# Metabolic and neurocognitive outcomes in Southern Italian preadolescents residing near an industrial complex: the role of residential location and socioeconomic status

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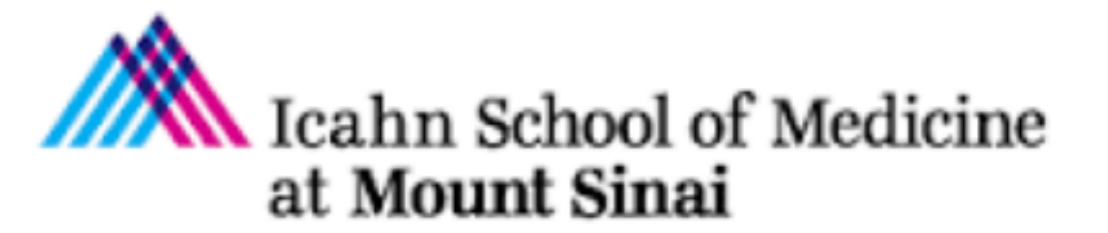
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Background:
Long-term exposure to industrial pollutants is a serious environmental health concern, yet its metabolic and cognitive outcomes in children remain unclear. This study describes trends in body mass index (BMI) Z-score, blood glucose concentration (BG), and neurocognitive function among a cohort of urban Italian children living near an industrial complex, in terms of residential proximity to the complex and socioeconomic status (SES).

Methods:
These analyses included 214 children ages 6-11 that resided uniquely in one of three zones within the municipality of Taranto, Italy since gestation. Participants were grouped into zones based on the distance between their residence and the external perimeter of the industrial pole (Zone 1: 0.00-4.99km, Zone 2: 5.00-9.99km, Zone 3: 10.00-15.00km). BMI Z-scores were calculated based on World Health Organization (WHO) pediatric BMI reference curves and thresholds. Scores for IQ and other neurocognitive subindices were obtained via the Wechsler Intelligence Scale for Children (WISC-IV).

Results:
Residential distance from the industrial complex was negatively associated with BMI-adjusted BG (p<0.05). Zone 1 participants had higher BG than Zone 2 and Zone 3 participants (p<0.05 vs. Zone 2; p<0.01 vs. Zone 3). Low SES participants did not have significantly different BG than medium SES or high SES participants. Zone 1 participants scored below Zone 2 and Zone 3 participants on overall IQ and subindices of: cognitive proficiency (CPI), general ability (GAI), working memory (WMI), verbal comprehension (VCI), and perceptual reasoning (PRI) (p<0.05 or less). Compared with high SES participants, low SES participants also scored significantly lower on: IQ, CPI, GAI, WMI, VCI, and PRI (p<0.05 or less).

Table 1. Sociodemographic & physical characteristics of study cohort [mean(±SD) or n(%)]

Characteristic	Total (N = 214)	Zone 1 (N = 62)	Zone 2 (N = 77)	Zone 3 (N = 75)
Sex (F)	114 (53.3%)	39 (62.9%)	38 (49.4%)	37 (49.3%)
Age (years)				
Mean (SD)	8.6 (±1.5)	8.9 (±1.6)	8.2 (±1.4)	8.6 (±1.5)
Weight (kg)				
Mean (SD)	33.1 (±10.1)	35.4 (±10.9)	31.5 (±9.4)	33.0 (±10.0)
Height (cm)				
Mean (SD)	133.6 (±11.5)	134.5 (±13.5)	132.3 (±10.6)	134.0 (±10.8)
BMI Percentile & Z-Scores				
Mean (SD)	0.8 (±1.5)	1.1 (±1.5)	0.62 (±1.5)	0.66 (±1.6)
Underweight (0.00-4.99%)	9 (4.2%)	2 (3.2%)	5 (6.5%)	2 (2.7%)
Healthy (5.00-84.99%)	109 (50.9%)	27 (43.6%)	39 (50.6%)	43 (57.3%)
Overweight (85.00-94.99%)	47 (22.0%)	16 (25.8%)	20 (26.0%)	11 (14.7%)
Obese (95.00-100.00%)	49 (22.9%)	17 (27.4%)	13 (16.9%)	19 (25.3%)
Socioeconomic Status				
Low	91 (42.5%)	41 (66.1%)	26 (33.8%)	24 (32.0%)
Medium	70 (32.7%)	16 (25.8%)	25 (32.5%)	29 (38.7%)
High	53 (24.8%)	5 (8.1%)	26 (33.8%)	22 (29.3%)
BG (mg/dL)	(N = 212)	(N = 62)	(N = 76)	(N = 74)
Mean (SD)	85.5 (±6.6)	87.8 (±6.3)	85.5 (±7.1)	83.5 (±5.6)

