Major project- Team: 07

Meta-Analysis of Maternal Nutrition and Adverse Birth Outcomes in Developing Countries

Under guidance of :

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CONTENTS

INTRODUCTION

- Maternal nutrition vital for health.
- Adequate nutrition supports fetal growth.
- Well-rounded diet crucial outcomes.
- Inadequate nutrition leads birth complications.
- Low birth weight risks.
- Global low-birth-weight prevalence.
- Essential iron, folic acid.
- Holistic approaches combat malnutrition.
- Identify factors tailor interventions.

OBJECTIVE

This meta-analysis aims to assess the impact of maternal nutrition interventions on the prevalence of low birth weight (LBW) in developing nations, specifically focusing on interventions involving iron and folic acid (IFA) supplementation, maternal hemoglobin (Hb) levels, and dietary diversity scores (DDS).

LIERATURE SEARCH

PICO FRAMEWORK :

P - population
I - intervention
C - control
O - outcomes

SEARCH TERM :

P		I		I		O
("pregnant women" OR "maternal health" OR "antenatal care" OR "pregnancy outcomes")	AND	("maternal nutrition" OR "prenatal nutrition" OR "gestational nutrition" OR "pregnancy diet" OR "maternal dietary patterns" OR "micronutrient")	AND	("developing countries" OR "low income countries" OR "middle income countries" OR "global health" OR "developing nations")	AND	("Low birth weight" OR "Premature birth" OR "Intrauterine growth restriction" OR "Neonatal outcomes" OR "Birth complications" OR "small for gestation period")
AND						
Study Design ("cross sectional study" OR "quasi experimental study" OR "case control study")						

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria :

1. Studies that assess the association between maternal nutrition and adverse birth outcomes in developing countries will be included.

2. Peer-reviewed journal articles will be evaluated for inclusion.

3. Studies in developing countries will be included, depending on the granted global classifications. Clear reporting of nations classified as "developing", "low-income" or "middle-income" will be well deserved.

4. Pregnant women of developing countries are included.

5. Studies will be included that assess various facets of maternal nutrition, but not limited to eating patterns, micro-nutrient status, and overall nutritional adequacy.

6. Studies reporting adverse birth outcomes such as low birth weight, small for gestation age, preterm birth will be considered.

7. Studies that include parameters such as sample size(n), case and control sample size will we adequate

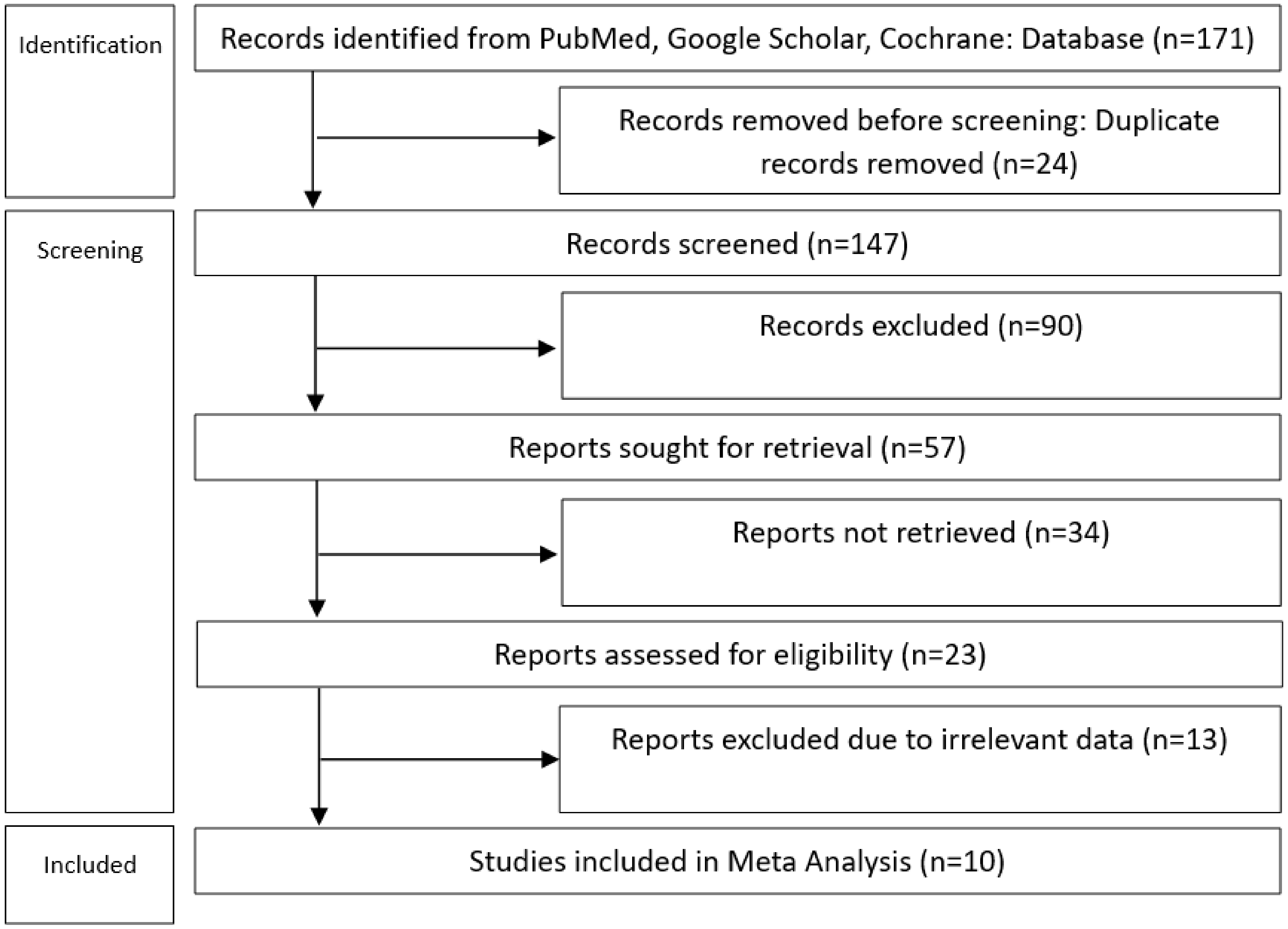
Exclusion criteria:

