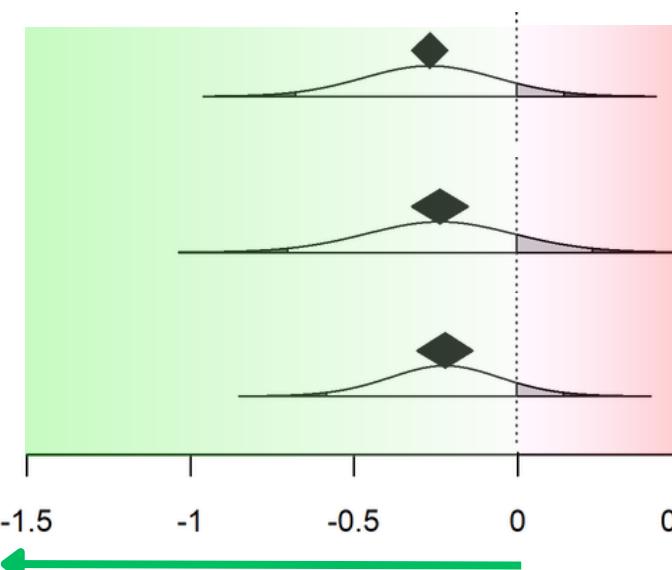
(1) What are there **evidence gaps** in LMIC?

- More than half of the evidence emerging from **cross-sectional studies in Iran and China**
- Only 4 studies from low-income countries: 3 estimates for depression, 1 for anxiety and 0 for stress

(2) What is the **estimated association** in LMIC?

Pooled estimates with clear precision boundaries (CI, predictive distributions)

Depression



Anxiety

Stress

Standardised Mean Difference:

-0.29 [-0.35, -0.23]

[-0.73, 0.16]

95% CI

-0.25 [-0.34, -0.16]

[-0.75, 0.25]

95% Predictive Distribution

-0.24 [-0.33, -0.14]

[-0.62, 0.15]

Magnitude of the association with healthy eating

(3) What is the **robustness of the evidence** in LMIC?

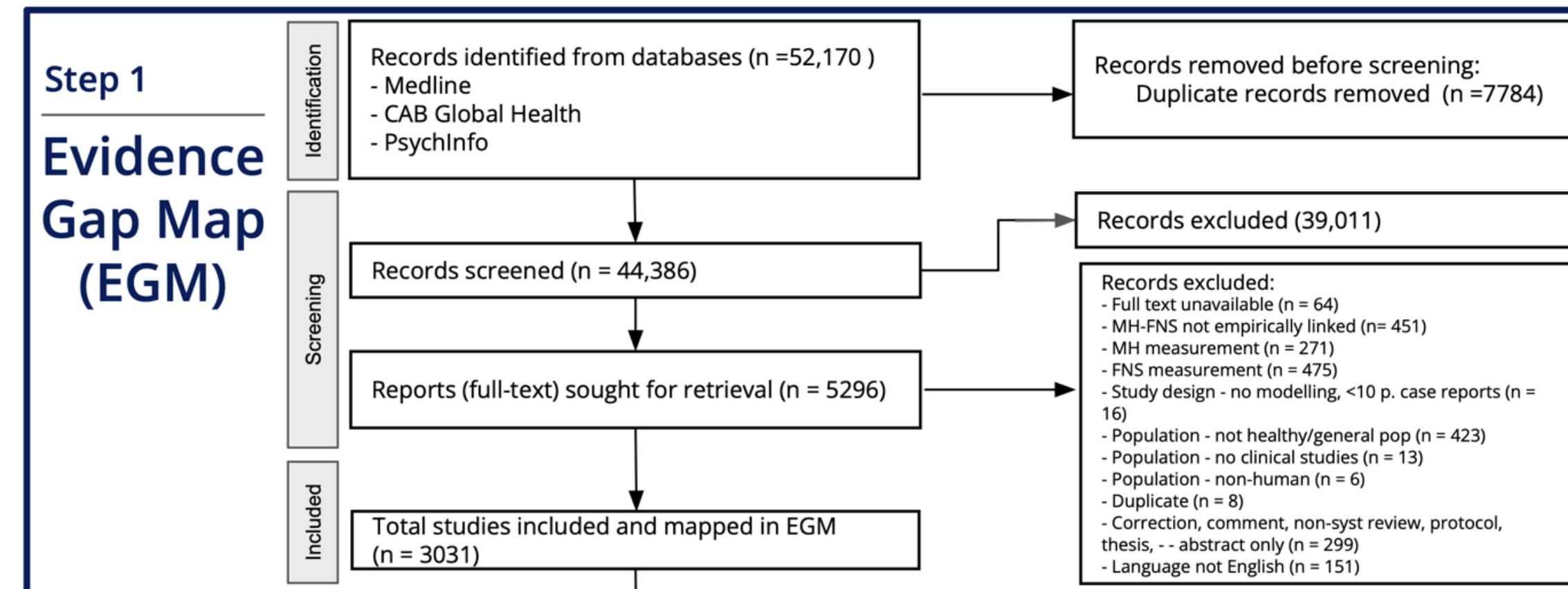
Consistent in direction and magnitude across outcomes

Consistent across **study designs, dietary measurements, diagnostic tools, and country income levels**

