
بسم الله الرحمن الرحيم

The Association Between Exposure to Ambient Particulate Matter and Childhood Obesity: A Systematic Review and Meta-analysis

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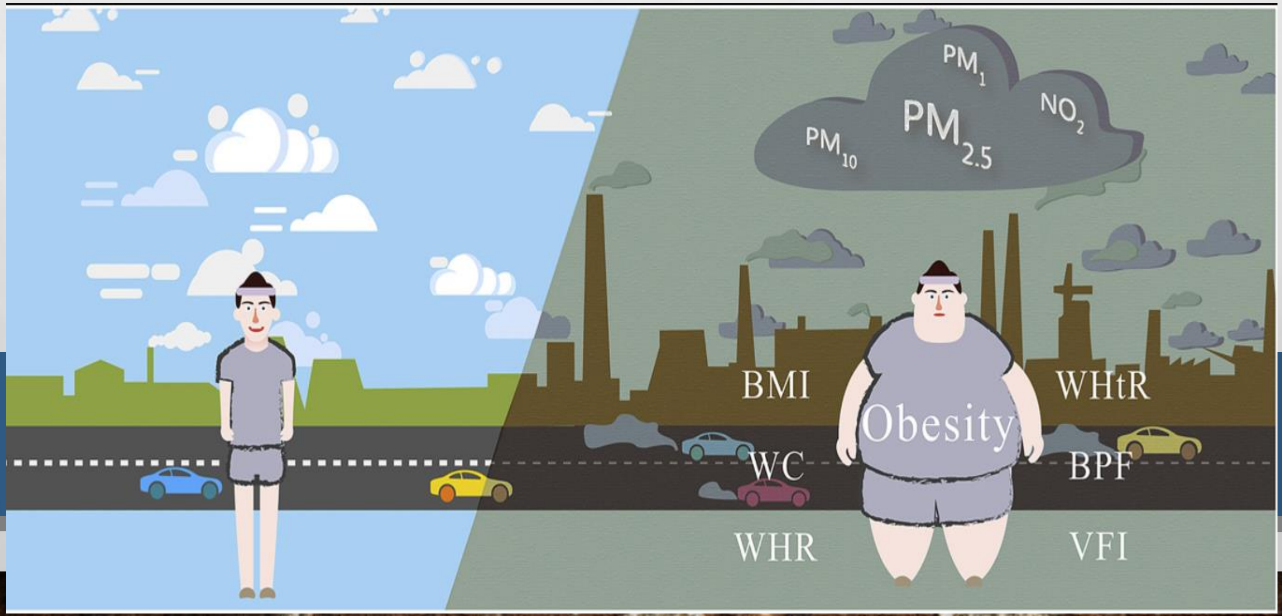


Introduction

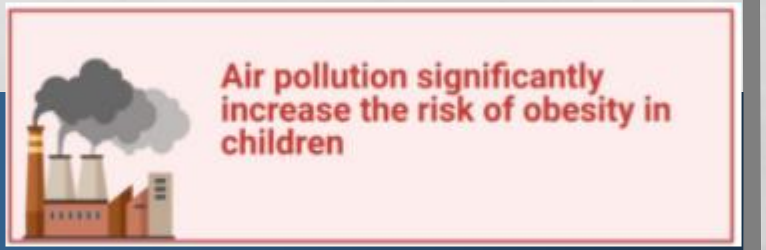
- Physical environment contamination and in particular, air pollution might cause long-term adverse effects in child growth and a higher risk of catching non-communicable diseases later in life.

Introduction

- Childhood obesity is a growing public health problem, even in developing countries .
- It is associated with several health complications during childhood, which will usually extend to adulthood .
- It has several underlying causes, both genetic and environmental factors .