Table 2. Associations of sociodemographic factors to: BMI Z-score & BMI-adjusted BG(mg/dL)

Sociodemographic Variable	BMI Z-Score	BG adjusted by BMI Z-Score
BMI Z-Score		0.337
		(-0.254, 0.928)
Zone 2 vs Zone 1	-0.223	-2.518*
	(-0.755, 0.309)	(-4.813, -0.224)
Zone 3 vs Zone 1	-0.052	-4.638***
	(-0.606, 0.501)	(-7.020, -2.255)
SES: Medium vs Low	-0.23	1.453
	(-0.729, 0.269)	(-0.699, 3.606)
SES: High vs Low	0.199	1.71
	(-0.699, 1.096)	(-2.157, 5.576)
Maternal Education: 13 years vs 5-8 years	-0.539*	-0.203
	(-1.056, -0.023)	(-2.450, 2.044)
Maternal Education: 16+ years vs 5-8 years	-1.031*	-0.761
	(-2.014, -0.048)	(-5.037, 3.514)
Constant	1.347***	87.036***
	(0.934, 1.760)	(85.089, 88.983)
R²	0.061	0.086
Adjusted R²	0.034	0.054
Residual Standard Error	1.488 (df = 204)	6.405 (df = 203)
F Statistic	2.227* (df = 6; 204)	2.726* (df = 7; 203)

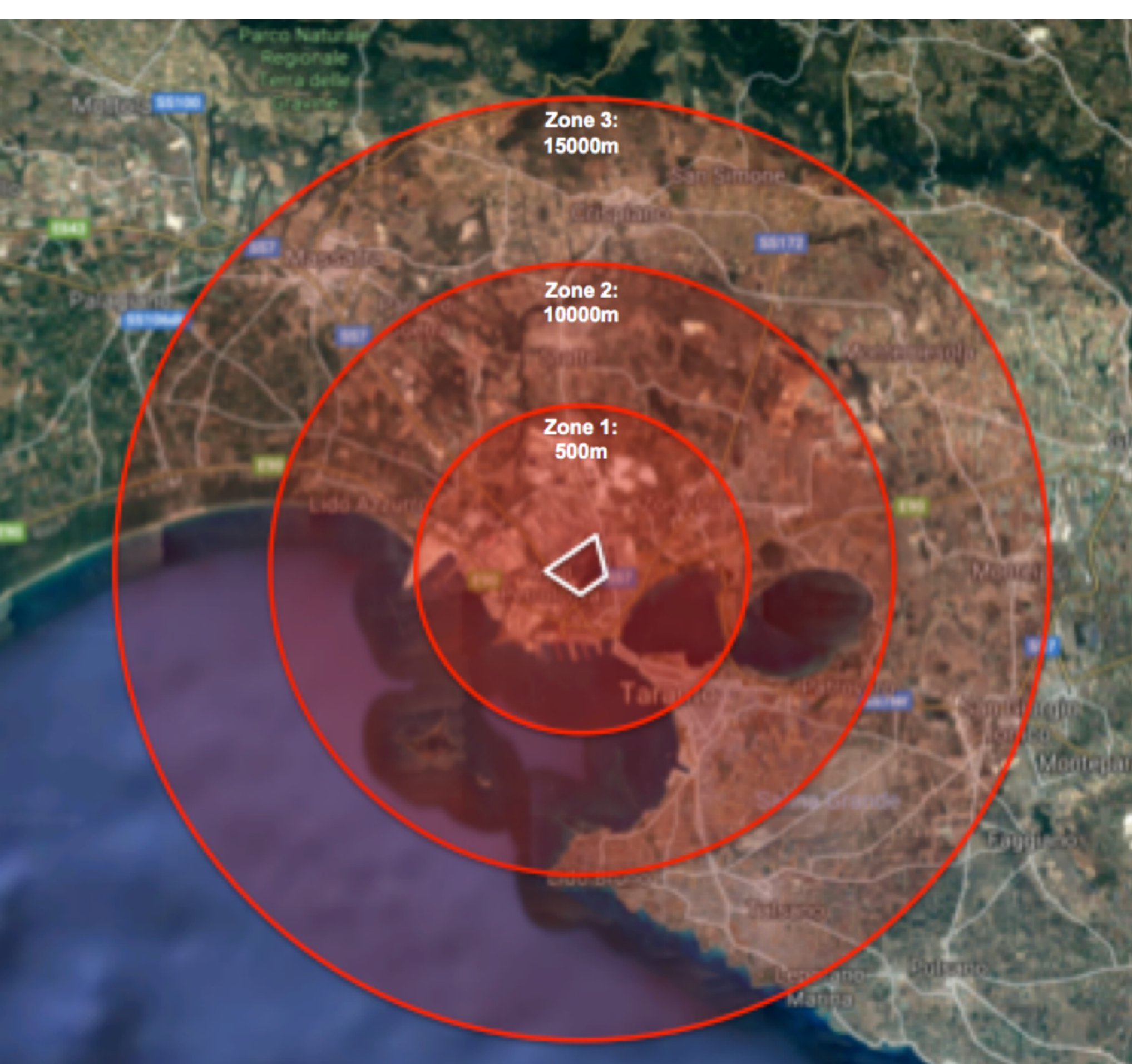*Note: . p<0.1, * p<0.05, ** p<0.01, *** p<0.001*