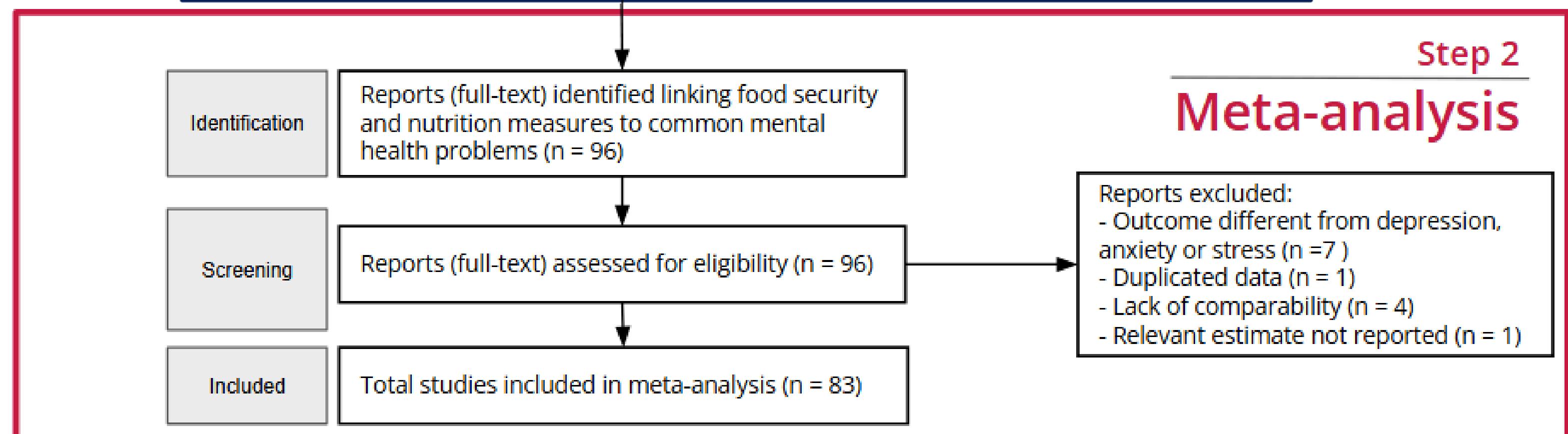
Methods: Meta-analysis from a Evidence Gap Map (EGM) dataset

Previous work

Sparling, T. M. et al. Systematic evidence and gap map of research linking food security and nutrition to mental health. *Nat. Commun.* 13, 4608 (2022)



This paper



Results: Measurements

| Dietary measurements | | Studies |
|--|--|---------|
| G1: Adherence and adequacy | - Adherence to diet recommendations - Nutrient adequacy | 2 |
| G2: Dietary patterns reducing nutrition-related chronic diseases | - Dietary Approaches to Stop Hypertension (DASH) - Dietary Inflammatory Index - Mediterranean diet | 22 |
| G3: Diet diversity indices | - Dietary diversity (MDD, IDDS) - Any other Dietary Variety Scores | 15 |
| G4: Diet quality indices | - Diet Quality Indexes (all) - Global Diet Quality Score - Global Dietary Index - Healthy Eating Indexes (all) | 19 |
| G5: Factor analysis and others | All comparisons between a healthy and an unhealthy diet. Unhealthy is a group with a processed, western, modern, traditional, or unhealthy diet determined for each study. | 26 |