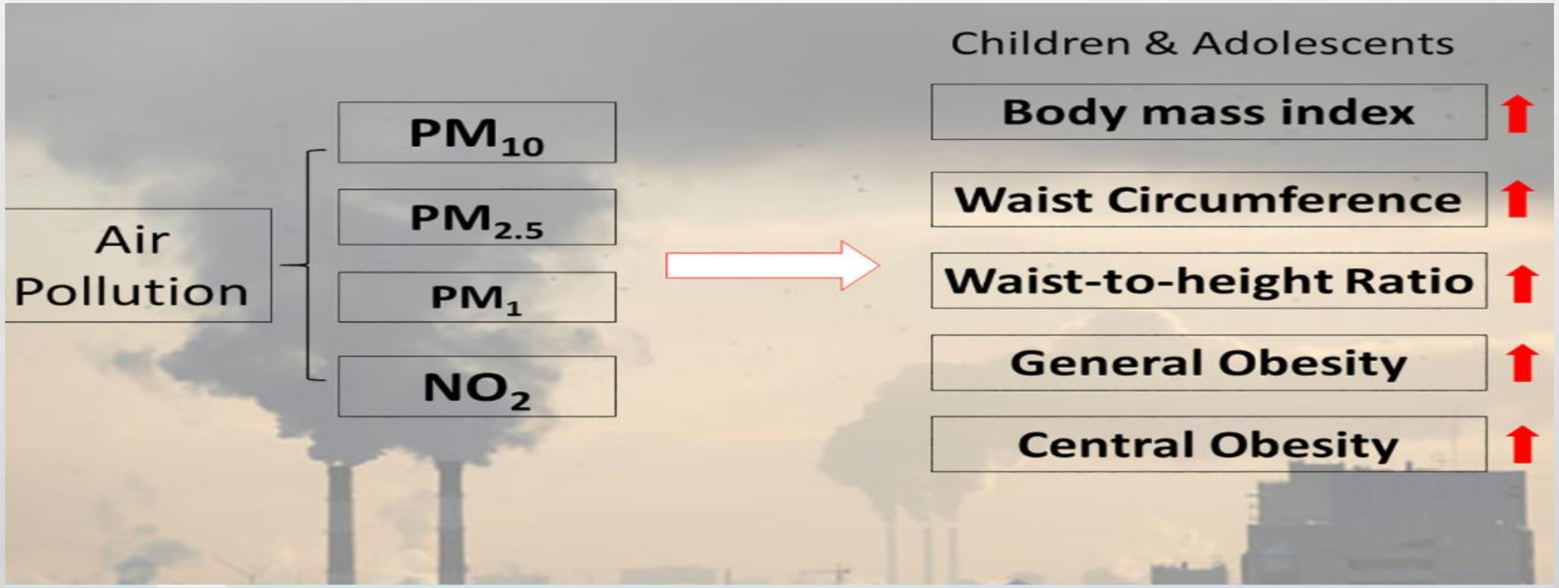
Introduction

- Recently, researchers have paid attention to the association between air pollution and obesity.
- Some studies suggest that ambient air pollution may increase the risk of cardiovascular diseases, diabetes and cancer in adults.
- However, little epidemiological evidence is available on the association of exposure to Ambient air pollution with obesity in children .



Purpose

- The objective of this study was to overview the studies on the association of exposure to ambient **particulate matter** (PM) with childhood obesity.



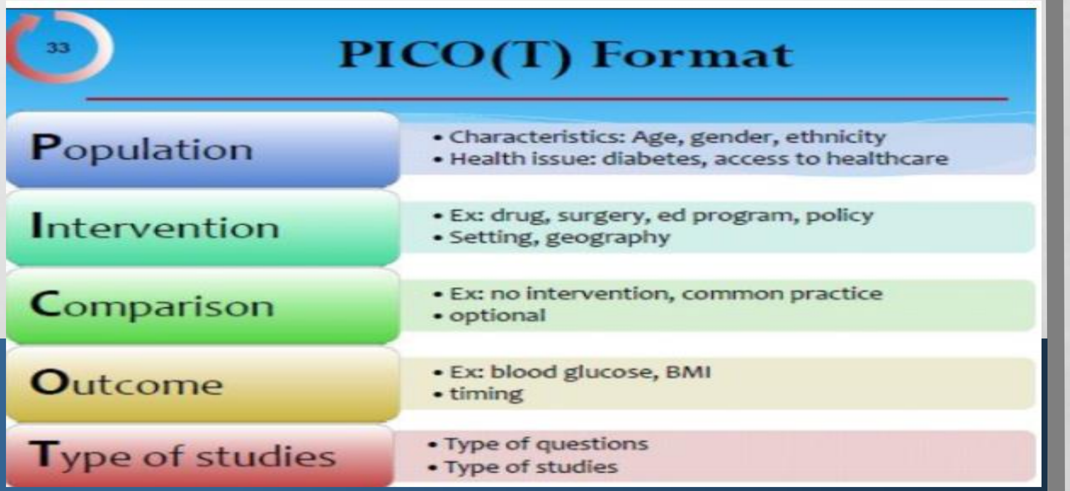
Material and methods

DATA SOURCES

- we performed a systematic review and meta-analysis of human studies that explored the association between PM exposure and childhood obesity.

Data sources

- We considered **PECO** as the following:
- Population : children and adolescents;
- Exposure : PM exposure;
- Comparison :(there is no comparison between exposed and non-exposed groups because we have reported the correlations of PM exposure and BMI);
- And outcome : childhood obesity (BMI).



Data sources

- We systematically searched human studies available on the study subject until march 2018 in **Pubmed, Scopus, Ovid, ISI web of science, Cochrane library, and Google scholar** databases.
- All cross-sectional and cohort studies were selected.

Search Strategy

- We used the search terms of

➢ “air pollution” OR “pollutants” OR “particulate matter”

➢ “obesity” OR “weight” OR “body mass index” OR “BMI” OR “overweight” OR “cardiometabolic” OR “metabolic syndrome” OR “metabolic syndrome X” OR “mets” OR “adiposity”

➢ “child” OR “adolescent” OR “school-aged” OR “youth” OR “teenager” OR “boy” OR “girl” OR “student” OR “pediatrics”

in the form of medical subject headings (mesh) and truncations.

- The relevant articles were examined without any language restriction.

STUDY SELECTION

- After removing the duplicates, the relevant papers were selected in three phases.
- In the first and the second phases, titles and abstracts of papers were screened, and the irrelevant papers were excluded.
- In the third phase, the full texts of the remaining papers were explored carefully to select only the relevant papers.
- To find any additional pertinent study, the reference list of all reviews and related papers were screened as well.

Study selection

- The inclusion criteria were as follows:
- 1. Observational cross-sectional design;
- 2. Longitudinal Cohort studies which report the study association;
- 3. Measurement of PM concentration as an index for air Pollution exposure;
- 4. Reporting the odds ratio (OR), relative risk (RR), and β-coefficient of PM with Child obesity.

