

The high prevalence of pre and postnatal risks
among 2,652 patients with prenatal alcohol exposure
evaluated for FASD at the Seattle FASDPN clinic

What proportion of the brain structural and functional abnormalities
observed among children with FASD is explained by their
prenatal alcohol exposure and their other prenatal and postnatal risks?

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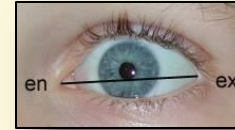
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All 2,562 patients received an FASD diagnostic evaluation using the FASD 4-Digit Diagnostic Code

Abbreviated Case-Definitions of 4-Digit Code

	3	4	3	4
Rank 4	H and W $\leq 3\%$	All 3 features	Structural / Neurological Abnormalities	Confirmed High
Rank 3	H or W $\leq 3\%$	2.5 features	Severe Dysfunction	Confirmed
Rank 2	H and W all else	1-2 features	Moderate Dysfunction	Unknown
Rank 1	H and W $> 10\%$	No features	No Dysfunction	Confirmed Absent
	Growth	Face	Brain	Alcohol



4-Digit Codes cluster into Diagnostic Categories

FAS / Alcohol Exposed

2433 3433 4433 2434 3434 4434
2443 3443 4443 2444 3444 4444 etc.

Static Encephalopathy / Alcohol Exposed

3133 3233 4133 4233 3134 3234 4134
4234 3143 3243 4143 4243 3144 3244 etc.

3 Diagnoses under the FASD Umbrella					
	Diagnosis	Growth	FAS Face	Brain	Alcohol
1.	FAS Fetal Alcohol Syndrome	growth	face	severe	alc
2.	SE/AE Static Encephalopathy / Alc Exposed			severe	alc
3.	ND/AE Neurodevelopmental Disorder / Alc Exposed			moderate	alc

The 4-Digit Code documents and ranks all prenatal and postnatal risks in addition to the PAE

FASD 4-Digit Code

	3	4	3	4	3	4
Rank 4	severe	all 3 features	abnormal structure/neurology	high	high	high
Rank 3	moderate	2.5 features	severe dysfunction	some	some	some
Rank 2	mild	1-2 features	moderate dysfunction	unknown	unknown	unknown
Rank 1	normal	no features	normal function	none	none	none
	Growth	Face	Brain	Prenatal Alcohol	Other Prenatal Risks	Other Postnatal Risks

FASD Umbrella

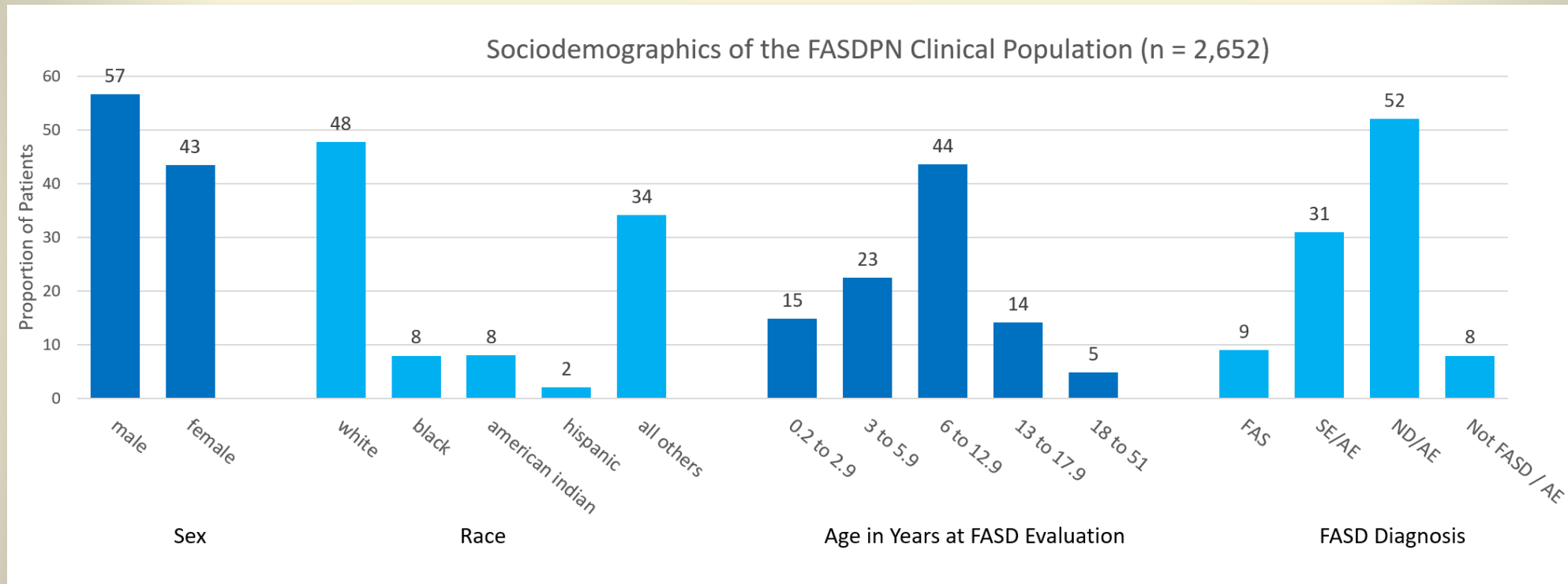
3 Diagnoses under the FASD Umbrella		Growth	FAS Face	Brain	Alcohol
1. FAS	<u>Fetal Alcohol Syndrome</u>	growth	face	severe	exposed
2. SE/AE	Static Encephalopathy / Alc-Exposed			severe	exposed
3. ND/AE	Neurodevelopmental Disorder / Alc-Exposed			moderate	exposed