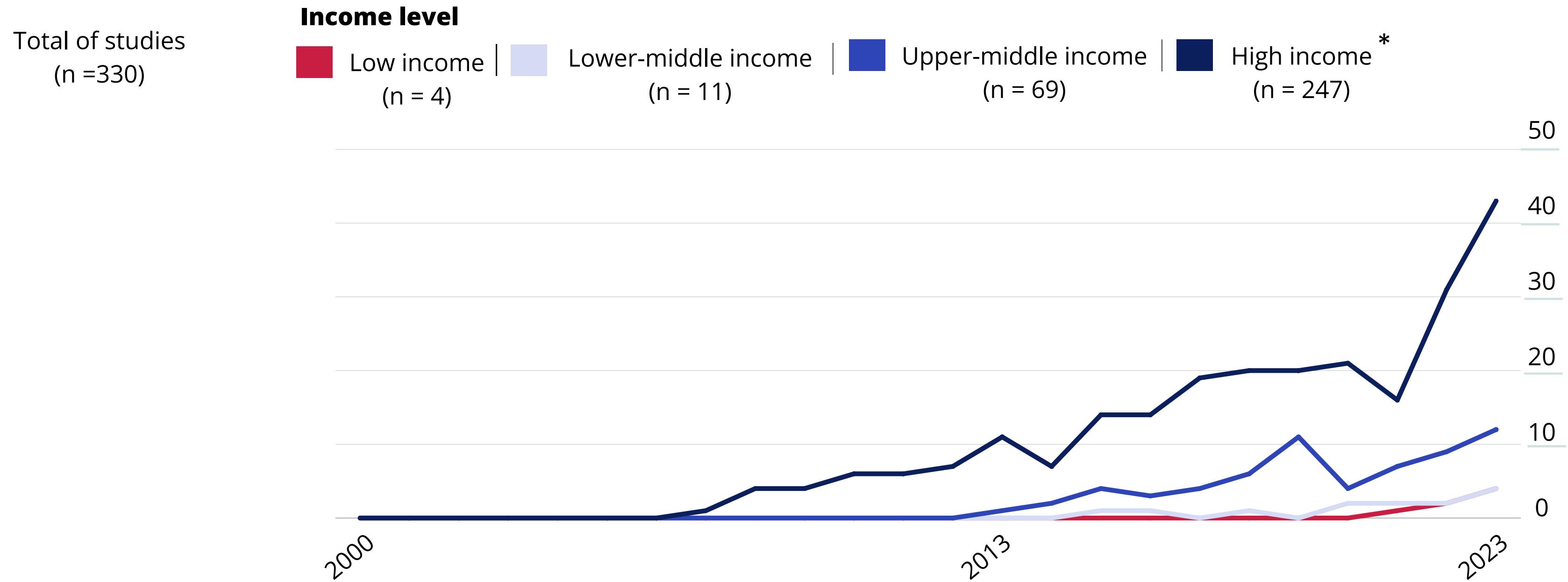
Health-promoting and disease-preventing

| Mental Health screening tools | | Studies |
|-------------------------------|---|---------|
| Depression (69) | Beck Depression Inventory (BDI) Center for Epidemiological Studies - Depression scale (CES-D) Clinical/diagnostic interview (CIDI - SF) Depression, Anxiety and Stress Scale (DASS) Edinburgh Postpartum Depression Scale (EPDS) Geriatric Depression Scale (GDS) Depression subscale of the Hospital Anxiety and Depression Scale (HADS-D) 6-item Kutcher Adolescent Depression Scale (KADS-6) Mini International Neuropsychiatric Interview (MINI) Multidimensional Sub-health Questionnaire of Adolescents (MSQA) Patient Health Questionnaire (PHQ-9) Primary Care Evaluation of Mental Disorders (PRIME-MD) Self-Rating Depression Scale (SDS) Zung self-rating scale | 69 |
| Anxiety (43) | Coronavirus Anxiety Scale (CAS) Depression, Anxiety and Stress Scale (DASS) General Anxiety Disorder Scale (GAD) Hospital Anxiety and Depression Scale (HADS-A) Mini International Neuropsychiatric Interview (MINI) Multidimensional Sub-health Questionnaire of Adolescents (MSQA) Primary Care Evaluation of Mental Disorders (PRIME-MD) Zung Self-reported Anxiety Scale (Zung SAS) State-Trait Anxiety Inventory (STAI) | 43 |
| Stress (26) | Depression, Anxiety and Stress Scale (DASS) General Health Questionnaire (GHQ) Hospital Anxiety and Depression Scale (HADS) Perceived Stress Scale (PSS) | 15 |

Screening tools (validated as threshold scores' correspondence to probability of clinical diagnosis)

Results (1) Evidence gaps

2000 - 2024



* High income country studies **not** included in the meta-analysis. Only plotted for comparison.

Results (1): Evidence gaps in LMIC

Sample populations

- **83 studies** (depression=69; anxiety=43; stress=26)
- **139 effect estimates** (depression=70; anxiety=43; stress=26)
- Estimates pooled from **633,317 unique individuals** (depression=473,236; anxiety=146,217; stress=24,690)
- Most studied populations: adults (n=42) and females (n=16)

Sample settings (in global perspective)

- 83 studies covered 23 countries
 - 69 upper-middle income
 - 11 lower-middle income
 - **4 low-income**
- **Most studies based in Asia (n=70), Iran (n=39) and China (n=17)**
- Outside of Asia: Brazil (n=8), Africa (n=6), Ethiopia (n=3)
- **188 administrative units (countries or dependencies) world-wide: not a single study on this topic**

Study characteristics

- **Study characteristics: cross-sectional designs**
- **Direction of association?**
 - Diet -> mental health symptoms (n=73)
 - Mental health symptoms -> diets (n=10)