DATA EXTRACTION

- Two reviewers extracted the data independently using a data collection form, including the first author’s name, publication year, sample size, study design, as well as age, exposure measurement, statistical analysis, and the variables adjusted in the analyses.

Quality assessment

- Two reviewers evaluated the quality of each study.
- The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist was used for the quality assessment of the papers.
- According to STROBE ,the studies were divided into three Groups.
- The studies scored 1-8 were ranked as **low-quality studies**,
- 9-16 as **medium-quality papers**,
- and 17-22 as **high-quality papers**.

STATISTICAL ANALYSIS

- The effect sizes of RR, OR, and β-coefficient from all articles were extracted .
- All effect sizes were transformed into (r: correlation), and fisher z-transformation of the r value was applied for the pooled analysis .

Statistical analysis

- The potential **heterogeneity** across studies was evaluated using the cochran's Q test and was expressed using the I2 index.
- The pooled results for fisher z-transformation were calculated by the fixed-effects model (for low heterogeneity) or the random-effects model (for high heterogeneity).

Statistical analysis

- **Publication bias** was evaluated by the egger's and the begg's tests.
- **Subgroup analyses** and **meta-regression** were performed to seek **the sources of heterogeneity**.
- The sensitivity analyses were performed by omitting one study at a time to gauge the robustness of our results.
- All statistical analyses were conducted in stata v. 14. 0.

Results

- We initially retrieved 4391 articles from the databases.
- Figure 1 represents the search results.
- After the initial study of the titles and abstracts, the duplicate papers were omitted, and out of 4276 papers, five articles remained.
- No additional references were identified through checking the reference lists of selected papers.

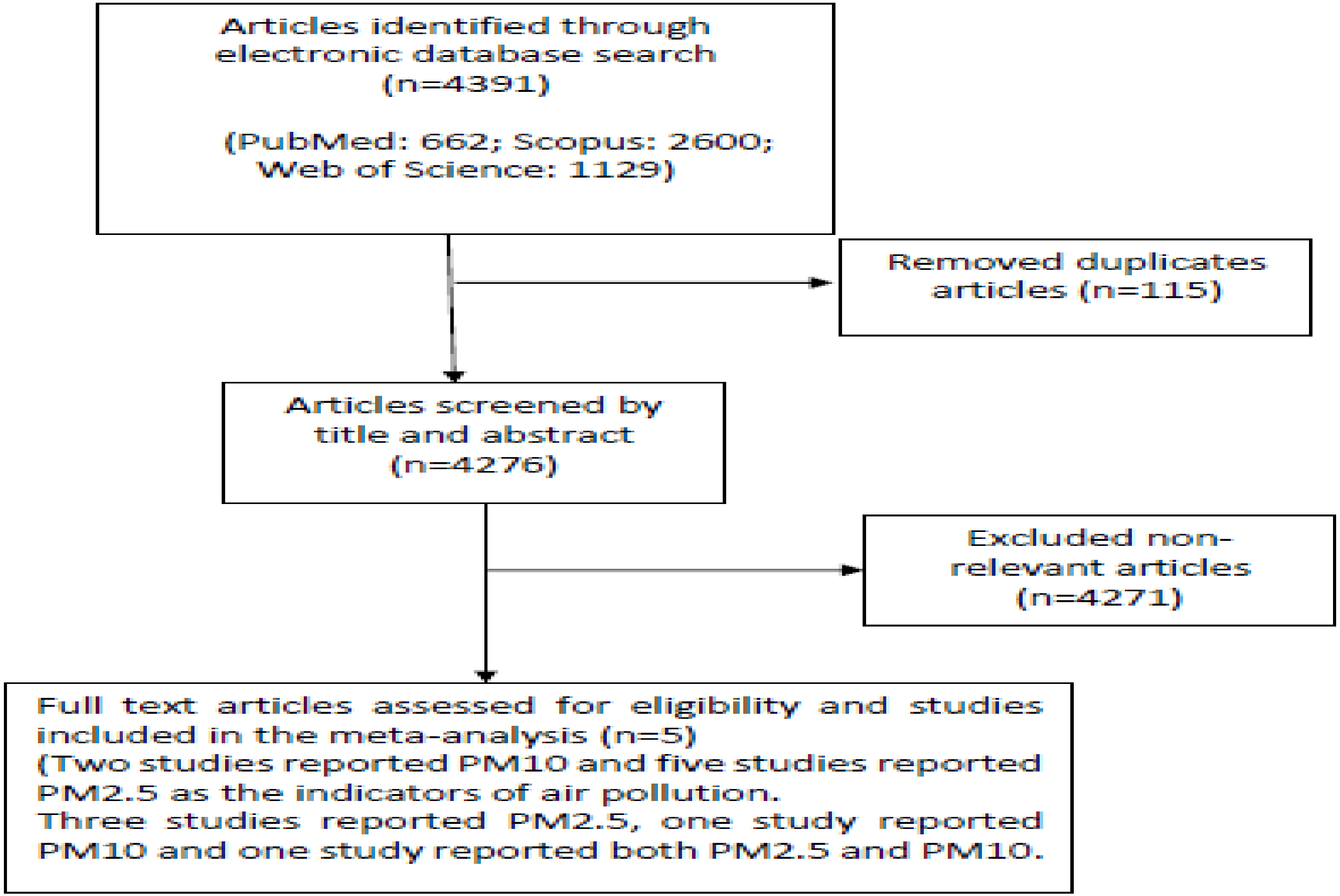


Figure 1. The flowchart of the search results

- The main characteristics of the studies included in the systematic review are presented in appendix 1.
- Overall, the studies reported data on 33825 subjects, and they were published between 2010 and 2018.