1. Unpublished research, conference abstracts, and grey literature will be rejected.

2. Studies emphasizing populations other than pregnant women, as well as those done solely in high-income settings, will be omitted.

3. Studies published in languages other than English are eliminated.

PRISMA FLOW DIAGRAM



DATA EXTRACTION AND QUALITY ASSESMENT

Authors, Year	Study Design	Events	Experimental		Control	
			Events	Total	Events	Total
Abdurke kure et al., 2021	Cross-sectional study	Low Birth Weight	59	161	34	239
Abera et al., 2019	Cross-sectional study	Low Birth Weight	29	66	33	292
Devaguru et al., 2023	Cross-sectional study	Low Birth Weight	162	162	66	300
Girotra et al., 2023	Cross-sectional study	Low Birth Weight	15360	90076	9995	64141
Habtu et al., 2022	Quasi-experimental study	Low Birth Weight	18	187	73	909
Saha et al., 2023	Case- control study	Low Birth Weight	45	87	60	123
Seid et al., 2022	Case- control study	Low Birth Weight	28	39	56	213
Sindiani et al., 2023	Case- control study	Low Birth Weight	45	65	27	155
		Total	**15746**	**90843**	**10344**	**66372**

Maternal HB

Authors, Year	Study Design	Events	Experimental		Control	
			Events	Total	Events	Total
Abdurke Kure et al., 2021	Cross-sectional study	Low Birth weight	64	175	29	225
Devaguru et al., 2023	Cross-sectional study	Low Birth weight	186	288	141	612
Seid et al., 2022	Cross-sectional study	Low Birth weight	31	42	53	210
Sindiani et al. 2023	Case- control study	Low Birth weight	13	104	59	116
Sutni et al., 2023	Cross-sectional study	Low Birth weight	11	13	2	12
		Total	**305**	**622**	**284**	**1175**

IFA

DATA EXTRACTION AND QUALITY ASSESMENT

Author, Year	Study Design	Events	Experimental		Control	
			Events	Total	Events	Total
Girotra et al., 2023	Cross-sectional study	Low Birth Weight	3473	19243	22893	140866
Habtu et al., 2022	Quasi-experimental study	Low Birth Weight	26	241	65	855
Walle et al., 2022	Cross-sectional study	Low Birth Weight	224	421	197	421
		Total	**3723**	**19905**	**23155**	**142142**

DDS

Reference	Year	Study duration(days)	StudyID	Average maternal age(years	Maternal Nutrition						Country	Initial sample size	Study design
					IFA		Maternal Hb		DDS				
					Events	Total	Events	Total	Events	Total			
Abdurke kure et al.	2021	38	36037087	26	64	175	59	161	-	-	Ethopia	403	Cross-sectional study
Abera et al.	2019	1095	31443690	30	-	-	29	66	-	-	Ethopia	358	Cross-sectional study
Devaguru et al.	2023	365	37288213	27	186	288	162	162	-	-	India	900	Cross-sectional study
Girotra et al.	2023	1095	37123748	32	-	-	15360	90076	3473	19243	India	1,75,240	Cross-sectional study
Habtu et al.	2022	242	35938121	30	-	-	18	187	26	241	Rwanda	1096	Quasi-experimental study
Saha et al.	2023	61	35836138	22	-	-	45	87	-	-	India	210	Case- control study
Seid et al.	2022	93	37457158	28	31	42	28	39	-	-	Ethiopia	255	Case- control study
Sindiani et al.	2023	365	36937486	26	13	104	45	65	-	-	Jordan	2260	Case- control study
Sutni et al.	2023	28	30813968	27	11	13	-	-	-	-	Indonesia	25	Cross-sectional study
Walle et al.	2022	579	32098043	30	-	-	-	-	224	421	Ethiopia	421	Cross-sectional study