Examples of prenatal and postnatal risks

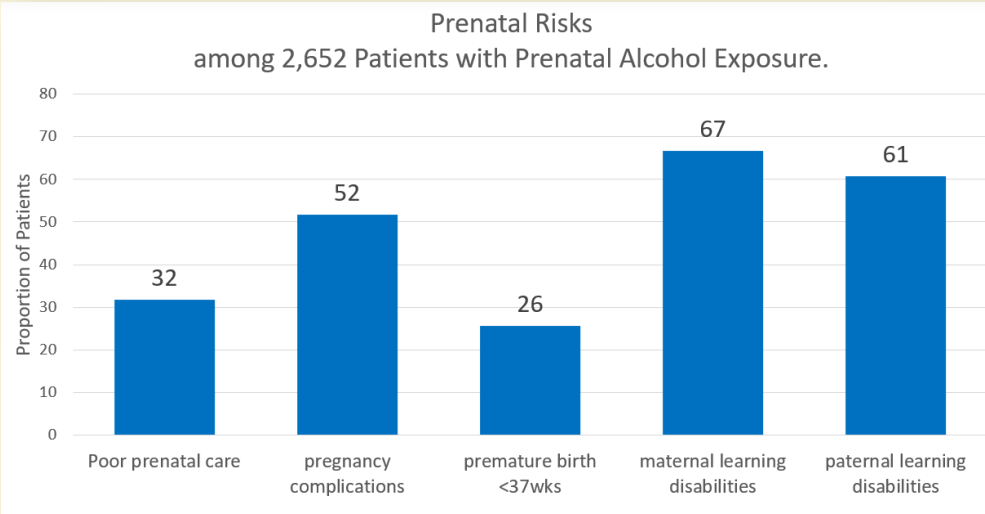
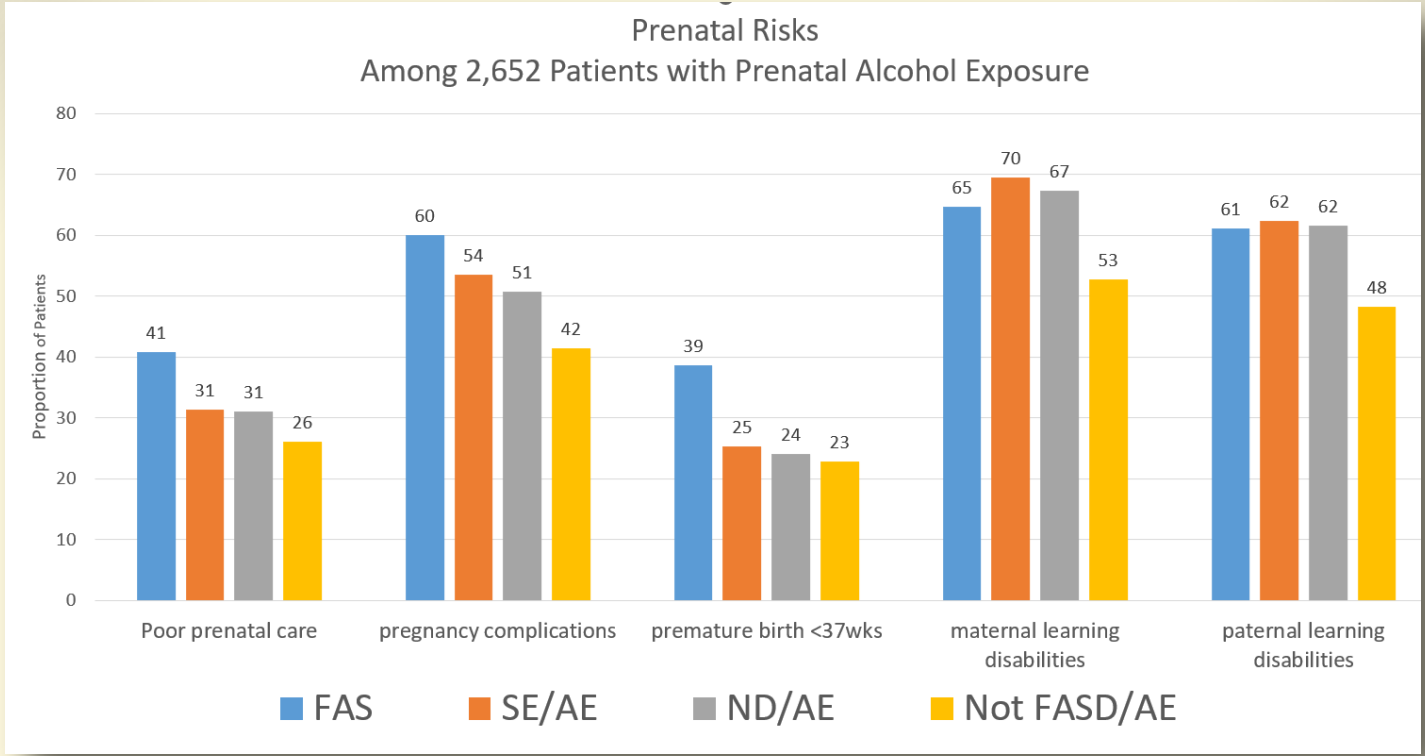
Prenatal Risks	Postnatal Risks
maternal alcohol use	premature birth < 37 weeks
paternal alcohol use?	perinatal complications, NICU
prenatal tobacco exposure	out of home placements
prenatal marijuana exposure	homelessness, poverty
prenatal illicit drug exposure	parental drug use
other teratogens (e.g., phenytoin)	neglect
poor or no prenatal care	domestic violence
pregnancy complications	death of family member
other syndromes, congenital birth defects	physical abuse
parental learning disabilities	sexual abuse
family mental health	serious medical issue
etc.	etc.

