REVIEW ARTICLE

Neurodevelopmental Disorder Associated with Aluminum-Adsorbed Vaccines: Reanalysis of Data from a Danish Nationwide Cohort Study

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Abstract

Andersson et al. published "Aluminum-Adsorbed Vaccines and Chronic Diseases in Childhood: A Nationwide Cohort Study" with a discussion and conclusion that contradict the data. Aluminum adjuvant safety studies are largely underwhelming, irrelevant to injectable aluminum, and are not designed to study neurodevelopmental disorders. The manuscript matches the original supplemental, in which many neurodevelopmental diagnoses were deleted, but not the updated supplemental, which shows an association with neurodevelopmental disorder. Neurodevelopmental disorders such as Asperger syndrome (now Level 1 autism spectrum disorder), other pervasive developmental disorders, autistic disorder, and autism spectrum disorder are all found to be statistically significantly associated with a higher cumulative dose of vaccine-derived aluminum.

Keywords: aluminum; vaccination; vaccine; neurodevelopmental; autistic; autism; autism spectrum disorder; Asperger syndrome

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Introduction

Aluminum salts have been used in human vaccines as early as 1932,[1] predating modern regulatory processes. They are widely used as adjuvants to stimulate the immune response to antigens - lowering the quantity and frequency of antigen exposure required for successful immunization.[2]

Mitkus et al.[3] is a highly cited study demonstrating the safety of aluminum adjuvant. It presents a weak theoretical model of equations based on many assumptions. The model derived a minimum risk level (MRL) of aluminum from the Agency for Toxic Substances and Disease Registry publication "Toxicological Profile of Aluminum".[4] Mitkus et al. derived an MRL value from the oral consumption of aluminum, even though the document clearly states "[d]ata on health effects of ingested aluminum in humans are unsuitable for MRL consideration".[4] They converted oral consumption levels to serum aluminum levels based on a study of 8 adult human males.[5] They then considered the conversion rate of aluminum citrate from aluminum hydroxide and aluminum phosphate adjuvants based on a study of only two rabbits each, where roughly 1% was deposited in the brain.[6] The human clearance of aluminum was then assessed from a single adult human male,[7] where roughly 4% persisted 1178 days post-injection.

Movsas et al.[8] is another frequently cited aluminum safety study, involving 15 pre-term infants. The authors measured elemental concentrations of iron, manganese, selenium, zinc, and copper in the blood before and after vaccination. Although they reported the percent increase or decrease of each element, they failed to report the value for aluminum (the only element named in their title), merely stating that "[n]o significant change in levels of urinary or serum aluminum were seen after vaccination". Given that the infants already had a high blood aluminum level (11.1 ng/mL) with a large variance (standard deviation of 10.3), the aluminum level in the blood would need to double for a statistically significant difference to be detected.

Karwowski et al.[9] is yet another often-cited aluminum safety study, which measured aluminum content in hair and blood of 85 healthy infants and neurodevelopmentally assessed them. However, the authors excluded one child as an extreme outlier, having 5-times the median aluminum level in the hair sample (212 ppm) and scoring below the 25th percentile on gross motor. They also excluded 7 children as extreme outliers of blood samples (in the range 98-952 ng/mL). A study that excludes 9.4% (8/85) of the study population cannot be considered informative of the correlation between aluminum concentrations and neurological development.

The aforementioned studies (Mitkus et al., Movsas et al., and Karwowski et al.) were cited as the standard for aluminum safety by Andersson et al. in their "Aluminum-Adsorbed Vaccines and Chronic Diseases in Childhood: A Nationwide Cohort Study".[10]

Daley et al.[11] is a publication by the Centers for Disease Control and Prevention-affiliated authors, which utilized the Vaccine Safety Datalink[12] (a collaboration of, as of this writing, 13 healthcare organizations covering over 15.5 million people) to assess cumulative childhood aluminum dose via vaccination in relation to eczema (atopic dermatitis) and asthma. They concluded that per 1 mg increase in

aluminum, the risk of asthma in children without eczema increases by 19% (adjusted hazard ratio (aHR) 1.19, 95% confidence interval (CI) 1.14, 1.25) and by 26% (aHR 1.26, 95% CI 1.07, 1.49) in those with eczema.