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Author(s)/ Date	Study Location	Study Design	Follow Up Duration	Sample Size	Age (y)	Outcome	Exposure Assessment Method	Exposure	Group / Subgroups	Effect Size CI (95%)	Adjustment Factors
Michael Jerrett, 2010	Southern California, USA	Cohort	8-year follow-up	2889	10–18 years	Body Mass Index (BMI)		Traffic-related air pollution	Annual average daily traffic (AADT) 150 m	B (SE): 0. 0039 (0. 0008)	Gender, cohorts variables parental education, personal weekly smoking, second hand smoke (current + past), ever asthma, buffer population, gamma index, proportion of below poverty people within census block, normalized difference vegetation index (NDVI), foreign-born, community-level violent crime rate, and having no food stores within 500-m road network buffer with random community effects
									AADT 300 m	0. 0013 (0. 0008)	
Pei, 2013	Germany	Cohort	10-year follow-up	3121 Females (N=1114), Males (N=1158)	10 (We predicted standardized body mass index (BMI) at 10 years of age using standardized BMIs from birth to 5 years.)		Maternal smoking during pregnancy			β (CI): 0. 13 (0. 03, 0. 22)	Parental education, family income, and maternal smoking during pregnancy
Michael Jerrett (2014)	Southern California, USA	Cohort	4-year follow-up	N=4550	5–11 years				Traffic density	B (SE) 0. 0002 (0. 0001)	Having asthma, parental education, immigrant status, the measure of green cover, street connectivity, recreational programming within 5 km of the home, and fast food access within 500 m of the home
									Non-Freeway NOx	0. 0861 (0. 0255)	

Author(s)/ Date	Study Location	Study Design	Follow Up Duration	Sample Size	Age (y)	Outcome	Exposure Assessment Method	Exposure	Group / Subgroups	Effect Size CI (95%)	Adjustment Factors
Guang-Hui Dong, 2014	China	Cross-sectional	-	30056	2-14	Obesity BMI> 95th percentile	Measurements of ambient PM_{10}, SO_2, NO2, and O_3 concentrations from 2006 to 2008 were obtained at municipal air pollution monitoring stations.	PM_{10} ($\mu g/m^3$) SO_2 (ppb) NO2 (ppb) O_3 (ppb)		OR(CI): 1. 19 (1. 11–1. 26) 1. 11 (1. 03–1. 20) 1. 13 (1. 04–1. 22) 1. 14 (1. 04–1. 24)	Age, gender, parental education, breast feeding, low birth weight, area of residence per person, house decorations, home coal use, ventilation device in the kitchen, air exchange in winter, passive smoking exposure, and districts
Rob McConnel, 2015	Southern California, USA	Cohort	8-year	3318	10-18	BMI	Residential near-roadway pollution exposure (NRP) was estimated based on a line source dispersion model accounting for traffic volume, proximity, and meteorology	Secondhand smoke		BMI growth (95%CI): One smoker at home: 0. 48 (0. 16, 1. 12) Two or more than 2 smokers at home: 1. 08 (0. 19, 1. 97) Maternal smoking during pregnancy: 0. 72 (0. 14, 1. 31) NRP: 1. 13 (0. 61, 1. 65). The difference in the attained BMI (95%CI): One smoker at home: 0. 95 (0. 42, 1. 47) ≥ 2 smokers at home: 1. 77 (1. 04, 2. 51 Maternal smoking during pregnancy; 1. 14 (0. 66, 1. 62	Ethnicity, sex, community, year of enrollment, and age

Author(s)/ Date	Study Location	Study Design	Follow Up Duration	Sample Size	Age (y)	Outcome	Exposure Assessment Method	Exposure	Group / Subgroups	Effect Size CI (95%)	Adjustment Factors
Fleisch, 2016	Boston, USA	Cohort	Early childhood (median: 3. 3 years of age) mid-childhood (median: 7. 7 years of age)	1418	Mean (standard deviation) of age at early childhood visit 3. 3 (0. 4), and at mid-childhood visit 8. 0 (0. 9)	BMI z-score	Spatiotemporal models to estimate prenatal and early life residential $PM_{2.5}$ and black carbon exposure as well as traffic density and roadway proximity.			3. 3 years	Child (age, sex and race/ ethnicity), mother (age, education, and smoking during pregnancy), neighborhood (census tract median income), season and date of health outcome
								$PM_{2.5}$ (µg/m³)	Third trimester	0. 0 (-0. 1, 0. 1)	
									Year prior to early childhood visit	-0. 0 (-0. 1, 0. 1)	
								Near-residence traffic density	Birth address	0. 0 (-0. 0, 0. 1)	
									Early childhood address	0. 0 (-0. 0, 0. 1)	
								Proximity to major roadway, birth address Reference:≥200m	<50m	0. 3 (0. 0, 0. 7)	
									[50, 100m]	-0. 0 (-0. 4,0. 3	
									[100, 200m]	0. 4 (0. 1, 0. 6)	
								Proximity to major roadway, early childhood address Reference:≥200m	<50 m	0. 1 (-0. 2, 0. 5)	
									[50, 100 m]	-0. 0 (-0. 4, 0. 3)	
									[100, 200 m]	0. 1 (-0. 2, 0. 3)	
Yueh-HsiuMathildaChiua 2017	Boston, USA	Cohort	4. 0±0. 7 years	239		BMI, z-score	Prenatal daily $PM_{2.5}$ exposure was estimated using a validated satellite-based spatiotemporal model. Prenatal $PM_{2.5}$ level (µg/m³) Median IQR 10. 7(9. 9–11. 4)	$PM_{2.5}$ (µg/m³)	Girls	-0. 12 (-0. 37,-0. 03)	Maternal age, race/ ethnicity, education, pre-pregnancy BMI, and child's age at anthropometric measurement
									Boys	0. 21 (0. 003,-0. 37)	