All of these risks can adversely impact growth and cognitive/behavioral development, just like prenatal alcohol exposure.

Prevalence of other prenatal and postnatal risks among 2,652 patients with prenatal alcohol exposure (PAE) evaluated at the FASDPN clinic between 1993 and 2024.

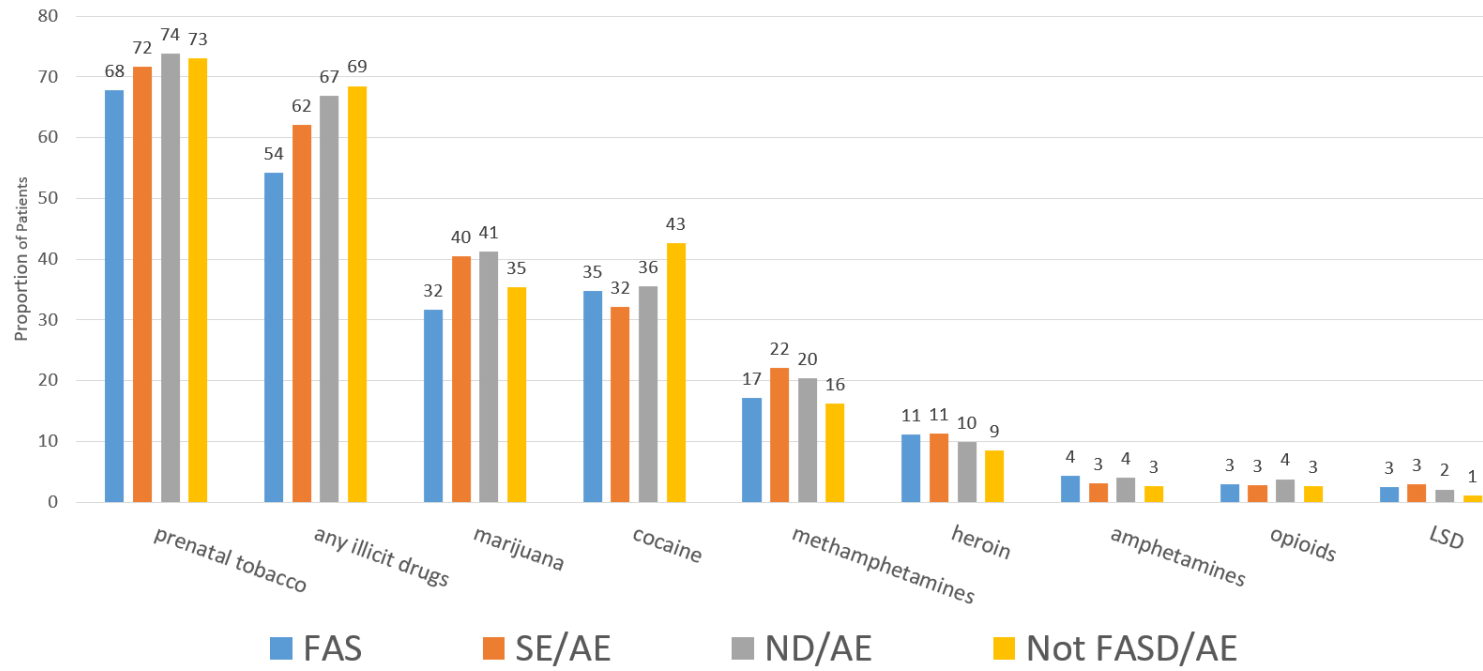


(Astley) Hemingway & Davies JK. **High prevalence of prenatal and postnatal risks among 2,652 patients with prenatal alcohol exposure evaluated for fetal alcohol spectrum disorder at the Washington State Fetal Alcohol Diagnostic & Prevention Network.** Journal of Child and Adolescent Trauma. Submitted 2026