Summary of studies included

STATISTICAL ANALYSIS

MATERNAL NUTRITION:

- IRON FOLIC ACID SUPPLEMENTATION
- MATERNAL HAEMOGLOBIN(HB) LEVELS
- DIETARY DIVERSITY SCORES(DDS)

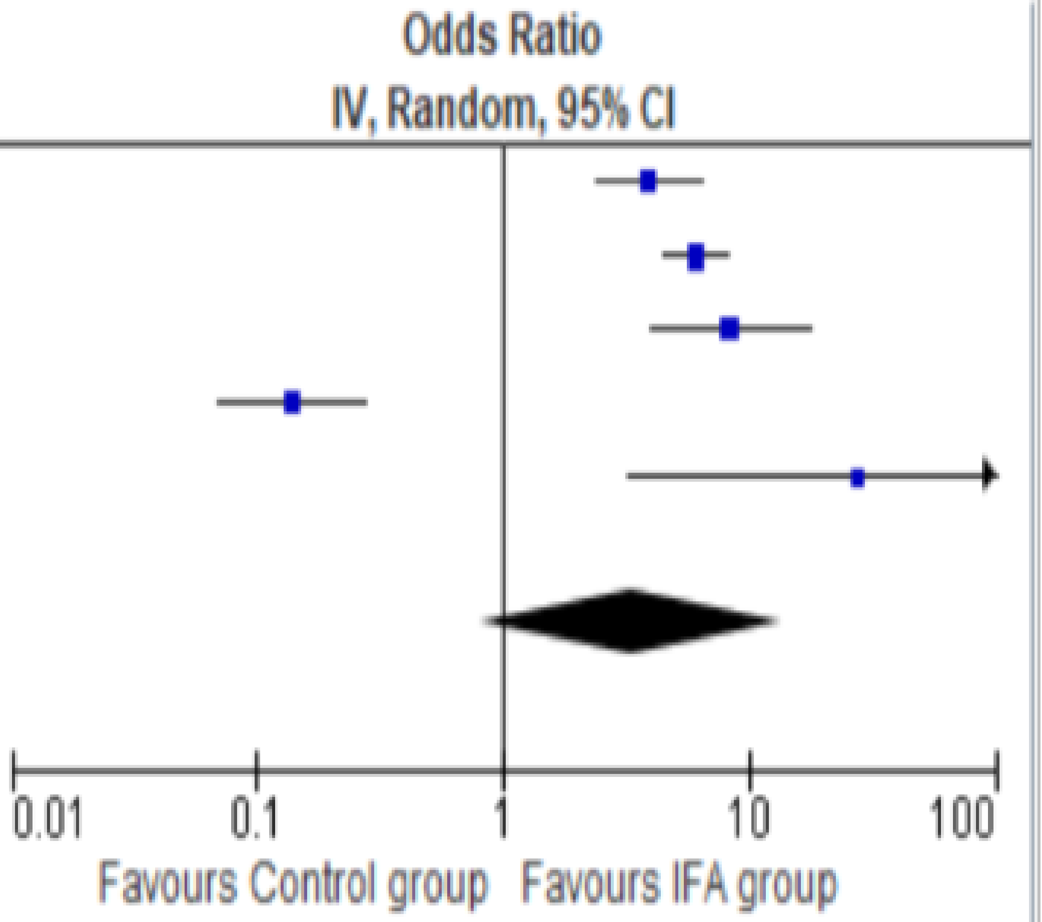
IRON FOLIC ACID SUPPLEMENTATION

- FOREST PLOT of Low Birth Weight associated with IFA supplementation.

	Iron Folic Acid		Control			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	IV, Random, 95% CI
Abdurke kure et al 2021	64	175	29	225	21.6%	3.90 [2.37, 6.40]
Devaguru et al 2023	186	288	141	612	21.9%	6.09 [4.49, 8.27]
Seid et al 2022	31	42	53	210	20.8%	8.35 [3.92, 17.76]
Sindiani et al 2023	13	104	59	116	21.0%	0.14 [0.07, 0.27]
Sutni et al 2023	11	13	2	12	14.6%	27.50 [3.24, 233.47]
Total (95% CI)		**622**		**1175**	**100.0%**	**3.32 [0.81, 13.53]**
Total events	305		284			

