

Supporting Information

Exposure to Aluminum, Cadmium, and Mercury and Autism Spectrum Disorder in Children: A Systematic Review and Meta-Analysis

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Key words: Aluminum, Cadmium, Mercury, Autism spectrum disorder, Systematic review, Meta-analysis

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Table S1 Differences of Exposure to Cadmium, Aluminum and Mercury (Mean and Standard Deviation, SD) Between the Case and Control Groups from Meta-analysis Based on the Studies Reported Mean and Standard Deviation.

Exposure	Sample	Case (n)	Control (n)	Mean (SD) Case	Mean (SD) Control	T-test (p – value)
Cadmium	Hair	329	608	0.45 (0.13)	0.72 (0.17)	< 0.001
Cadmium	Urine	116	120	0.31 (0.15)	0.45 (0.24)	< 0.001
Aluminum	Blood	240	214	21.8 (14.6)	29.8 (22.2)	< 0.001
Aluminum	Hair	316	465	23.5 (12.1)	8.0 (3.8)	< 0.001
Aluminum	Urine	97	89	40.9 (38.2)	15.5 (8.8)	< 0.001
Mercury	Blood	744	665	7.6 (1.9)	4.8 (1.1)	< 0.001
Mercury	Hair	465	526	1.17 (0.32)	0.49 (0.09)	< 0.001
Mercury	Urine	119	179	1.66 (5.11)	0.69 (1.02)	0.05

Table S2: Sensitivity analysis for the meta-regression using the DerSimonian–Laird method and the Student T-test, by consecutively excluding one study from the main analysis models.

Exposure	Biomarker	Exclude study	Mean (Case)	SD (Case)	I2 (Case)	Heterogeneity P-value (Case)	T- Test P- value
Cadmium	hair	Adam et al. 2006	0.06	0.02	83.73	0.00	<0.05
Cadmium	hair	Al-Ayadhi et al. 2005	0.09	0.03	79.98	0.00	<0.05
Cadmium	hair	Albizatti et al. 2012	0.06	0.02	83.32	0.00	<0.05
Cadmium	hair	Al Farsi et al. 2012	0.05	0.02	74.17	0.00	<0.05
Cadmium	hair	Blaurock-Busch et al. 2011	0.06	0.02	83.65	0.00	<0.05
Cadmium	hair	Blaurock-Busch et al. 2012	0.05	0.02	81.20	0.00	<0.05
Cadmium	hair	DePalma et al. 2012	0.07	0.02	83.76	0.00	<0.05
Cadmium	hair	Fido et al. 2005	0.04	0.02	78.45	0.00	<0.05
Cadmium	hair	Kern et al. 2007	0.06	0.02	83.44	0.00	<0.05
Cadmium	hair	Shearer et al. 1982	0.06	0.02	83.46	0.00	<0.05
Cadmium	hair	Skalny et al. 2017a	0.09	0.03	82.98	0.00	<0.05
Cadmium	hair	Skalny et al. 2017b	0.07	0.02	83.72	0.00	<0.05
Cadmium	hair	Wecker et al. 1985	0.06	0.02	83.32	0.00	<0.05
Cadmium	hair	Yasuda et al. 2005	0.06	0.02	82.82	0.00	<0.05
Cadmium	urine	Adams et al. 2013	0.21	0.13	55.59	0.08	<0.05
Cadmium	urine	Adams et al. 2017	0.18	0.12	45.64	0.14	<0.05
Cadmium	urine	Albizatti et al. 2012	0.34	0.11	0.00	0.96	<0.05
Cadmium	urine	Blaurock-Busch, 2011	0.19	0.11	52.58	0.10	<0.05
Cadmium	urine	Yorbik et al. 2009	0.19	0.11	55.04	0.08	<0.05
Aluminum	blood	Macedoni-Luksic et al. 2015	15.84	4.26	40.30	0.18	<0.05
Aluminum	blood	Rahbar et al. 2016	12.81	3.55	52.20	0.11	<0.05
Aluminum	blood	Skalny et al. 2017	10.01	5.66	50.30	0.12	<0.05
Aluminum	blood	Vergani et al. 2011	12.57	3.63	48.20	0.13	<0.05
Aluminum	hair	Adams et al. 2006	4.57	1.12	89.04	0.00	<0.05
Aluminum	hair	Al-Ayadhi et al. 2005	5.56	1.28	89.31	0.00	<0.05