Results (1) Evidence Gaps

2000 - 2024

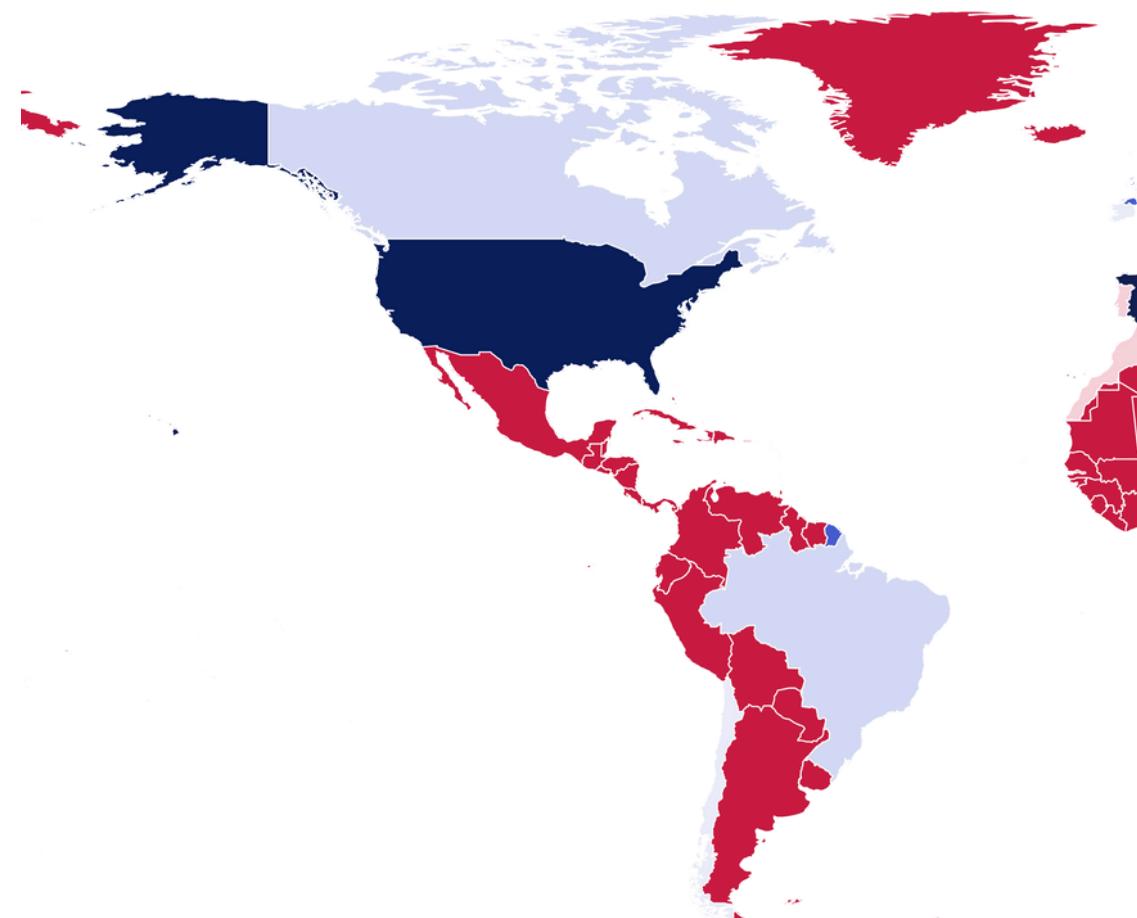
Least studies

Ethiopia, Germany, Switzerland, Turkey 3

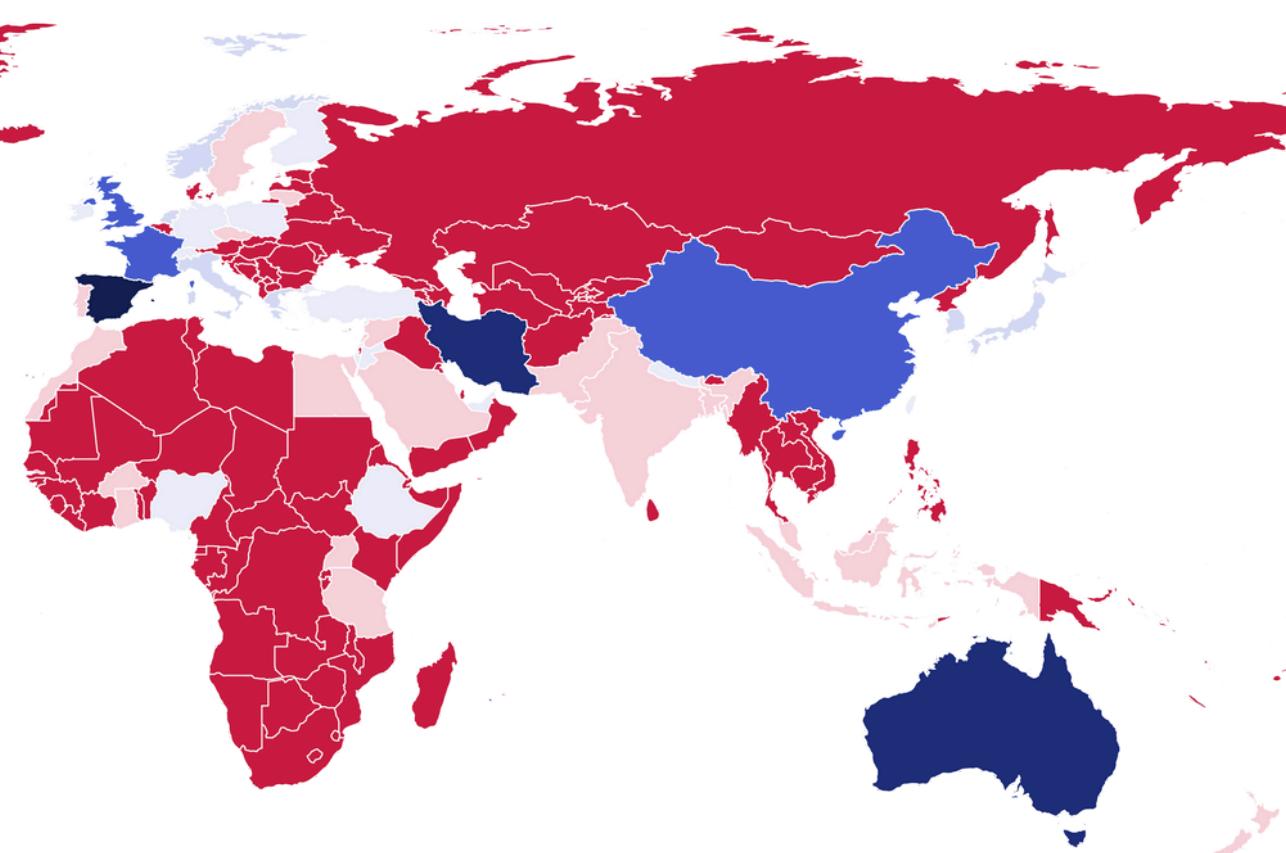
Cyprus, Finland, Ireland, Israel, Jordan, Nepal, Nigeria, Poland, Taiwan, United Arab Emirates 2