Publication Under Focus

Andersson et al.

The study evaluated 1,384,357 live-born children in Denmark between 1997 and 2018.[10] It excluded 160 181 children from data analysis for various reasons, which included 34 547 children (2.5%) who were documented with an "implausible number of vaccines" [more than 3 of any one aluminum adjuvant vaccine]. A total of 1 224 176 children were included in the study. For specific outcomes, the authors excluded between 0 and 466 047 children while documenting the outcome in the first 2 years of life [Andersson et al.'s Figure 1]. Of the included cohort: 15 237 received no aluminum-adsorbed vaccines; 42 990 received >0 mg-1.5 mg cumulative aluminum dose; 701 571 received >1.5 mg-3 mg cumulative aluminum dose; 464 378 received >3 mg-4.5 mg cumulative aluminum dose. A total of 1 208 939 children received at least some aluminum dose in this cohort study. Each outcome model was adjusted for a priori–defined potential confounders, including birth year and season, sex, maternal age at delivery, maternal place of birth, maternal smoking during pregnancy, parity, preterm birth, birthweight, number of visits to a general practitioner before age 2 years, maternal prescription drug use during pregnancy, selected maternal conditions within 5 years before the child's birth date, and parental household income.

The study claims that "[t]his nationwide cohort study did not find evidence supporting an increased risk for autoimmune, atopic or allergic, or neurodevelopmental disorders associated with early childhood exposure to aluminum-adsorbed vaccines."[10]

In fact, the study's analysis [Andersson et al.'s Figure 3], also reproduced here in Table 1, supports the claim that aluminum-adsorbed vaccines are protective against 12 disease states: ulcerative colitis aHR 0.72 (0.52-0.98); erythema nodosum aHR 0.74 (0.58-0.95); asthma aHR 0.96 (0.94-0.98); angioedema and urticaria aHR 0.90 (0.86-0.95); allergy unspecified aHR 0.86 (0.80-0.92); anaphylaxis or epinephrine autoinjector aHR 0.84 (0.78-0.91); food allergy aHR 0.84 (0.79-0.89); total neurodevelopmental outcomes aHR 0.93 (0.90-0.97); autistic disorder aHR 0.94 (0.89-0.99); autism spectrum disorder (ASD)-composite aHR 0.93 (0.89-0.97); attention deficit-hyperactivity disorder (ADHD) aHR 0.90 (0.84-0.96); and other pervasive developmental disorders 0.89 (0.83-0.95).

In other words, the authors are at least 95% confident that an increase in exposure to 1 mg of aluminum through aluminum-adsorbed vaccines administered in the first two years of life is associated with reduced disease outcomes between 2 and 5 years old. A relative risk reduction of ulcerative colitis by 28%; erythema nodosum by 26%; asthma by 4%; angioedema and urticaria by 10%; allergy unspecified by 14%; anaphylaxis or epinephrine autoinjector by 16%; food allergy by 16%; neurodevelopmental outcomes by 7%; autistic disorder by 6%; ASD-composite by 7%; ADHD by 10%; and other pervasive developmental disorders by 11%, was concluded. This lacks biological plausibility and support in the medical literature associating aluminum-adsorbed vaccines with protective effects against the gamut of diseases asserted. The observed protective effects, however, are symptomatic of what may be found in a biased data set and/or with flawed statistical adjustments. Such a demonstration of implausible protective effects is consistent with residual confounding, which occurs when one or more unmeasured or inadequately controlled factors (such as socioeconomic status, healthcare-seeking behavior, or underlying health differences between groups) continue to influence both the exposure (aluminum vaccine dose) and the outcomes, thereby creating a spurious inverse association that makes the exposure falsely appear protective.

Table1. Andersson et al.'s Figure 3 reported association between cumulative aluminum exposure through early childhood vaccination and chronic disease in children.