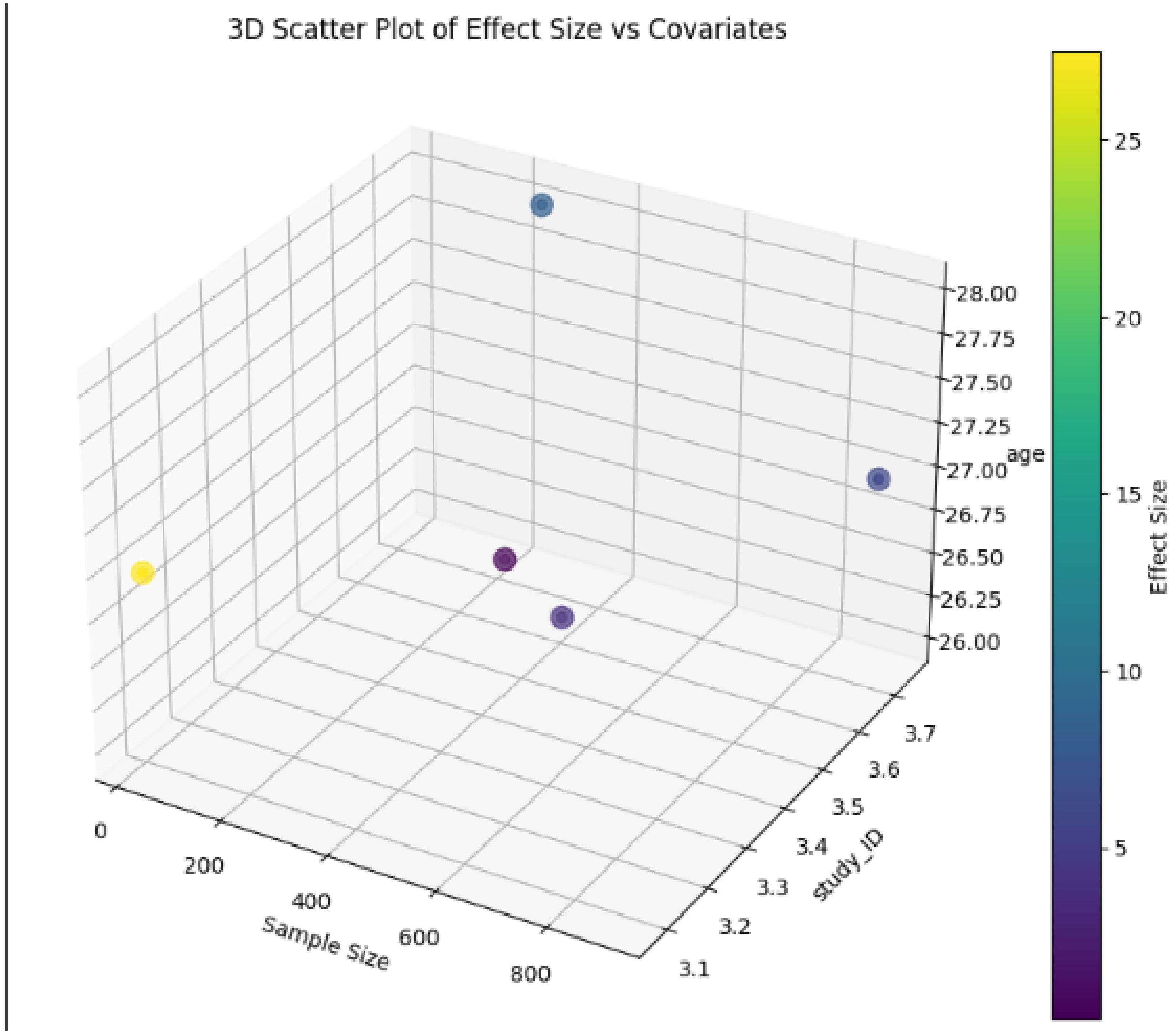
Heterogeneity: $Tau^2 = 2.32$; $Chi^2 = 106.40$, df = 4 ($P < 0.00001$); $I^2 = 96\%$

Test for overall effect: Z = 1.67 (P = 0.09)



- # META REGRESSION TO ASSESS THE SOURCE OF HETEROGENITY

(of Low Birth Weight associated with IFA supplementation)