Bahrain, Bangladesh, Burkina Faso, Czechia, Egypt, Ghana, India, Indonesia, Lebanon, Lithuania, Luxembourg, Malaysia, Morocco, New Zealand, Pakistan, Portugal, Puerto Rico, Saudi Arabia, Singapore, Sweden, Syria, Tanzania, Uganda 1

Afghanistan, Aland, Albania, Algeria, American Samoa, Andorra, Angola, Anguilla, Antigua and Barbuda, Argentina, Armenia, Aruba, Ashmore and Cartier Islands, Austria, Azerbaijan, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, British Indian Ocean Territory, British Virgin Islands, Brunei, Bulgaria, Burundi, Cabo Verde, Cambodia, Cameroon, Cayman Islands, Central African Republic, Chad, Colombia, Comoros, Cook Islands, Costa Rica, Croatia, Cuba, Curacao, Democratic Republic of the Congo, Denmark, Djibouti, Dominica, Dominican Republic, East Timor, Ecuador, El Salvador, Equatorial Guinea, Eritrea, Estonia, eSwatini, Falkland Islands, Faroe Islands, Federated States of Micronesia, Fiji, French Polynesia, French Southern and Antarctic Lands, Gabon, Gambia, Georgia, Greenland, Grenada, Guam, Guatemala, Guernsey, Guinea, Guinea-Bissau, Guyana, Haiti, Heard Island and McDonald Islands, Honduras, Hong Kong S.A.R., Hungary, Iceland, Indian Ocean Territories, Iraq, Isle of Man, Ivory Coast, Jamaica, Jersey, Kazakhstan, Kenya, Kiribati, Kosovo, Kuwait, Kyrgyzstan, Laos, Latvia, Lesotho, Liberia, Libya, Liechtenstein, Macao S.A.R., Madagascar, Malawi, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Moldova, Monaco, Mongolia, Montenegro, Montserrat, Mozambique, Myanmar, Namibia, Nauru, New Caledonia, Nicaragua, Niger, Niue, Norfolk Island, North Korea, North Macedonia, Northern Cyprus, Northern Mariana Islands, Oman, Palau, Palestine, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Pitcairn Islands, Qatar, Republic of Serbia, Republic of the Congo, Romania, Russia, Rwanda, São Tomé and Príncipe, Saint Barthélemy, Saint Helena, Saint Kitts and Nevis, Saint Lucia, Saint Martin, Saint Pierre and Miquelon, Saint Vincent and the Grenadines, Samoa, San Marino, Senegal, Seychelles, Siachen Glacier, Sierra Leone, Sint Maarten, Slovakia, Slovenia, Solomon Islands, Somalia, Somaliland, South Africa, South Georgia and the Islands, South Sudan, Sri Lanka, Sudan, Suriname, Tajikistan, Thailand, The Bahamas, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkmenistan, Turks and Caicos Islands, Tuvalu, Ukraine, United States Virgin Islands, Uruguay, Uzbekistan, Vanuatu, Vatican, Venezuela, Vietnam, Wallis and Futuna, Western Sahara, Yemen, Zambia, Zimbabwe 0