Outcome	Adjusted Hazard Ratio
Autoimmune outcomes	0.98 (0.94-1.02)
Rheumatoid arthritis	1.10 (0.72-1.68)
Hashimoto thyroiditis	0.92 (0.54-1.56)
Idiopathic thrombocytopenic purpura	1.13 (0.97-1.31)
Hypothyroidism	0.98 (0.74-1.30)
Vitiligo	0.80 (0.53-1.23)
Kawasaki disease	1.00 (0.83-1.19)
Juvenile arthritis	1.05 (0.94-1.16)
Type 1 diabetes	1.03 (0.92-1.15)
Vasculitis unspecified	0.84 (0.64-1.10)
Celiac disease	0.98 (0.87-1.10)
Crohn disease	0.82 (0.62-1.07)
Psoriasis	0.81 (0.61-1.07)
Henoch-Schönlein purpura	0.96 (0.85-1.08)
Myositis	0.69 (0.47-1.01)
Ulcerative colitis	**0.72 (0.52-0.98)**
Erythema nodosum	**0.74 (0.58-0.95)**
Atopic and allergic outcomes	0.99 (0.98-1.01)
Insect sting allergy	1.09 (0.66-1.79)
Atopic dermatitis	1.02 (1.00-1.04)
Drug allergy	0.96 (0.90-1.02)
Allergic rhinoconjunctivitis	0.99 (0.97-1.01)
Asthma	**0.96 (0.94-0.98)**
Angioedema and urticaria	**0.90 (0.86-0.95)**
Allergy unspecified	**0.86 (0.80-0.92)**
Anaphylaxis or epinephrine autoinjector	**0.84 (0.78-0.91)**
Food allergy	**0.84 (0.79-0.89)**
Neurodevelopmental outcomes	**0.93 (0.90-0.97)**
Asperger syndrome	1.13 (0.89-1.44)
Atypical autism	0.94 (0.79-1.12)
Autistic disorder	**0.94 (0.89-0.99)**
Autism spectrum disorder composite	**0.93 (0.89-0.97)**
Attention deficit-hyperactivity disorder	**0.90 (0.84-0.96)**
Other pervasive developmental disorders	**0.89 (0.83-0.95)**

Note: Adjusted Hazard Ratio (95% CI) per 1-mg Increase in Aluminum Received Through Vaccines by Age 2 y

Original Supplemental Material

The original supplemental material posted with the article on July 15th, 2025 represented all 5174 diagnoses for autoimmune outcomes, all 39 465 diagnoses for atopic and allergic outcomes, but less than half (43.1%) of the 5200 diagnoses for neurodevelopmental outcomes. Merely 2239 diagnoses were represented. It was likely a deletion of diagnoses, not the exclusion of individual children, because the case count for all other disease categories remained unchanged. This implies that if 2961 children were excluded, then none of them had any autoimmune, allergic, or atopic disease.

Importantly, the deleted neurodevelopmental diagnoses appear incompatible with random deletion, as one would expect from a random mistake. Had it been a random deletion, the deleted diagnoses in the parts would be comparable to the deleted diagnoses of the whole. Overall, the original supplemental material saw a 56.9% reduction in neurodevelopmental outcomes (from 5200 to 2239). In its parts, the reductions were: 82.3% reduction in Asperger syndrome (now Level 1 ASD) (175 was reduced to 31); 59.1% reduction in atypical autism (276 was reduced to 113); 47.3% reduction in ADHD (1580 was reduced to 832); 73.2% reduction in other pervasive developmental disorders (1702 was reduced to 457); 58.4% reduction in autistic disorder (2686 was reduced to 1118); and, 64.5% reduction in ASD-composite (4806 was reduced to 1705).

Additionally, neurodevelopmental outcome is defined in Andersson et al.'s Supplemental Table 1 as a combination of both ADHD and ASD-composite. We can compute how many children have both. Derived from Andersson et al.'s Figure 3, 1580 have ADHD, while 4806 have ASD-composite. A total of 6386 diagnoses in 5200 neurodevelopmental outcomes means 1186 children (22.8%) have both. In Andersson et al.'s Supplementary Figure 7, however, 832 have ADHD and 1705 have ASD-composite from 2239 neurodevelopmental outcomes, meaning 298 children (13.3%) have both. If the diagnoses were deleted at random, the percentage of children with overlapping ADHD and ASD-composite diagnoses would be comparable. However, they are not. It appears that children diagnosed with a more extreme disposition were excluded from this supplement.