Author(s)/ Date	Study Location	Study Design	Follow Up Duration	Sample Size	Age (y)	Outcome	Exposure Assessment Method	Exposure	Group / Subgroups	Effect Size CI (95%)	Adjustment Factors
Tanya. Alderete, 2017	Los Angeles, USA	Cohort	3. 4 years	314 overweight and obese children	8-15 years	BMI	NO2 and $PM_{2.5}$ were modeled as long-term exposure using cumulative 12-month averaged exposure during the follow-up. Estimated effect estimates were reported for a A 5-ppb difference in NO2 and a 4-μg/m³ difference in $PM_{2.5}$	NO_2 (ppb) $PM_{2.5}$ (μg/m³)		2. 1 (0. 1, 4. 1) 3. 8 (1, 6. 6)	Sex, Tanner stage, the season of testing (warm/cold), prior year exposure at each follow-up visit, social position, body fat percentage (where appropriate), study wave, and study entry year
Poursafa, 2017	Iran	Cross-sectional	—	186	6-18	BMI	The air quality index (AQI) is used to describe the level of air pollution with adverse health effects. We used $PM_{2.5}$ data.			B=0. 34	Age and gender
Sara Fioravant, 2018	Italy	Cohort	8-year follow-up	581	Birth-8 years	Prevalence of overweight/ obesity was 9. 3% and 36. 9%	Air pollution was assessed at the residential address	NO2 (per 10 μg/m³) NOX (per 20 μg/m³) PM_{10} (per 10 μg/m³) $PM_{2.5}$ (per 5 μg/m³) PMcoarse (per 5 μg/m³) $PM_{2.5}$abs (per 1 μg/m³)		0. 99 (0. 86, 1. 12) 0. 98 (0. 86, 1. 12) 0. 971 (0. 77, 1. 23) 1. 02 (0. 75, 1. 40) 0. 91 (0. 77, 1. 09) 1. 10 (0. 88, 1. 37)	Maternal and paternal education, maternal pre-pregnancy BMI, maternal smoking during pregnancy, gestational diabetes, maternal age at delivery, gestational age, childbirth weight, breast-feeding duration, age (in months) at weaning
Guangyun Mao, 2017	Boston, USA	Cohort	2-year follow-up	1,446	first 2 years of life			Comparing the highest and lowest quartiles of PM (2:5 μg/m³)		The adjusted Relative Risks (RRs) 1. 3 (1. 1, 1. 5)	Maternal age at delivery, race/ ethnicity, education level, smoking status, diabetes, marriage status, household income per year, the season of childbirth, preterm birth, birth weight, and breastfeeding

6. 1. META-ANALYSIS OF THE CORRELATIONS

- Figure 2 showed the pooled results using random effect model.
- It showed that PM exposure was associated with the increased BMI (fisher-z= 0. 022; 95% ci (-0.057, 0. 102)) that overall effect size was not significant and heterogeneity of the included studies was as same fixed effect model.