Low income average
Lower-middle income average
Bangladesh



Upper-middle income average

World average
High income average
Ethiopia Turkey
UK China Iran USA

Most studies

USA 54

Spain 41

Iran 39

Australia 35

UK 18

China 17

France 11

Greece, South Korea 9

Brazil, Italy, Japan 8

Netherlands 7

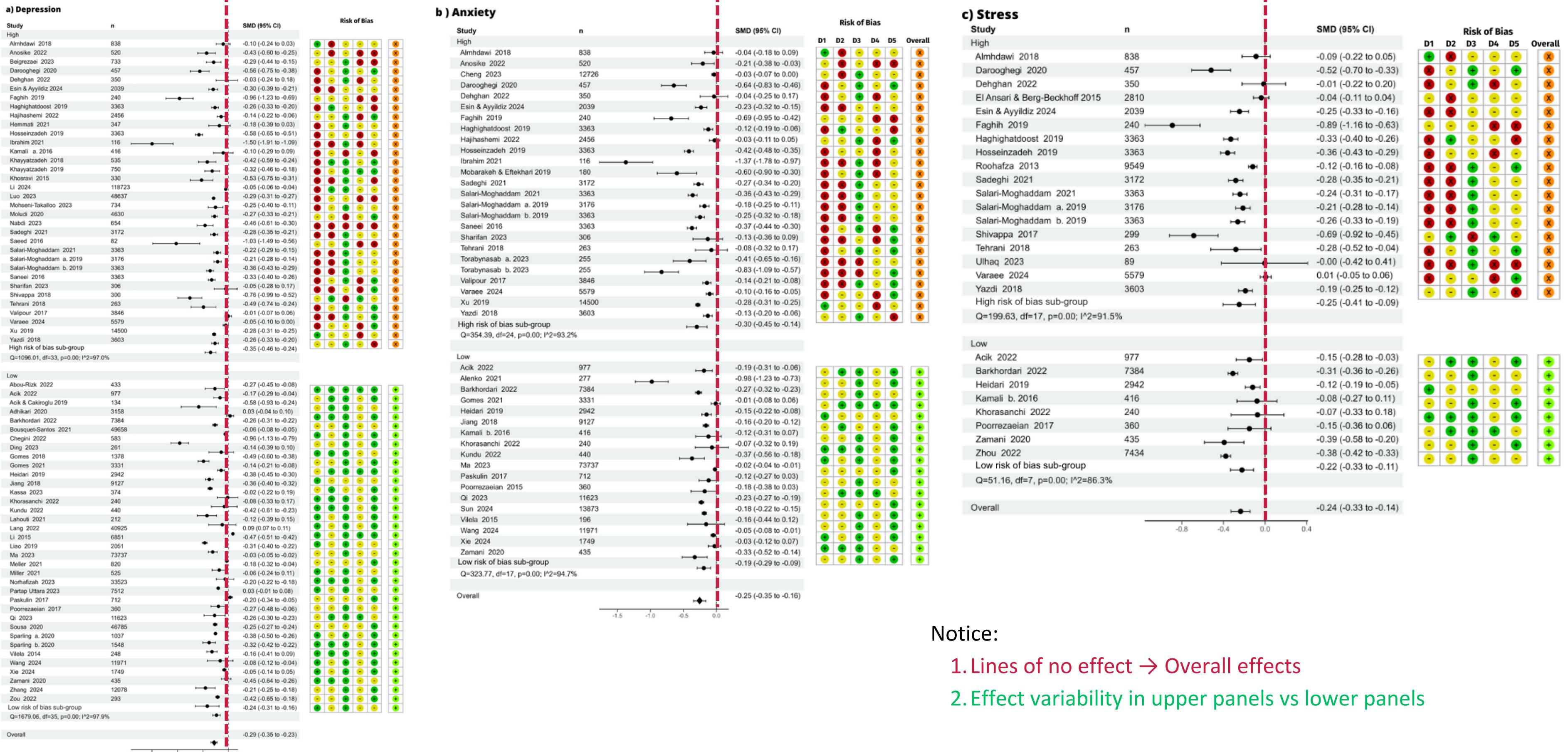
Canada 6

Norway 5

Chile 4



Results (2): Estimating the association in LMIC

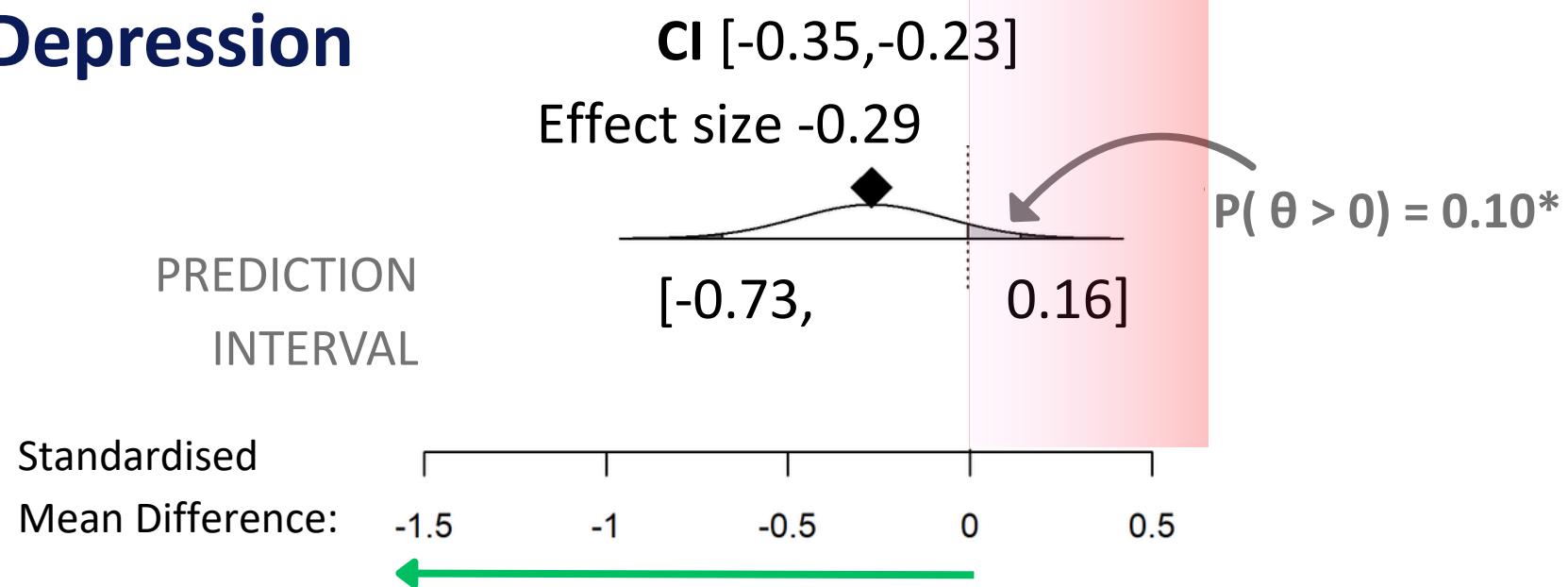


Notice:

1. Lines of no effect → Overall effects
2. Effect variability in upper panels vs lower panels

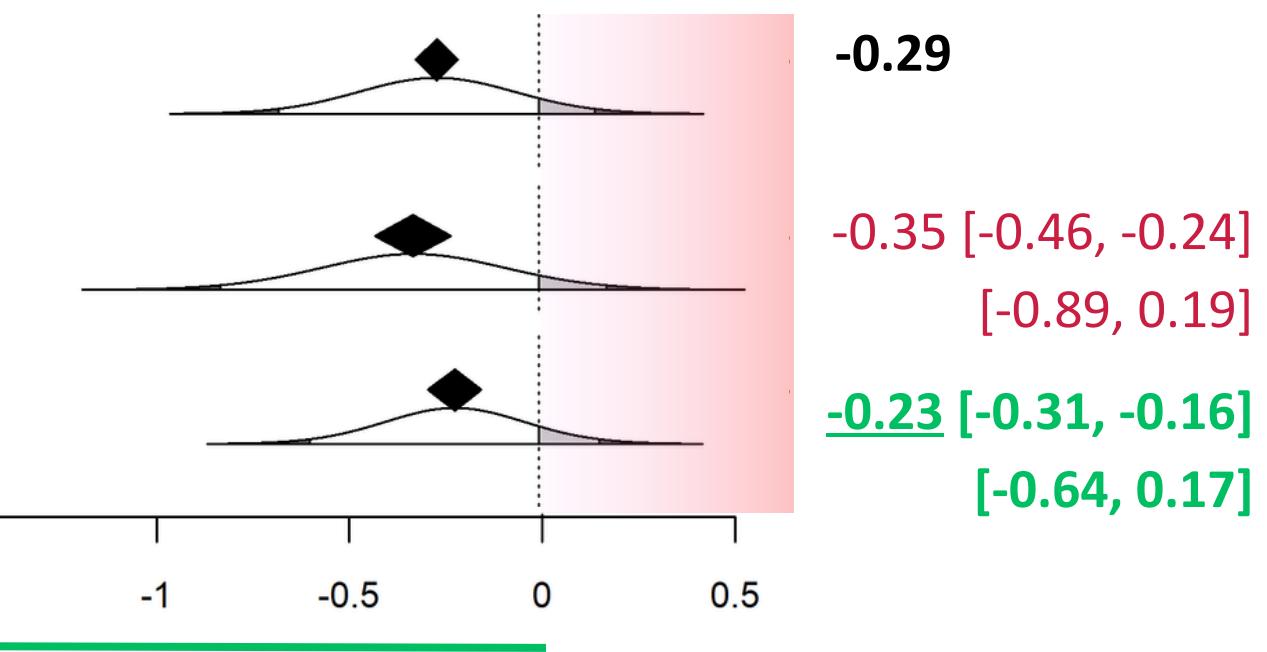
(3) Robustness: evaluating direction and magnitude consistency