Table 2. Unadjusted analysis or zero-exposure group

Outcome	Total cohort	Some aluminum	Zero aluminum	OR (some vs zero)	95% CI	*P* value
	SupFig7(Age 2-5)	SupFig5	subtraction			
N	1224176	1208939	15237			
Autoimmune outcomes	5174	5104	70	0.92	(0.73, 1.16)	.4817
Rheumatoid arthritis	51	51	0	1.29	(0.08, 20.84)	.8597
Hashimotos thyroiditis	26	26	0	0.66	(0.04, 10.76)	.7673
Hypothyroidism	104	102	2	0.64	(0.16, 2.61)	.5359
Myositis	**40**	**38**	**2**	**0.24**	**(0.06, 0.99)**	**.0488**
Idiopathic thrombocytopenic purpura	422	419	3	1.76	(0.57, 5.48)	.329
Crohn's disease	85	82	3	0.34	(0.11, 1.09)	.0698
Psoriasis	**114**	**109**	**5**	**0.27**	**(0.11, 0.67)**	**.0047**
Erythema nodosum	**112**	**107**	**5**	**0.27**	**(0.11, 0.66)**	**.0042**
Type 1 diabetes	669	662	7	1.19	(0.57, 2.51)	.6439
Juvenile arthritis	809	803	6	1.69	(0.76, 3.77)	.2018
Celiac disease	652	644	8	1.01	(0.51, 2.04)	.9675
Kawasaki disease	266	265	1	3.34	(0.47, 23.80)	.2287
Vitiligo	39	39	0	0.98	(0.06, 16.00)	.9905
Ulcerative colitis	68	66	2	0.42	(0.10, 1.70)	.2216
Vasculitis unspecified	97	96	1	1.21	(0.17, 8.68)	.8496
Henoch-Schonlein purpura	1722	1696	26	0.82	(0.56, 1.21)	.3213
Atopic and allergic outcomes	39465	38956	509	0.96	(0.88, 1.05)	.4117
bug allergy	33	33	0	0.83	(0.05, 13.58)	.8972
drug allergy	2275	2253	22	1.29	(0.85, 1.97)	.2331
atopic dermititis	**22978**	**22749**	**229**	**1.26**	**(1.10, 1.43)**	**.0006**
allergic rhinoconjuctivitis	**22841**	**22649**	**192**	**1.5**	**(1.30, 1.73)**	**<.0001**
asthma	28346	27973	373	0.94	(0.85, 1.05)	.274
angioedema and urticaria	3435	3384	51	0.84	(0.63, 1.10)	.2044
allergy unspecified	1621	1601	20	1.01	(0.65, 1.57)	.9685
anaphylasis or epinephrine autoinjector	1372	1358	14	1.22	(0.72, 2.07)	.4542
food allergy	2288	2266	22	1.3	(0.85, 1.98)	.2228
neurodevelopment outcomes	2239	2202	37	0.75	(0.54, 1.04)	.0825
asperger syndrome	31	30	1	0.38	(0.05, 2.77)	.3387
atypical autism	113	111	2	0.7	(0.17, 2.83)	.6164
attention-deficit/ hyperactivity disorder	832	819	13	0.79	(0.46, 1.37)	.4092
other pervasive developmental disorders	457	451	6	0.95	(0.42, 2.12)	.8953
autistic disorder	1118	1101	17	0.82	(0.51, 1.32)	.406
autism spectrum disorder composite	1705	1679	26	0.81	(0.55, 1.20)	.2971