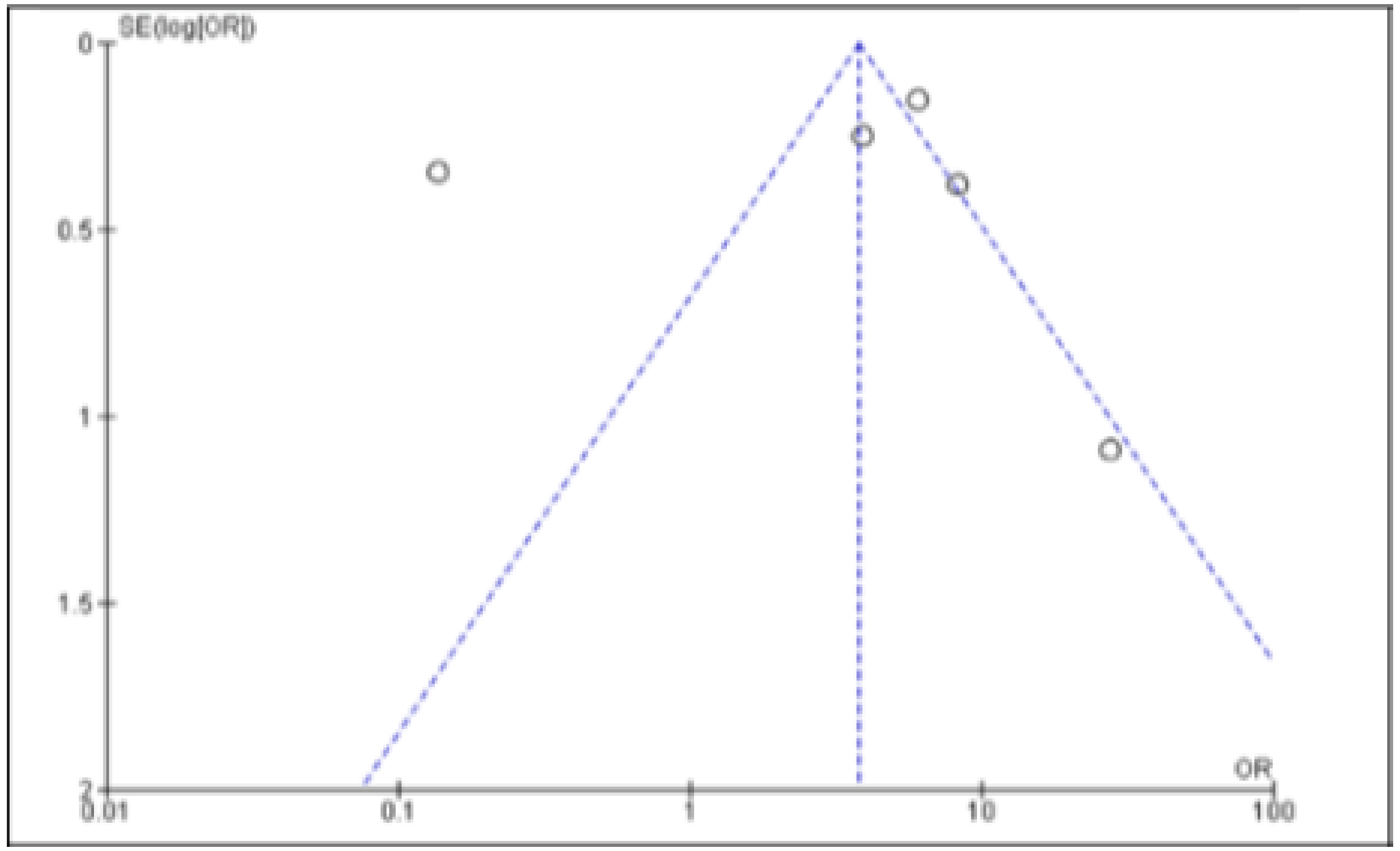


3D SCATTER PLOT OF EFFECT SIZE vs COVARIATES

```
P-values:
Intercept: 0.2879980602812809
sample_size: 0.05707684245804439
StudyID: 0.005930304920366876
age: 0.011865994045245784
```

P-values for different covariates

- **PUBLIICATION BIAS AND EGGER's REGRESSION TEST**



Funnel plot

```
[1] import numpy as np
    import statsmodels.api as sm


    log_or = np.array([3.90, 6.09, 8.35, 0.14, 27.50]) # effect sizes (log odds ratios)

    se_log_or = np.array([0.142, 0.093, 0.184, 0.017, 1.016]) # standard errors


    se_log_or[se_log_or == 0] = 1e-6

    # Egger's test
    X = sm.add_constant(1/se_log_or)
    model = sm.OLS(log_or, X).fit()
    intercept, slope = model.params
    p_value = model.pvalues[1]  # P-value corresponding to the slope

    print(f"Egger's test p-value: {p_value}")

    Egger's test p-value: 0.30598672555289025
```