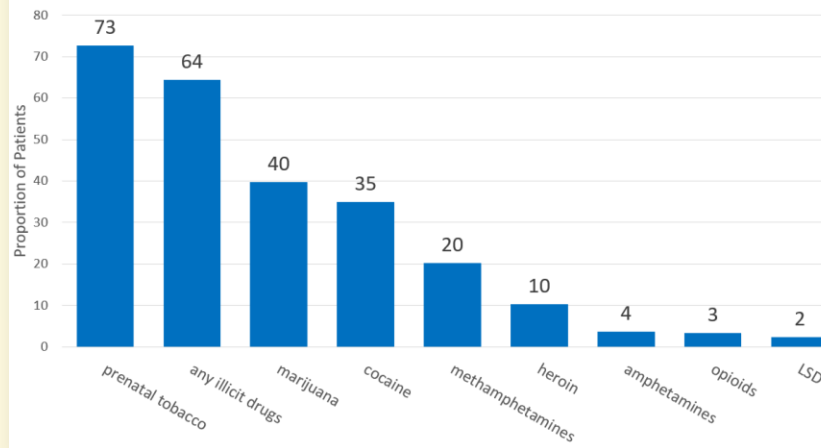


Prenatal Risks

Prenatal Substance Exposures
among 2,652 Patients with Prenatal Alcohol Exposure

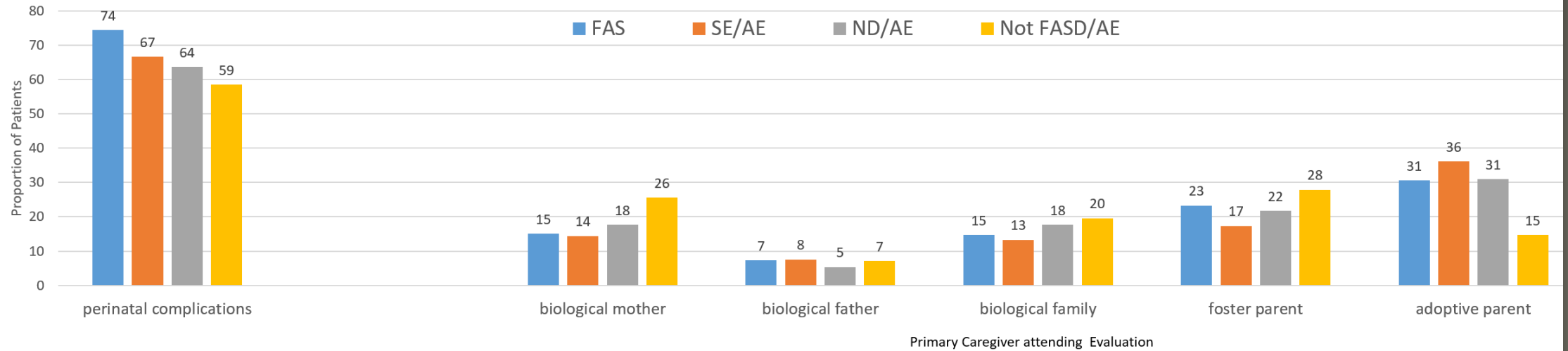


Prenatal Substance Exposures
among 2,652 Patients with Prenatal Alcohol Exposure



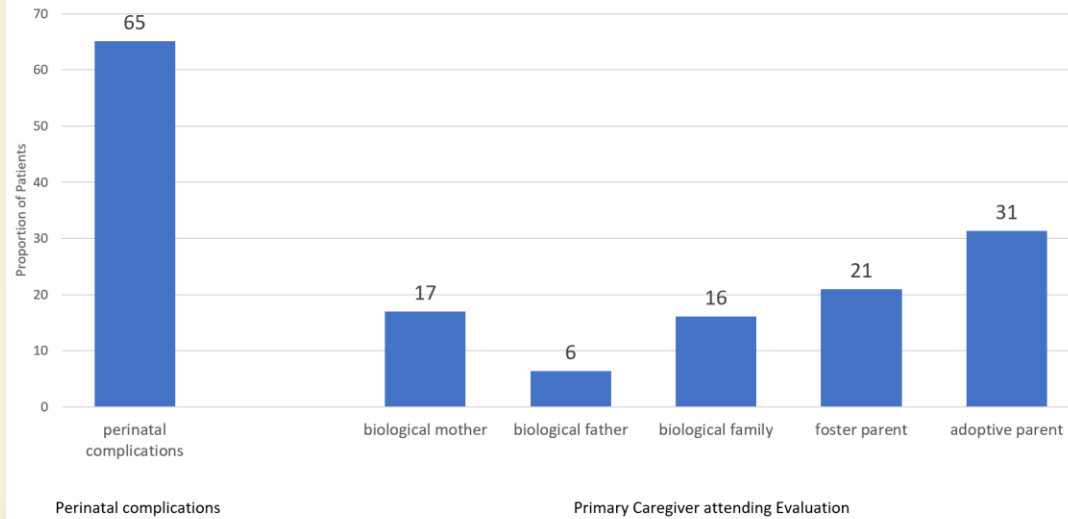
Prenatal Risks

Postnatal Risks among 2,652 FASDPN Patients with Prenatal Alcohol Exposure

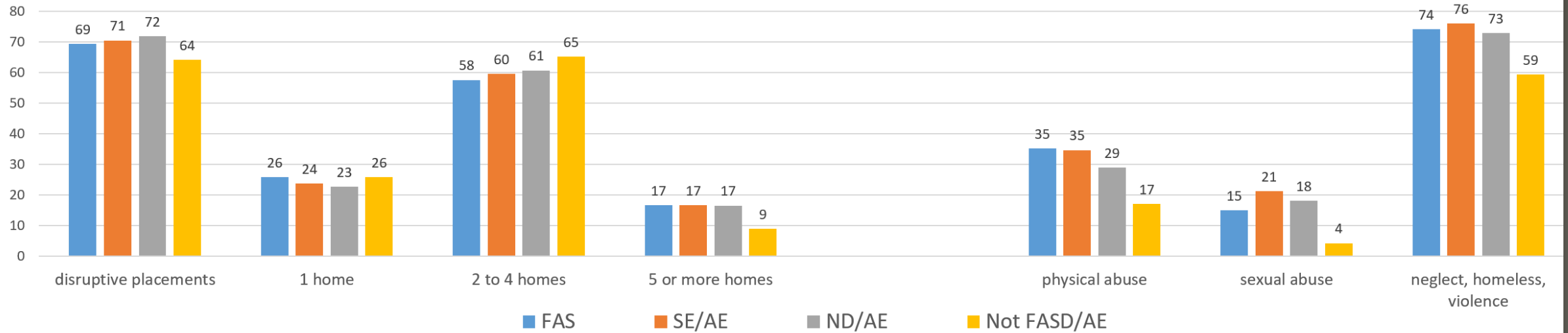


Postnatal Risks

Postnatal Risks among 2,652 FASDPN Patients with Prenatal Alcohol Exposure

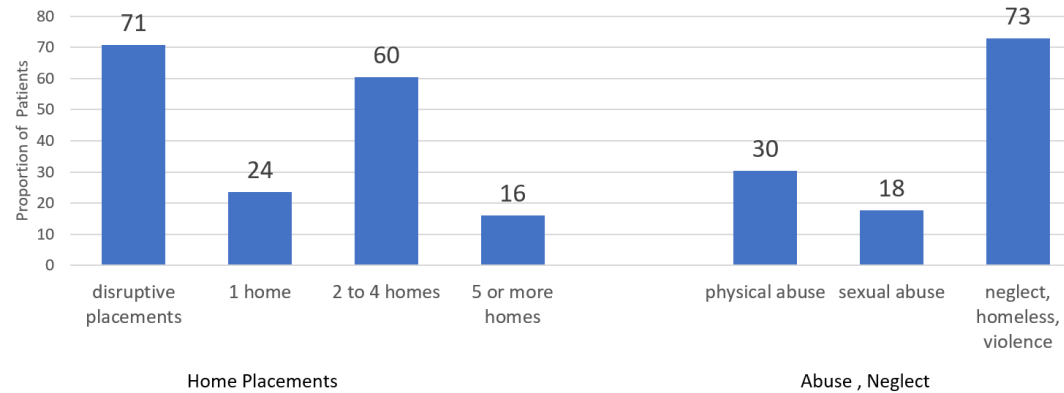


Postnatal Risks among 2,652 FASDPN Patients with Prenatal Alcohol Exposure



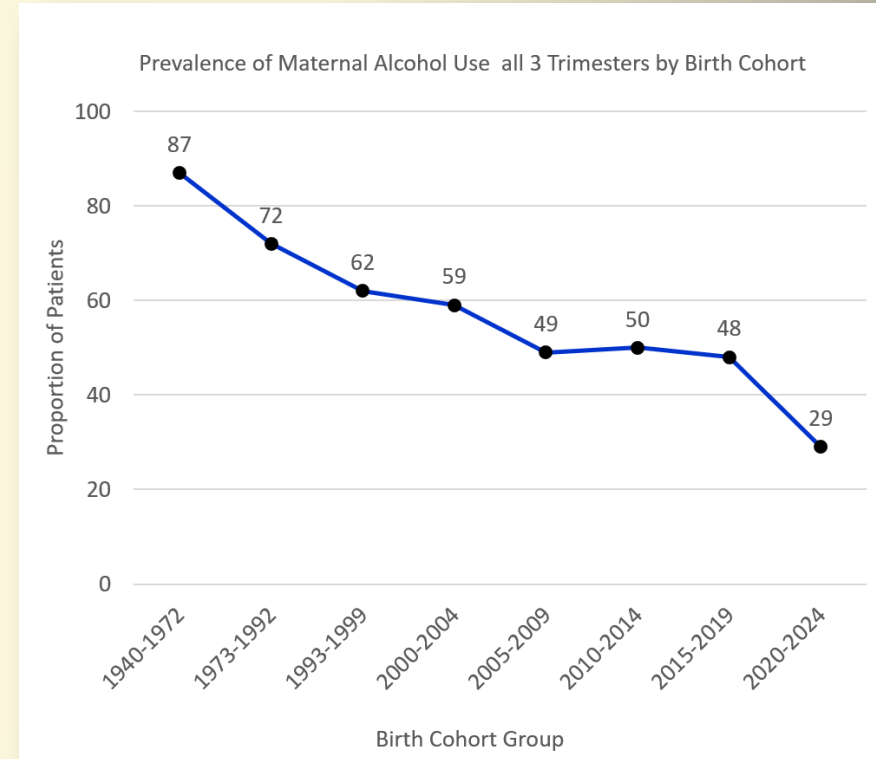
Postnatal Risks