Though the study never intended to and did not analyze a zero-exposure group, such an unadjusted analysis is possible and is done here in Table 2. Andersson et al.'s Supplemental Figure 5 included an analysis of only children exposed to some aluminum via vaccination (omitting the zero-exposure group), intending to show no significant difference with the inclusion or exclusion of the zero-exposure group. If we subtract the disease prevalence in Andersson et al.'s Supplemental Figure 5 from the disease prevalence of the main analysis (Andersson et al.'s Figure 3), we are left with the disease prevalence of the zero-exposure group. Though a small zero-exposure cohort (n = 15 237), it has significant outliers. Of atopic dermatitis diagnoses, 22 749 had some aluminum exposure, while 229 had zero exposure. Of allergic rhinoconjunctivitis, 22 649 had some aluminum

exposure, while 192 had zero exposure. Of the neurodevelopmental outcomes, 2202 had some aluminum exposure, while 37 had zero exposure. Within the total cohort, 1 208 939 had some aluminum exposure, while 15 237 had zero exposure. Odds ratios may be calculated from the resulting 2 × 2 matrix by many statistical software and web application programs (e.g., https://www.medcalc.org/calc/odds_ratio.php). The unexposed vs. exposed odds ratio for atopic dermatitis is 0.796 (0.698-0.907, P = .0006); for allergic rhinoconjunctivitis is 0.668 (0.579-0.771, P < .0001); and for neurodevelopmental outcomes is 1.334 (0.964-1.847, P = .0825).

In other words, children not vaccinated with an aluminum-containing vaccine had a relative risk reduction of 20.4% for contracting atopic dermatitis and 33.2% for contracting allergic rhinoconjunctivitis. They also had a non-statistically significant relative risk increase of 33.4% for neurodevelopmental disorder (with 92% confidence, not reaching 95% confidence, but still notable).

Updated Supplemental Material

On July 17th, 2025, the publishing journal issued an erratum and presented updated supplemental material. According to the PDF file's metadata, it was created on July 9th, 2025.

With the updated supplemental material, the signal for an association between the zero-exposure group and neurodevelopmental outcomes vanished. Within neurodevelopmental outcomes, 5140 had some aluminum exposure, and 60 had zero exposure, yielding an odds ratio of 0.926 (0.718-1.195, P = .554).

Statistically significant indicators for neurodevelopmental disorder may be found in Andersson et al.'s Supplemental Figure 4 for Asperger syndrome, aHR 1.67 (1.01, 2.77), per 1 mg increase in aluminum received through vaccines by age 2 for children born between 2007 and 2018. Asperger syndrome is also found to be significant in the risk difference comparison (>0 mg-1.5 mg compared to >3 mg-4.5 mg) of Andersson et al.'s Supplemental Figure 11: 1.02 (0.66, 1.38) per 10 000 vaccinated. Andersson et al.'s Supplemental Figure 11 also indicates a statistically significant association between the cumulative dose of aluminum and the neurodevelopmental disorder risk difference. Each of the 11 figures that assessed Asperger syndrome (Andersson et al.'s Figure 3 and Supplemental Figures 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12) found it to be positively associated with increased exposure to aluminum-adsorbed vaccines.

Furthermore, in Andersson et al.'s Supplemental Figure 11, comparing the risk difference of children who, in their first 2 years, received either >1.5 mg-3 mg or >3 mg-4.5 mg, the analysis finds an increased risk with increased aluminum dose of: overall neurodevelopmental outcomes of 9.73 (5.41, 14.05) per 10 000 vaccinated; other pervasive developmental disorders 3.74 (1.55, 5.94) per 10 000 vaccinated; autistic disorder 4.49 (1.75, 7.24) per 10 000 vaccinated; and ASD-composite 8.68 (4.98, 12.38) per 10 000 vaccinated.

Comments on the Published Paper and the Authors' Response

On July 29th, 2025, the journal published external peer comments highlighting that the "conclusion contradicts the analysis". Andersson et al. authors responded on August 11th, 2025,[13] "Supplemental Figure 11 violated the positivity assumption" as there were 268,522 children born between 1997 and 2001 who received >1.5 mg-3 mg and 0 children who received the higher dose. Accordingly, in their response, the authors excluded children born before 2002 from a reanalysis and reported the overall neurodevelopmental outcomes risk difference as 2.30 (-2.60, 7.21). No subcomponents of the neurodevelopmental outcomes were reported from the reanalysis. The loss of statistical significance is in accord with removing 38.3% of the original 701 571 moderate-dosed cohort, thereby reducing the statistical power which is needed to find an association.