Depression



High risk of bias - D

Low risk of bias - D



Magnitude of the association with healthy eating

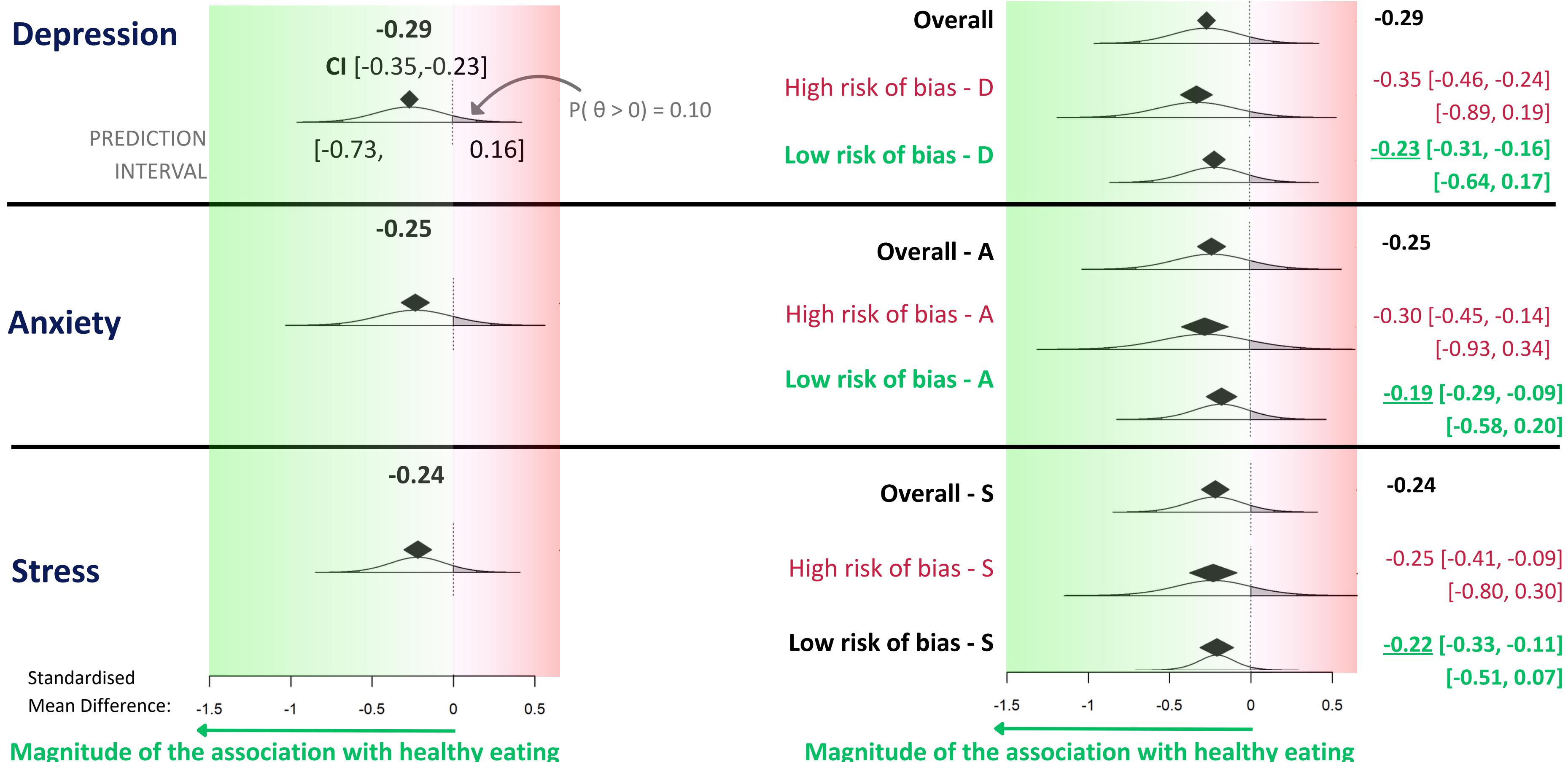
Magnitude of the association with healthy eating

Evaluating the consistency of the effect (direction)

*Probability of the true effect size being greater or equal than 1

(lighter gray: area on the opposite side of the pooled effect)

(3) Robustness: evaluating direction and magnitude consistency



(3) Robustness

Summary effects and Risk of bias

- Study participation (domain 1)
- Confounding (domain 4)

Outliers and influential studies

- 2 outliers and 6 influential studies
- Restricting to low RoB, **no outliers remained**, and only **1 study remained an influential** for depression

Heterogeneity: statistics (I^2) and prediction intervals

Sensitivity analyses

- Findings consistent in direction and magnitude across
(1) country income levels, (2) study design, (3) dietary measurements, (4) effect size indices
- **Only 9 longitudinal studies:** identical results

Discussion

Interpretation of findings

- **Consistent association** healthy diets and better mental health
- **Similar magnitude** of pooled effects for depression, anxiety and stress (-0.29, -0.25 and -0.24, respectively)
- Confident that estimates are **precise and robust**
- Effect estimates **consistent across dietary measurements, mental health screening tools and study designs**
- Most LMIC evidence comes from two middle-income countries: Iran and China
- Studies from other LMIC (Brazil, Bangladesh, Ethiopia or Turkey) scarce and not strong enough (methods)
- Evidence gaps in low-income settings, and LMICs other than Iran and China

Limitations

- Search until January 2024, so studies indexed in non-English repositories, not in English or published after this date are not included
- Classified country-level income status at the time of this analysis
- Excluded studies focused solely on ‘unhealthy’ diets

Implications and ways forward

(1) RESEARCH on pathways to IMPACT

What **CHANGES, MODIFIES or MEDIATES** the relationship between diets and mental health in **specific settings?**

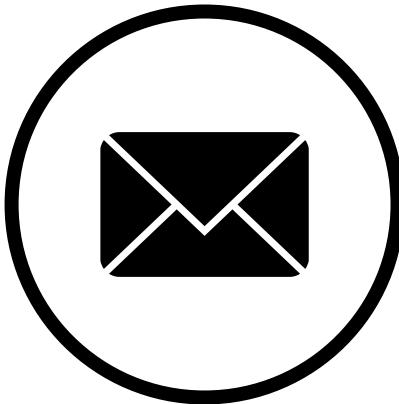
- **Answer these questions BY DESIGN:** longitudinal, prospective analyses, accounting robustly for a variety of potentially influential factors, reducing likely sources of bias, across diverse settings

(2) INTERVENTION RESEARCH on POTENTIAL SYNERGIES:

What interventions components (**not specifically designed to improve mental health or nutrition outcomes**) has greater impact?

- Mental health interventions -> nutrition outcomes
- Nutrition-sensitive interventions -> improve mental health

Contacts



Thalia.Sparling@lshtm.ac.uk

Acknowledgments and Disclosures

This work is funded through the Innovative Methods and Metrics for Agriculture and Nutrition Action (IMMANA) programme, led by the London School of Hygiene & Tropical Medicine (LSHTM), in partnership with Tufts University and the University of Sheffield. IMMANA is co-funded with UK International Development from the UK government and by the Gates Foundation INV-002962 / OPP1211308.