EGGER's REGRESSION TEST

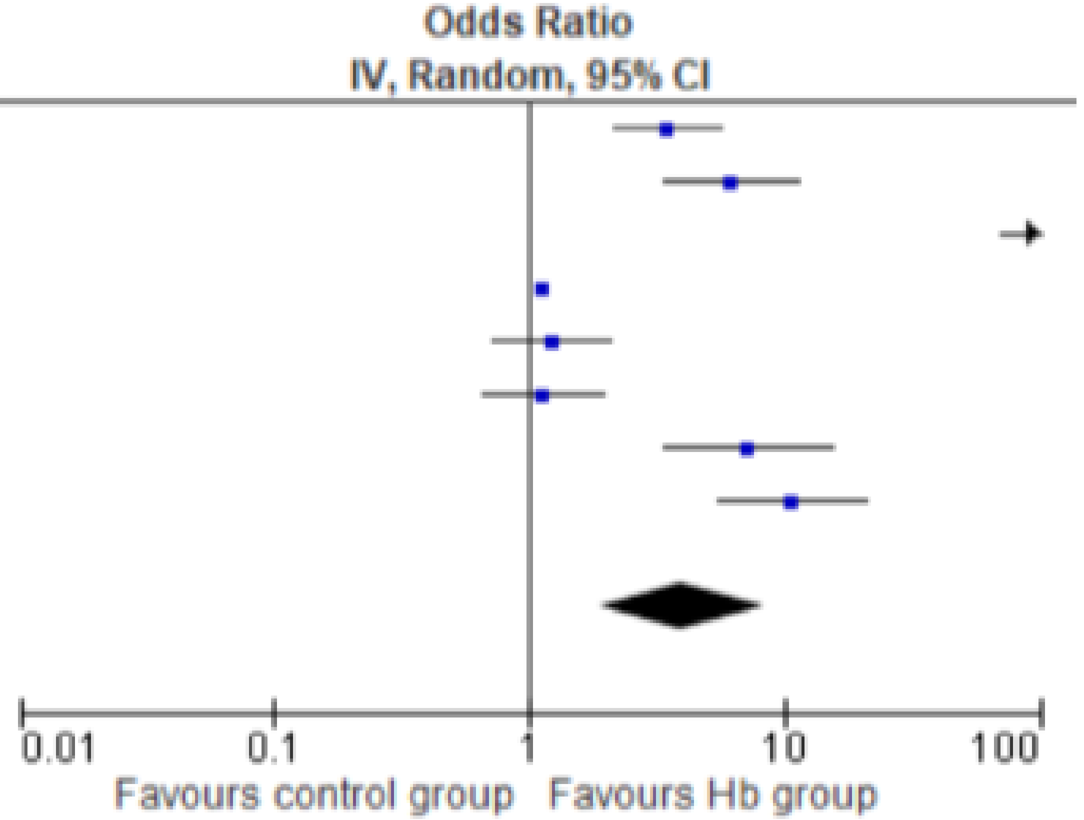
MATERNAL HAEMOGLOBIN(Hb) LEVELS

- FOREST PLOT of Low Birth Weight associated with maternal haemoglobin(hb) levels.

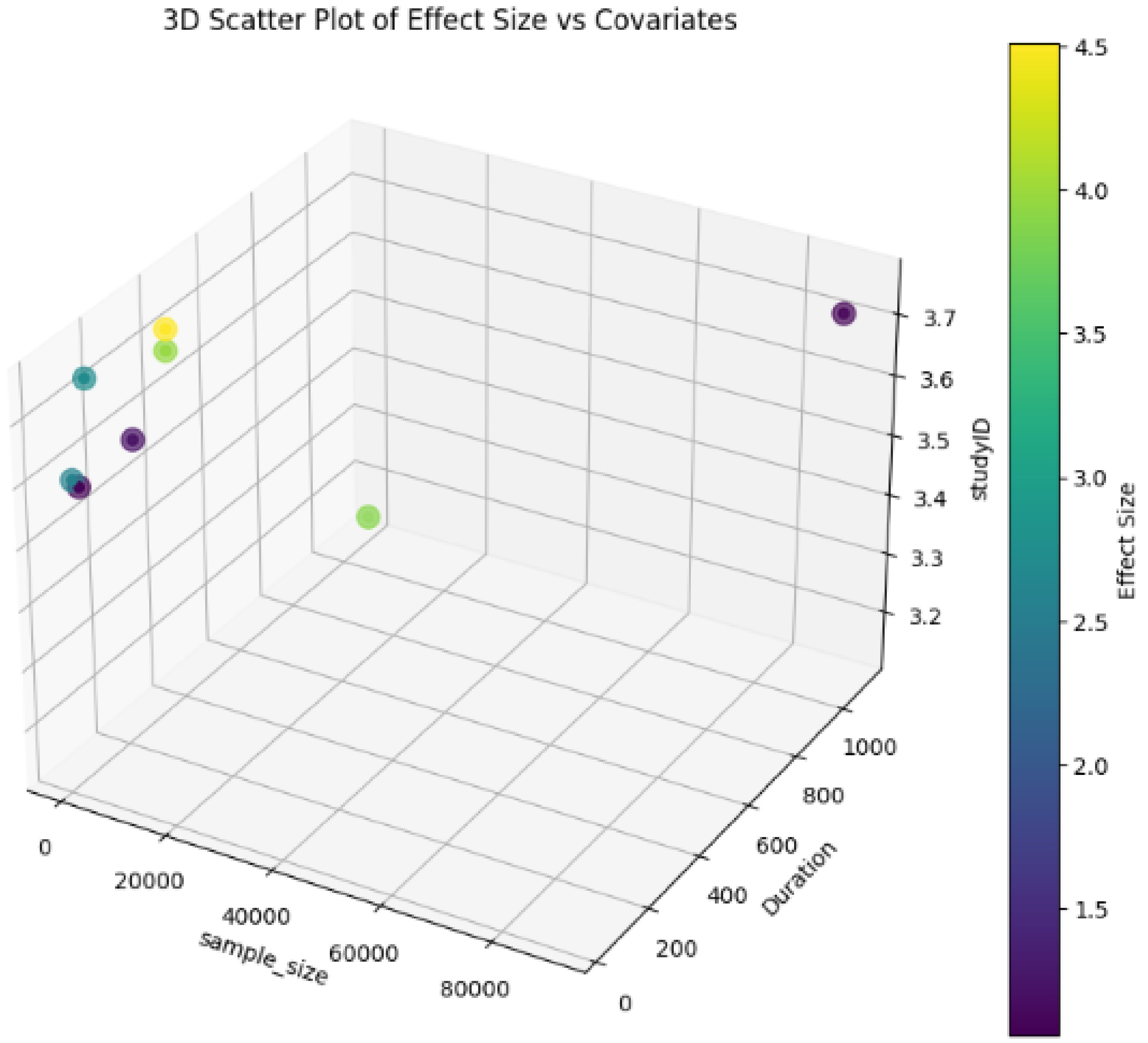
	Hemoglobin		Control			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	IV, Random, 95% CI
Abdurke kure et al 2021	59	161	34	239	13.9%	3.49 [2.15, 5.66]
Abera et al 2019	29	66	33	292	13.4%	6.15 [3.36, 11.28]
Devaguru et al 2023	162	162	66	300	4.8%	1146.05 [70.43, 18647.56]
Girotra et al 2023	15360	90076	9995	64141	14.7%	1.11 [1.08, 1.14]
Habtu et al 2022	18	187	73	909	13.7%	1.22 [0.71, 2.10]
Saha et al 2023	45	87	60	123	13.6%	1.13 [0.65, 1.95]
Seid et al 2022	28	39	56	213	12.8%	7.14 [3.33, 15.28]
Sindiani et al 2023	45	65	27	155	13.2%	10.67 [5.45, 20.86]
Total (95% CI)		**90843**		**66372**	**100.0%**	**3.97 [1.88, 8.38]**
Total events	15746		10344			