Aluminum	hair	Albizatti et al. 2012	6.36	1.45	87.88	0.00	<0.05
Aluminum	hair	Al Farsi et al. 2012	6.57	1.54	88.62	0.00	<0.05
Aluminum	hair	Blaurock-Busch et al. 2011	4.72	1.14	89.33	0.00	<0.05
Aluminum	hair	DePalma et al. 2012	4.67	1.13	89.25	0.00	<0.05
Aluminum	hair	Fido et al. 2005	3.13	0.69	70.90	0.00	<0.05
Aluminum	hair	Mohamed et al. 2015,	4.76	1.12	89.15	0.00	<0.05
Aluminum	hair	Skalny et al. 2017a	4.65	1.14	89.26	0.00	<0.05
Aluminum	hair	Skalny et al. 2017b	4.70	1.15	89.32	0.00	<0.05
Aluminum	hair	Yasuda et al. 2005	6.58	1.64	86.88	0.00	<0.05
Aluminum	urine	Adams et al. 2013	7.08	1.42	54.30	0.11	<0.05
Aluminum	urine	Adams et al. 2017	7.11	1.46	55.40	0.10	<0.05
Aluminum	urine	Albizatti et al. 2012	9.34	5.81	51.30	0.14	<0.05
Aluminum	urine	Blaurock-Busch et al. 2011	7.15	1.42	61.10	0.08	<0.05
Mercury	blood	Adams et al. 2013	3.32	1.16	90.39	0.00	<0.05
Mercury	blood	Alabdali et al. 2014	1.57	0.67	78.91	0.00	<0.05
Mercury	blood	Albizatti et al. 2012	2.99	1.05	86.91	0.00	<0.05
Mercury	blood	Geier et al. 2010	2.38	0.82	88.80	0.00	<0.05
Mercury	blood	Hertz-Pannier et al. 2010	2.81	0.92	89.12	0.00	<0.05
Mercury	blood	Ip et al. 2004	2.13	0.79	87.52	0.00	<0.05
Mercury	blood	Khaled et al. 2016	2.39	0.82	88.68	0.00	<0.05
Mercury	blood	Stamova et al. 2009	2.89	0.96	88.93	0.00	<0.05
Mercury	blood	Yau et al. 2014	2.33	0.91	86.66	0.00	<0.05
Mercury	hair	Albizatti et al. 2012	1.44	0.37	97.69	0.00	<0.05
Mercury	hair	DePalma et al. 2012	1.33	0.27	97.79	0.00	<0.05
Mercury	hair	El-baz et al. 2010	1.37	0.28	97.99	0.00	<0.05
Mercury	hair	Hodgson et al. 2014	0.84	0.18	94.40	0.00	<0.05
Mercury	hair	Ip et al. 2004	1.24	0.27	97.66	0.00	<0.05
Mercury	hair	Kern et al. 2007	1.45	0.31	97.94	0.00	<0.05
Mercury	hair	Majewska et al. 2010	1.54	0.30	98.18	0.00	<0.05
Mercury	hair	Mohamed et al. 2015	1.41	0.28	97.99	0.00	<0.05
Mercury	hair	Obrenovich et al. 2011	1.43	0.28	97.99	0.00	<0.05

Mercury	hair	Priya et al. 2011	1.26	0.43	98.09	0.00	<0.05
Mercury	urine	Adams et al. 2013	0.69	0.07	36.50	0.18	<0.05
Mercury	urine	Adams et al. 2017	0.69	0.07	43.20	0.16	0.91
Mercury	urine	Albizatti et al. 2012	0.56	0.38	29.90	0.21	0.24
Mercury	urine	Wright et al. 2012	0.69	0.07	35.50	0.19	0.87
Exposure	Biomarker	Exclude study	Mean (Control)	SD (Control)	I ² (Control)	Heterogeneity (Control)	
Cadmium	hair	Adam et al. 2006	0.66	0.12	99.11	0.00	
Cadmium	hair	Al-Ayadhi et al. 2005	0.70	0.14	97.85	0.00	
Cadmium	hair	Albizatti et al. 2012	0.64	0.12	99.11	0.00	
Cadmium	hair	Al Farsi et al. 2012	0.55	0.12	99.10	0.00	
Cadmium	hair	Blaurock-Busch et al. 2011	0.65	0.12	99.11	0.00	
Cadmium	hair	Blaurock-Busch et al. 2012	0.70	0.13	96.70	0.00	
Cadmium	hair	DePalma et al. 2012	0.68	0.13	99.11	0.00	
Cadmium	hair	Fido et al. 2005	0.65	0.13	99.10	0.00	
Cadmium	hair	Kern et al. 2007	0.62	0.12	99.11	0.00	
Cadmium	hair	Shearer et al. 1982	0.62	0.12	99.11	0.00	
Cadmium	hair	Skalny et al. 2017a	0.66	0.13	99.11	0.00	
Cadmium	hair	Skalny et al. 2017b	0.69	0.13	99.11	0.00	
Cadmium	hair	Wecker et al. 1985	0.59	0.12	98.87	0.00	
Cadmium	hair	Yasuda et al. 2005	0.40	0.09	99.11	0.00	
Cadmium	urine	Adams et al. 2013	0.52	0.26	53.49	0.09	
Cadmium	urine	Adams et al. 2017	0.46	0.24	30.34	0.23	
Cadmium	urine	Albizatti et al. 2012	0.48	0.19	0.00	0.70	
Cadmium	urine	Blaurock-Busch, 2011	0.41	0.21	47.54	0.13	
Cadmium	urine	Yorbik et al. 2009	0.29	0.14	49.73	0.11	
Aluminum	blood	Macedoni-Luksic et al. 2015	31.87	24.22	55.80	0.11	
Aluminum	blood	Rahbar et al. 2016	21.54	10.38	60.20	0.09	
Aluminum	blood	Skalny et al. 2017	33.65	28.56	61.50	0.08	
Aluminum	blood	Vergani et al. 2011	28.75	25.56	57.70	0.10	
Aluminum	hair	Adams et al. 2006	11.28	3.11	91.82	0.00	