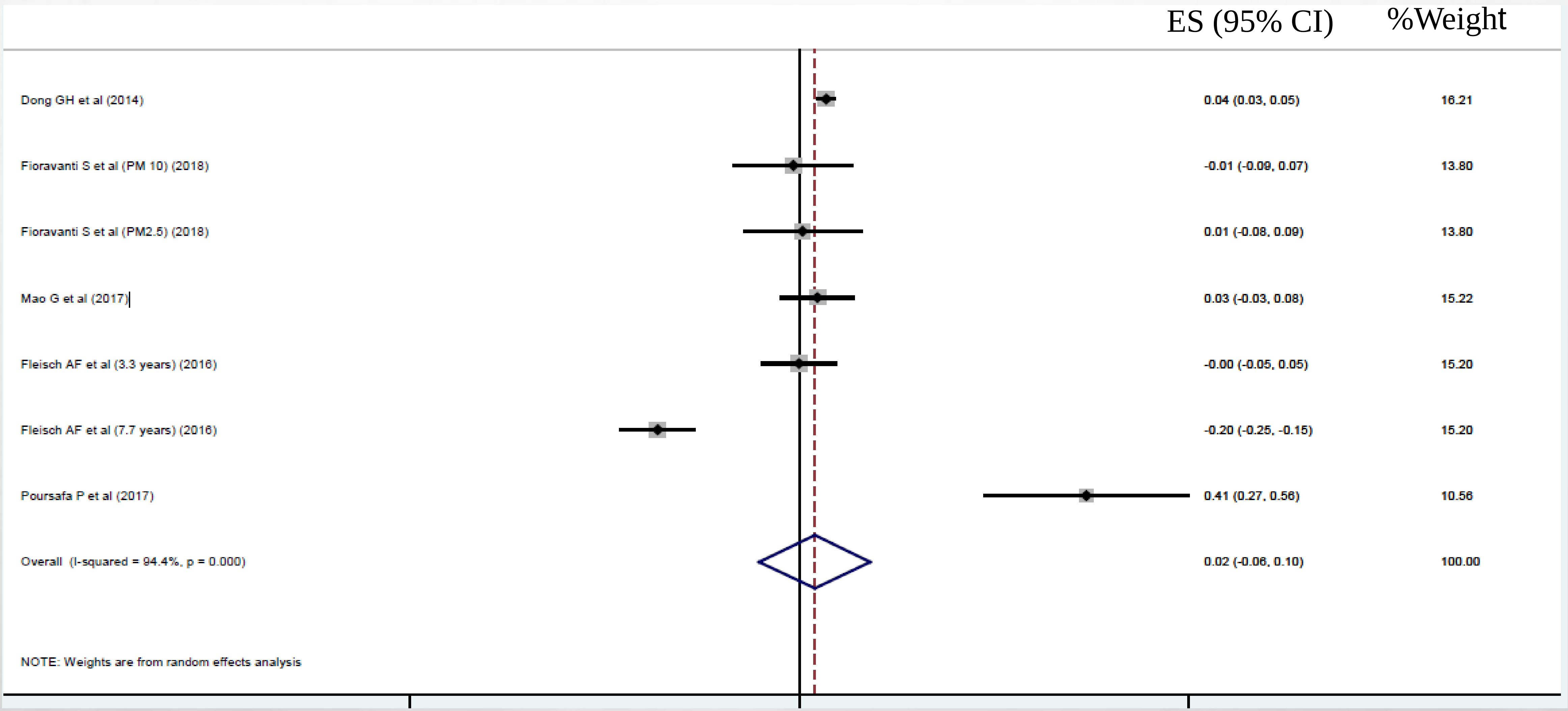

Figure 2. Forest plot of Fisher's z values indicating the correlation between PM and BMI

Table 1. Results of meta-regression analyses for the potential source of heterogeneity

Covariate		B	SE	P	95% CI
Year of publication		0. 016	0. 056	0. 790	(-0. 128, 0. 159)
Mean age		0. 040	0. 030	0. 243	(-0. 038, 0. 118)
PM2. 5 (Ref, PM10)		0. 024	0. 162	0. 889	(-0. 392, 0. 440)
Sample size of study		-0. 0000002	0. 000007	0. 974	(-0. 00002, 0. 00002)
Study location: (Ref. : Asia)	USA	-0. 264	0. 144	0. 107	(-0. 664, 0. 136)
	Europe	-0. 207	0. 159	0. 109	(-0. 649, 0. 235)
Study type: Cohort (Ref: Case control)		-0. 238	0. 121	0. 107	(-0. 550, 0. 074)

SE: Standard Error; CI: Confidence Interval

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The analyses indicated that none of the factors contributed to the heterogeneity of meta analysis

Table 2. Results of subgroup analysis on the association between PM and BMI

Variables	Groups	NO. of Study	Effect Size (Fisher' z) 95% CI	P	Heterogeneity	
					I^2 (%)	P
PM type	10	2	0. 034 (0. 007, 0. 061)	0. 015	16. 60	0. 274
	2. 5	3	0. 035 (-0. 099, 0. 169)	0. 606	95. 30	< 0. 001
Study type	Cross-sectional	2	0. 218 (-0. 148, 0. 583)	0. 243	96. 10	< 0. 001
	cohort	3	-0. 037 (-0. 132, 0. 057)	0. 442	91. 60	< 0. 001
Study location	Asia	2	0. 218 (-0. 148, 0. 583)	0. 243	96. 10	< 0. 001
	Europe	1	-0. 001 (-0. 06, 0. 057)	0. 961	0. 00	0. 818
	USA	2	-0. 059 (-0. 2, 0. 083)	0. 416	95. 50	< 0. 001