Postnatal Risks among 2,652 FASDPN Patients with Prenatal Alcohol Exposure



The prevalence of prenatal & postnatal risks in the FASDPN clinic population (n = 2,652) is magnitudes higher than in the general U.S. population

Prenatal & Postnatal Risks	WA State FASDPN Clinic %	General U.S. Population %
prenatal alcohol exposure	100	15
prenatal alcohol all three trimesters	63	8
prenatal tobacco exposure	73	8-10
prenatal marijuana	40	1-8
prenatal cocaine	35	0.3
prenatal methamphetamines	20	0.7-4.8
prenatal illicit drugs	64	8
poor prenatal care	32	7
Premature birth < 37 weeks	26	10.5
other syndromes, congenital birth defects	2	3-4
premature birth	26	9
out of home placement	71	0.4
physical abuse	30	18
sexual abuse	18	9



The prevalences of other pre- and postnatal risks among children with FASD in other FASD clinical populations are comparable to that observed in the FASDPN.

Flannigan et al., *Characterizing adverse childhood experiences among children and adolescents with PAE and FASD*, *Child Abuse & Neglect* 112 (2021) 104888.

McLachlan et al., *J Popul Ther Clin Pharmacol* Vol 22(1):e108-e124; April 28, 2015.

Which risk factors pose the greatest risk to a child's growth and cognitive/behavioral development?

Prenatal alcohol exposure?

Prenatal tobacco exposure?

Prenatal illicit drug exposure?

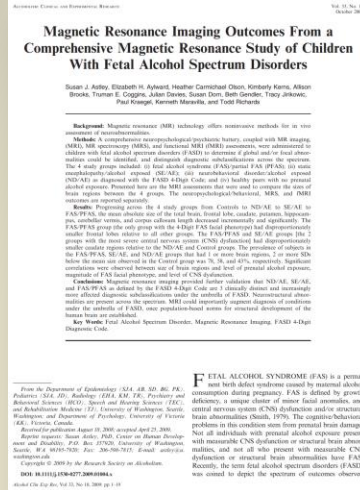
No prenatal care?

Multiple home placements?

Physical/sexual abuse?

Neglect, homelessness, domestic violence?