Aluminum	hair	Al-Ayadhi et al. 2005	13.05	3.42	91.97	0.00	
Aluminum	hair	Albizatti et al. 2012	12.12	3.48	90.78	0.00	
Aluminum	hair	Al Farsi et al. 2012	11.47	3.08	91.82	0.00	
Aluminum	hair	Blaurock-Busch et al. 2011	12.01	3.09	92.10	0.00	
Aluminum	hair	DePalma et al. 2012	11.99	3.18	92.08	0.00	
Aluminum	hair	Fido et al. 2005	8.76	2.91	70.89	0.00	
Aluminum	hair	Mohamed et al. 2015,	11.00	1.88	92.10	0.00	
Aluminum	hair	Skalny et al. 2017a	12.04	3.12	92.09	0.00	
Aluminum	hair	Skalny et al. 2017b	12.24	3.27	92.07	0.00	
Aluminum	hair	Yasuda et al. 2005	14.94	4.35	91.28	0.00	
Aluminum	urine	Adams et al. 2013	11.01	5.99	65.70	0.06	
Aluminum	urine	Adams et al. 2017	15.46	8.78	63.80	0.07	
Aluminum	urine	Albizatti et al. 2012	13.36	6.78	67.70	0.05	
Aluminum	urine	Blaurock-Busch et al. 2011	10.04	5.32	65.80	0.06	
Mercury	blood	Adams et al. 2013	5.40	1.33	92.33	0.00	
Mercury	blood	Alabdali et al. 2014	4.81	1.13	89.58	0.00	
Mercury	blood	Albizatti et al. 2012	4.96	1.24	88.69	0.00	
Mercury	blood	Geier et al. 2010	3.92	1.03	91.02	0.00	
Mercury	blood	Hertz-Pannier et al. 2010	5.98	1.26	91.29	0.00	
Mercury	blood	Ip et al. 2004	3.67	1.00	84.70	0.00	
Mercury	blood	Khaled et al. 2016	4.36	1.12	90.92	0.00	
Mercury	blood	Stamova et al. 2009	5.18	1.22	91.20	0.00	
Mercury	blood	Yau et al. 2014	5.40	1.41	90.18	0.00	
Mercury	hair	Albizatti et al. 2012	0.49	0.11	83.95	0.00	
Mercury	hair	DePalma et al. 2012	0.50	0.10	84.63	0.00	
Mercury	hair	El-baz et al. 2010	0.50	0.11	81.46	0.00	
Mercury	hair	Hodgson et al. 2014	0.48	0.11	51.45	0.02	
Mercury	hair	Ip et al. 2004	0.32	0.10	82.65	0.00	
Mercury	hair	Kern et al. 2007	0.51	0.12	83.03	0.00	
Mercury	hair	Majewska et al. 2010	0.53	0.12	85.61	0.00	
Mercury	hair	Mohamed et al. 2015	0.54	0.13	84.39	0.00	

Mercury	hair	Obrenovich et al. 2011	0.48	0.11	84.58	0.00	
Mercury	hair	Priya et al. 2011	0.53	0.17	85.60	0.00	
Mercury	urine	Adams et al. 2013	0.56	0.36	45.50	0.13	
Mercury	urine	Adams et al. 2017	0.70	1.03	47.5	0.1	
Mercury	urine	Albizatti et al. 2012	0.64	0.88	50.1	0.09	
Mercury	urine	Wright et al. 2012	0.71	1.51	48.3	0.11	