Heterogeneity: $Tau^2 = 0.99$; $Chi^2 = 141.19$, $df = 7$ ($P < 0.00001$); $I^2 = 95\%$

Test for overall effect: $Z = 3.61$ ($P = 0.0003$)



- **META REGRESSION TO ASSESS THE SOURCE OF HETEROGENITY**
(of Low Birth Weight associated with HAEMOGLOBIN(Hb) levels

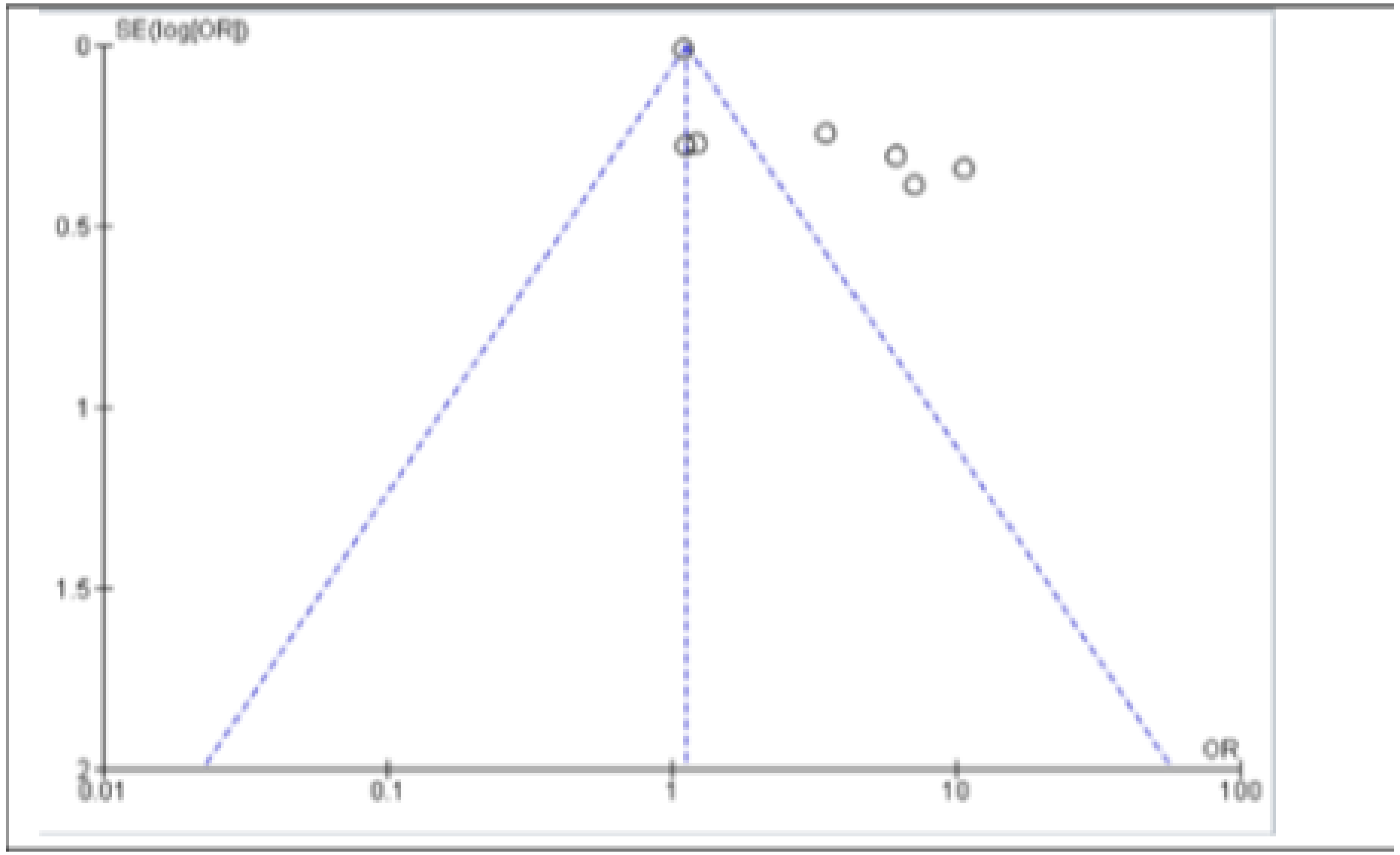


3D SCATTER PLOT OF EFFECT SIZE vs COVARIATES

```
P-values:
Intercept: 0.09142684751873327
sample_size: 0.023466074289432627
Duration: 0.035368627929949714
studyID: 0.0741792925412512
```

P-values for different covariates

- **PUBLIICATION BIAS AND EGGER's REGRESSION TEST**



Funnel plot

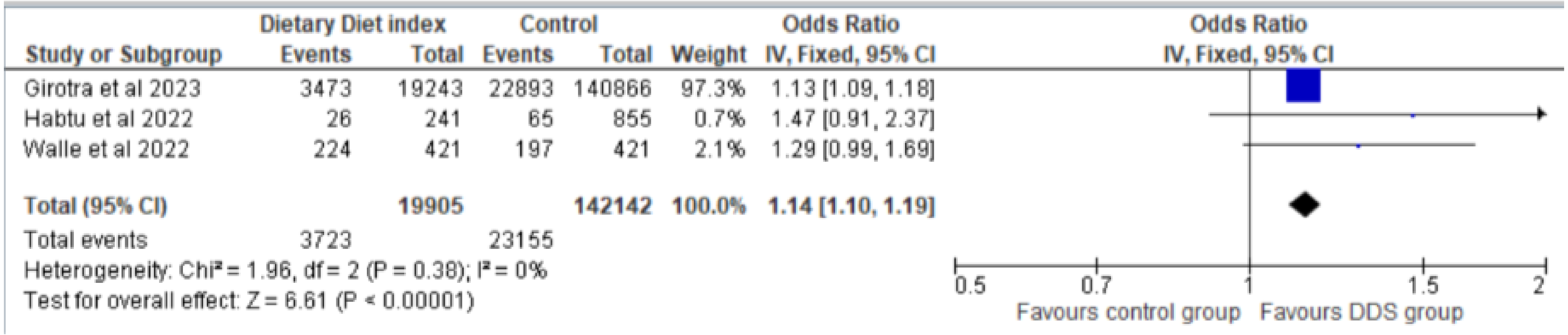
```python
import numpy as np
import statsmodels.api as sm


log_or = np.array([2.58, 3.89, 4.51, 1.09, 1.20, 1.06, 2.73, 3.97]) # effect sizes

se_log_or = np.array([0.20415467159765388,
 0.4748539735707475,
 0.3549092092375468,
 0.0036404872190515716,
 0.08709877432424935,
 0.11206507098323593,
 0.1691980185577489,
 0.49489102004551745]
)                                                   # standard errors

# Egger's test
X = sm.add_constant(1/se_log_or)
model = sm.OLS(log_or, X).fit()
intercept, slope = model.params
p_value = model.pvalues[1]  # P-value corresponding to the slope