In 2009 the FASDPN Conducted a FASD MRI & Neuropsychological Study



Study Population:

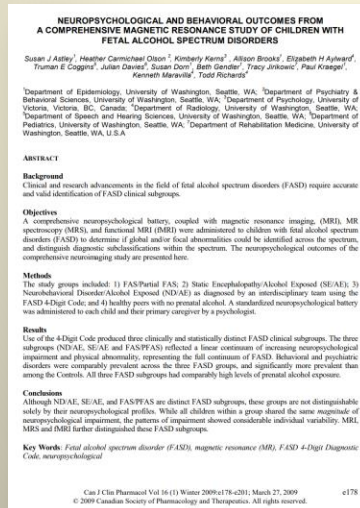
Four groups of children (20 per group)

1. FAS
2. Static Encephalopathy/Alcohol Exposed
3. Neurodevelopmental Disorder / Alcohol Exposed
4. Typically developing children with no alcohol exposure

8-15 years old

<https://depts.washington.edu/fasdpn/htmls/literature.htm>

Data collected:



MRIs to assess size of brain, frontal lobe, caudate, putamen, hippocampus, cerebellar vermis and corpus callosum.

Neuropsychological assessment of intelligence, adaptation, academic achievement, executive function, memory, attention, language, motor, mental health.

PAE and other prenatal/postnatal risks collected during the FASD diagnostic evaluation.

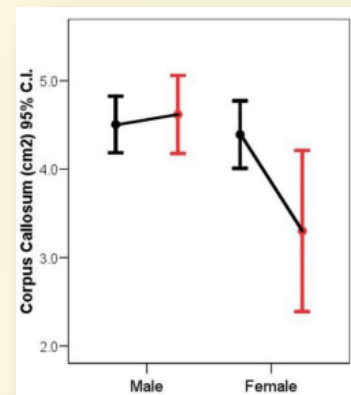
Adverse impact of PAE and pre- and postnatal risks on brain structure & function

Brain Outcome	Proportion of variance explained/ Adjusted R ²	Prenatal Risks							Postnatal Risks						
		Alc: days/wk	Alc: all 3	any illicit	cigs	cocaine	mj	any drugs	# homes	not w/ birth parent	SES: educ	SES: occup	SES: low income	phys abuse	sex abuse
Brain:															
Total brain volume (cm3)	.17 .31	2		1											
Total brain midsagittal area (cm2)	.20	1													
Current OFC (cm)	0.26	1													
Frontal Lobe:															
Frontal lobe gray matter volume (cm3)	.20 .29 .35 .43	1		2			3						4		
Frontal lobe white matter volume (cm3)	.13	1													
Frontal lobe volume (cm3)	.21 .28	1		2											
Caudate:															
R. Caudate volume (cm3)	.30 .39		1				2								
L. Caudate volume (cm3)	.29 .38		1				2								
Total Caudate volume (cm3)	.30 .40		1				2								
Putamen:															
R. Putamen volume (cm3)	.08						1								
L. Putamen volume (cm3)	.12								1						
Total Putamen volume (cm3)	.10								1						
Hippocampus:															
R. Hippocampus volume (cm3)	.94	1													
L. Hippocampus volume (cm3)	.28 .32	1								2					
Total Hippocampus volume (cm3)	.33	1													
Cerebellar Vermis:															
Total CV: midsagittal area (cm2)	.10													1	
CV: lobules I-VI midsagittal area (cm2)	.10 .18 .29			3			2	1						1	
CV: lobules VII-VIII midsagittal area (cm2)	.09													1	
CV: lobules VIII-X midsagittal area (cm2)	.15					1									
Corpus Callosum:															
CC: midsagittal area (cm2)	.13 .23											2		1	
CC: Region 1 (genu) (cm2)	.16 .26											1		2	
CC: Region 2 (cm2)	.10													1	
CC: Region 3 (cm2)	.10													1	
CC: Region 4 (cm2)	.11											1			
CC: Region 5 (splenium) (cm2)	.10						1								
CC: Length (cm)*	.20 (.26)	1													
Soft Neurologic Signs:	QNST-II: Total Score (raw)	.24	1												
General Intellectual Function:	WISC III Full Scale IQ (ss)	.46 .54 .58	1	3						2					
	WISC III Verbal IQ (ss)	.43 .56 .62	1	3						2					
	WISC III Performance IQ (ss)	.40 .47 .51	1							3			2		
	WISC III Freedom from Distractability (ss)	.42 .49	1	2											
	WISC III Processing Speed (ss)	.30 .40	1			2									
Academic Achievement:	WIAT Basic Reading (ss)	.37	1												
	KeyMath Total (ss)	.42 .53	1									2			
Visuospatial Skills, Visual Memory, Organization:	VMI: Total (ss)	.28 .34	1			2									
	RCFT: Copy (raw)	.19 .25 .32	1					3				2			
	RCFT: Immediate Recall (T)	.28 .38	1									2			
	RCFT: Delayed Recall (T)	.44 .52	1									2			
Executive Function:	DKEFS: Tower, Total Achievement (ss)	.20										1			
	D-KEFS: Tower, Total Rule/Violation (cumulative Ntile Rank)	.22 .30 .36									3	1	2		
	D-KEFS: Verbal Fluency Conds 1-3 % Switch Accuracy (ss)	.22 .29			2					1					
	D-KEFS: Color Word Inhibit/Switch Complete Time (ss)	.12			1										
	D-KEFS: Trails, #/Letter Switch Complete Time (ss)	.31 .42			2		1			1					
	WCST: Total Errors (ss)	.22 .34			1							2			
Visual Memory:	CVLT-C: List A, Total Trials %Correct (T)	.35 .45 .50 .53	1		3					2	4				
	CVLT-C: List A, Trial 1, Free Recall (T)	.17	1												
Attention:	IVA: Full Response Control Quotient (ss)	.14 .21				1						2			
Language:	TOWK & TOLD (ss)	.40 .48 .55	1	2						3					
	TLC 1 & 2 (ss)	.41 .55	1			2									
Adaptive Behavior:	VABS: Adaptive Behav. Composite (ss)	.46 .52 .56	2	1	3										
	VABS: Socialization (ss)	.46 .50	2	1											
Behavioral Problems:	CBCL: Social Problems (T)	.24 .31			1									2	
	CBCL: Attention Problems (T)	.49 .56	1									2			
	CBCL: Internalizing Problems (T)	.31 .39	2											1	
	CBCL: Externalizing Problems (T)	.29 .34	1				2								
	CBCL: Total Competence (T)	.40 .46 .51	1				3							2	
Caregiver Report of Behavior:	BRIEF: Gen.Execut. Composite (T)	.44 .48	1	2											
	BRIEF: Behavioral Regulation Index (T)	.39 .43	1							2					
Mental Health: DISC # symptoms	Panic Disorder	none													
	Social Phobia	.36 .46			2									1	
	Obsessive Compulsive Disorder	.20												1	
	Post Traumatic Stress Disorder	.19												1	
	Schizophrenia	.22 .28								2				1	
	Mania / Hypomania	.41 .47 .52	1							2				3	
	Generalized Anxiety Disorder	.34 .45 .49	2				3			1					
	Attention Deficit/Hyperactivity Disorder	.47 .51	1	2											
	Separation Anxiety Disorder	.17													
	Conduct Disorder	.30 .35	1											2	
	Oppositional Defiant Disorder	.13	1												