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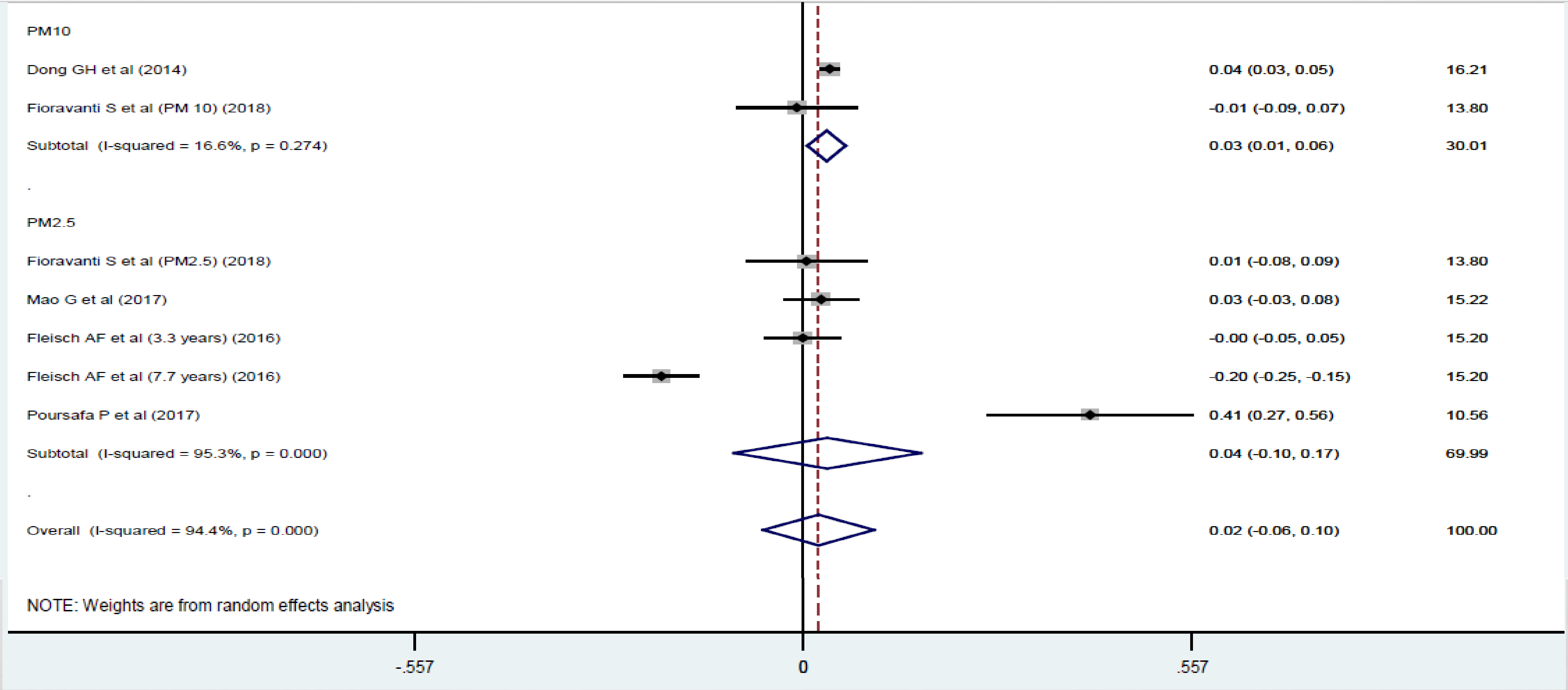
We observed significant association between PM10 exposure and the increased BMI

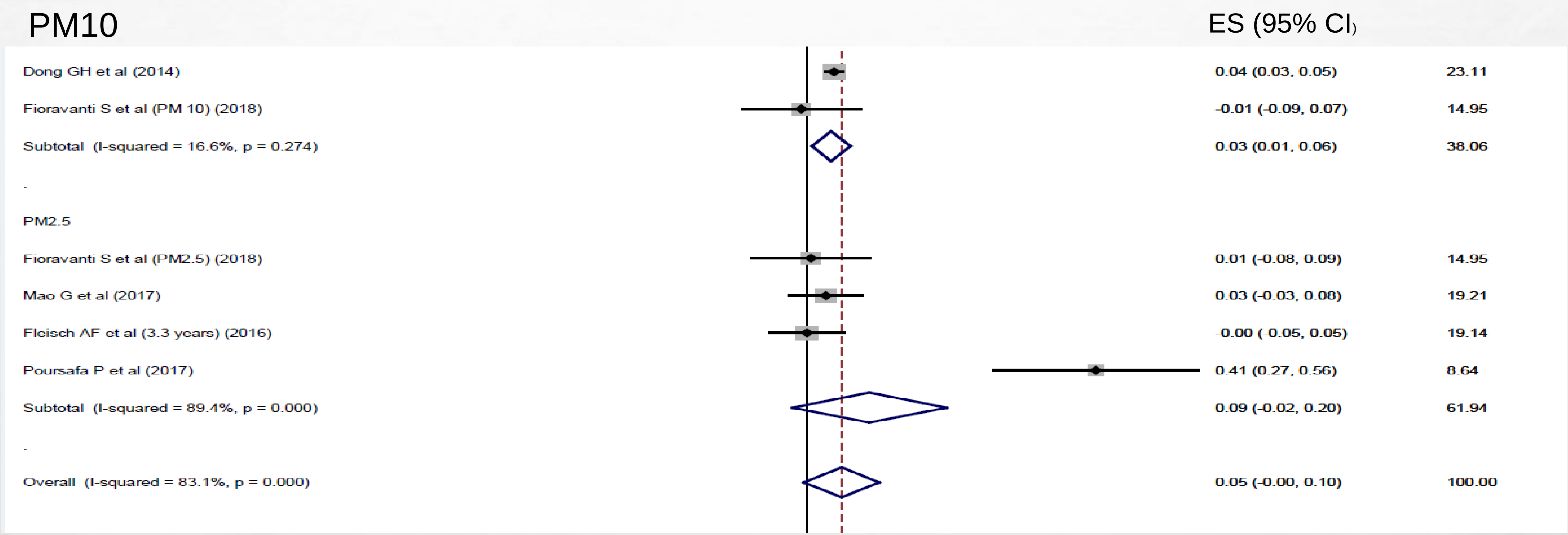
Figure 3. Forest plot of Fisher’s z values indicating the correlation between PM and BMI by PM type



It suggests that the PM type may account for the heterogeneity among the studies on BMI.