print(f"Egger's test p-value: {p_value}")
```

```
Egger's test p-value: 0.2376543252464296
```

EGGER's REGRESSION TEST

DIIETARY DIVERSITY SCORE(DDS)

- FOREST PLOT of Low Birth Weight associated with DDS.



Study or Subgroup	Dietary Diet index Events	Dietary Diet index Total	Control Events	Control Total	Weight	Odds Ratio IV, Fixed, 95% CI
Girotra et al 2023	3473	19243	22893	140866	97.3%	1.13 [1.09, 1.18]
Habtu et al 2022	26	241	65	855	0.7%	1.47 [0.91, 2.37]
Walle et al 2022	224	421	197	421	2.1%	1.29 [0.99, 1.69]
Total (95% CI)		**19905**		**142142**	**100.0%**	**1.14 [1.10, 1.19]**
Total events	3723		23155			

Heterogeneity: Chi² = 1.96, df = 2 (P = 0.38); I² = 0%
Test for overall effect: Z = 6.61 (P < 0.00001)

CONCLUSION

The meta-analysis underscores the importance of maternal nutrition interventions in reducing low birth weight rates in developing nations. It identifies key associations with iron and folic acid supplementation, maternal hemoglobin levels, and dietary diversity score. While these findings are significant, additional research is essential to determine the most effective approaches for tackling this pressing public health issue.

Thankyou