Figure 1. Geographic representation of residential zones (circles) in relation to industrial complex (polygon)

Table 3. Associations of sociodemographic factors to overall IQ & subindices on the WISC-IV intelligence test

Sociodemographic Variable	IQ	CPI	GAI	WMI	PSI	VCI	PRI
Zone 2 vs Zone 1	6.624**	5.897*	6.143*	8.867***	1.723	6.002*	8.342**
	(1.704, 11.545)	(0.809, 10.985)	(0.886, 11.400)	(4.057, 13.676)	(-3.635, 7.082)	(0.537, 11.466)	(3.263, 13.422)
Zone 3 vs Zone 1	7.282**	6.587*	5.620*	7.207**	0.802	7.992**	6.535*
	(2.325, 12.240)	(1.464, 11.709)	(0.181, 11.059)	(2.272, 12.143)	(-4.567, 6.171)	(2.354, 13.629)	(1.375, 11.694)
Medium SES vs Low SES	1.095	0.539	1.865	-0.602	2.985	4.01	-1.064
	(-3.300, 5.490)	(-4.003, 5.081)	(-2.975, 6.705)	(-5.014, 3.810)	(-1.889, 7.860)	(-1.016, 9.036)	(-5.652, 3.525)
High SES vs Low SES	5.687*	3.808	5.809*	4.021	1.658	9.106**	1.428
	(0.429, 10.945)	(-1.550, 9.166)	(0.396, 11.222)	(-0.901, 8.943)	(-3.840, 7.155)	(3.419, 14.793)	(-3.785, 6.641)
Maternal SPM	0.145**	0.093*	0.147**	0.076.	0.085.	0.041	0.177***
	(0.057, 0.232)	(0.006, 0.179)	(0.055, 0.240)	(-0.010, 0.162)	(-0.004, 0.174)	(-0.054, 0.136)	(0.088, 0.267)
Constant	88.954***	88.997***	91.418***	87.296***	94.280***	96.795***	88.116***
	(82.705, 95.204)	(82.842, 95.152)	(84.838, 97.998)	(81.293, 93.298)	(87.931, 100.629)	(90.111, 103.479)	(81.820, 94.412)
R²	0.185	0.112	0.167	0.146	0.04	0.157	0.172
Adjusted R²	0.163	0.089	0.144	0.122	0.013	0.132	0.151
Residual Standard Error	13.344 (df = 192)	13.537 (df = 187)	13.785 (df = 179)	12.681 (df = 180)	13.980 (df = 180)	14.005 (df = 167)	13.627 (df = 190)
F Statistic	8.694*** (df = 5; 192)	4.733*** (df = 5; 187)	7.032*** (df = 5; 175)	6.116*** (df = 5; 179)	1.491 (df = 5; 180)	6.237*** (df = 5; 167)	7.919*** (df = 5; 190)

Conclusion: These results offer new evidence that residing near industrial activity is a significant predictor for adverse effects on the metabolic and neurocognitive health of children. This study provides useful evidence for the design of public health policies and interventions for children living in the setting of industrial activity.