Publication bias

- Begg’s test and egger’s test revealed no obvious publication bias among these studies.
- The p-values for these tests were higher than 0. 05 (p=0. 661 and 1. 0, respectively).



- The results of sensitivity analyses showed that with excluding the study of fleisch AF et al. (7. 7 years), the pooled fisher's z for the subgroup PM2. 5 increased.
- Although this change was not significant, it decreased the overall heterogeneity (I2=83. 1%, p<0. 001) (figure 4).

Figure 4. Forest plot of Fisher's z values, indicating the correlation between PM and BMI by PM type after excluding the study of Fleisch AF et al (7. 7 years)

Table 3. The correlation between PM exposure and BMI

Variables	Effect Size			Heterogeneity		
	Pooled r	95% CI	P	I^2	P	τ^2
PM10	0. 034	(0. 007, 0. 061)	0. 015	16. 60%	0. 0002	0. 0002
PM2. 5	0. 035	(-0. 099, 0. 167)	0. 606	95. 30%	0. 0216	0. 022
overall	0. 022	(-0. 057, 0. 102)	0. 579	94. 40%	0. 0101	0. 010

τ^2: Between-studies variance

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Table 3 Presents the results of converting fisher's z values into correlation values.

We found a significant relationship between PM10 and BMI (r=0. 034, p=0. 015), but the association of PM2. 5 and BMI was not statistically significant (r=0. 035, p=0. 606).

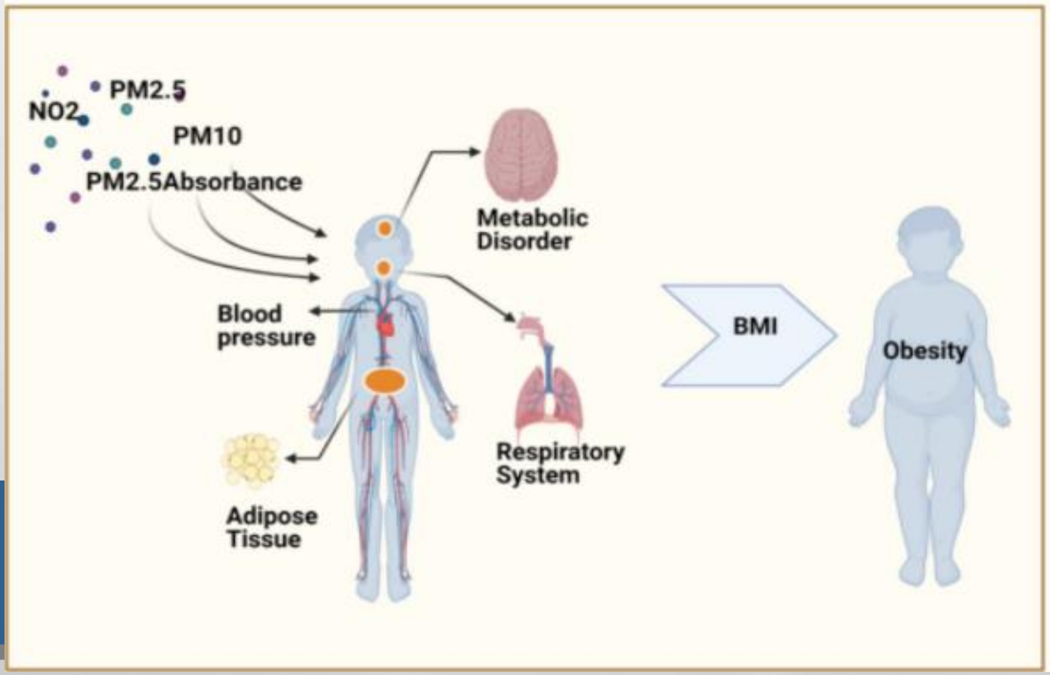
DISCUSSION

- This systematic review and meta-analysis revealed a weak positive association between ambient PM10 and child obesity.
- However, the results for PM2. 5 was not significant.

- Five of the seven studies included in the current Meta-analysis reported the direct association of air Pollution and child weight, whereas two cohort studies Did not report such association .

- Such discrepancies among these studies results may be due to confounding factors like age, sex, ethnicity, physical activity, level of exposures, and some other factors.
- These findings might be confounded by heterogeneity due to multiple dispersions between studies such as study design, different techniques to measure PM concentration, the way PM levels is reported, and other various confounders which were adjusted in the analysis.

- The mechanisms linking air pollution to obesity risk and type-2 diabetes are not entirely determined.
- The effects of air pollutants on immune response, oxidative stress, and insulin resistance might explain the results .



- Animal studies suggest that higher exposure to air pollutants might result in increased adipose tissue inflammation, accumulation of glucose in skeletal muscles, and therefore it might contribute to metabolic dysfunction and obesity .

- The findings of the current study should be considered with caution.
- The cross-sectional design of some studies used for this meta-analysis might preclude any causality.
- Another limitation is the high heterogeneity between studies.
- Other potential risk factors like child physical activity, socioeconomic status, and climate conditions were not available in some studies.

CONCLUSIONS

- This systematic review and meta-analysis indicate that exposure to PM10 has a positive association with childhood obesity.
- This finding should be considered in future studies and preventive programs.
- Our results are also useful for health policymakers and health care providers to design health promotion interventions and preventive strategies.
- More research is needed to clarify the effect of other ambient air pollutants on child health status.

Thank you for your attention