Findings:

- The prevalence of other prenatal and postnatal risks was substantially high among this clinical population of patients with PAE.
- PAE was the dominant risk factor explaining the largest proportion of variance (up to 53%) across the greatest number of brain structural and functional measures.
- Individually, each of the other prenatal and postnatal risk factors explained a statistically significant, but smaller proportion of variance in brain outcome compared to PAE.
- All associations were in the direction expected (the more severe the risk, the more severe the outcome).
- The outcomes were strikingly consistent with the trauma, SES, tobacco and illicit drug literature.

Sexual Abuse (no, yes)



Literature Findings:

- Sex abuse: female CC
- Tobacco: cerebellar vermis, attention, LBW
- Phys abuse: behavior, psychiatric disorders.
- Illicit drugs: caudate, behavior, ADHD,
- SES: Hippocamp, IQ, Exec. Function, memory, language

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	Attention Deficit/Hyperactivity Disorder	.47 .51	1	2											
	Separation Anxiety Disorder	.17													
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	Oppositional Defiant Disorder	.13	1												

By presenting the outcomes of this study as a single, colored graphic one can see some important patterns.

- Despite the fact all subjects were exposed to alcohol, alcohol was rarely the only risk factor significantly contributing to an adverse outcome and roughly 1/3 of the time alcohol did not contribute at all to the adverse outcome. The adverse outcome was explained solely by the other pre and postnatal risk factors.
- These outcomes illustrate why there is need for caution when labeling a patient's diagnosis based on a single risk factor, especially when multiple other risks are present.
- Not all individuals with PAE present with adverse outcomes. In the FASDPN clinic, 8% with PAE (even high levels of PAE) present with normal growth and development. Not everyone is equally susceptible to the teratogenic impact of PAE. Our twin study illustrated that the effects of the teratogen alcohol can be modified by genetic differences in fetal susceptibility and resistance.

Conclusion

A better understanding of the high prevalence of other prenatal and postnatal risks and their adverse impact on the growth and development of individuals with prenatal alcohol exposure will lead to:

1. more accurate FASD diagnoses,
2. more effective intervention strategies and
3. further illustrates the need for caution when labeling a patient's diagnosis based on a single risk factor (Aase et al 1995; Astley Hemingway 1997, 2024; Eliason et al., 2024).

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