Further, for the risk difference in Andersson et al.'s Supplemental Figure 11 to have been overstated by 423% (risk difference of 9.73 vs. 2.30), necessarily, the neurodevelopmental outcomes risk associated with receiving >1.5-3 mg cumulative dose must be substantially lower in the 268 552 children born before 2002 than in the remaining 433 019 children born in or after 2002. Though possible, if true, it would be reflected in Andersson et al.'s Supplemental Figure 4 as a substantial difference between birth years 1997- 2006 and 2007-2018. The aHRs for those two cohorts for neurodevelopmental outcomes are 0.93 (0.87, 0.98) and 0.93 (0.89, 0.98), respectively – differing only in the lower-bound CI. If everything else is held to be true, the reanalysis appears internally inconsistent with the originally reported results.

Additionally, there is an unexplained and inexplicable change [gratitude to Dr. Suzanne Burdick for bringing it to our attention] in the difference between old and new supplemental material. The count of children under the header "atopic and allergic outcomes" changes from old to new. They differ in Andersson et al.'s Supplemental Figure 11 [risk difference], but not in Supplemental Figure 10 [risk difference compared to its reference group]. To change one and not the other is impossible. Additionally, Andersson et al.'s Supplemental Figure 7 [describing age of diagnosis] changed, while Supplemental Figure 4 [separating birth cohort] did not, which is highly unlikely. The changes appear only in the overall outcomes for the group, but not in the individual parts of the group. This difference is possible if the parts of the group not reported (because they were too small - Andersson et al.'s Supplemental Table 3) also changed, which they did not. Since the cumulative incidences changed in Andersson et al.'s Supplemental Figure 11, all tables that adjust for aluminum exposure must also reflect the change, but they

did not. Based on this discrepancy alone, the public must know what conditions were set for both versions of the supplemental material, which remain undisclosed.

Discussion

An increase in immune system-mediated diseases such as atopic dermatitis and allergic rhinoconjunctivitis in the aluminum-based vaccinated group compared to the zero-exposure group is unsurprising. However, neurodevelopmental disorders with high prevalence in the zero-exposure group have no known biological plausibility.

The Andersson et al. manuscript, as written, comports with the original supplemental material, where the neurodevelopmental diagnoses of the more severely impacted kids were deleted. The manuscript does not align with the updated supplemental material, where those diagnoses were included and depict an association between aluminum exposure and neurodevelopmental disorders.

Andersson et al., one of the largest aluminum-adjuvanted vaccine and autism studies ever conducted, is a flawed work. The study that claims it "did not find evidence" simultaneously presents evidence for disease associations. The neurodevelopmental health of the highest aluminum-dosed children is significantly worse than that of the moderately-dosed children. This is a dose-response, not relative to zero-exposure but to moderate-exposure.

Many in the international scientific community have called for its immediate retraction. We firmly agree that a retraction is in order. A retraction would certainly validate that the study was a product of poor execution. Under the guidelines[14] of the Committee on Publication Ethics (COPE), "if there is clear evidence of major errors…that compromise the reliability of the findings", retraction might be warranted.

Conclusion

Overall neurodevelopmental outcomes, as described by Andersson et al.'s own data, show a risk difference of 9.73 (5.41, 14.05) per 10 000 vaccinated at a cumulative high dose compared to a moderate dose. The authors' post-publication reanalysis of risk difference does not comport with other aspects of their study. Hence, Andersson et al. is a flawed study, where the conclusion (no evidence of harm) does not match the analysis (with evidence of harm).

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

This study was unfunded. Children's Health Defense® is a 501(c)(3) non-profit organization. Our mission is to restore and protect the health of children by eliminating exposures to environmental toxins, holding responsible parties accountable, and establishing safeguards to prevent future harm to children's health. Protecting Children. Exposing Harms. Seeking Justice.

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