

Variation in Rates of ADHD Diagnoses Across Public Schools in Arkansas

Supplement 1: Additional Study Information and Sensitivity Analysis

eTable 1. Diagnostic codes for ADHD and [co-occurring](#) conditions

eFigure 1. Description of regions and region characteristics

eTable 2. Selected characteristics of kindergarteners, by region

eFigure 2. Subject Attrition diagram

eTable 3. Sociodemographic of study population

eTable 4. School level child and school characteristics, by quintile of proportion of children newly diagnosed with ADHD during kindergarten – Expanded sample

eTable 5. Adjusted odds ratios from multilevel model for the outcome of ADHD diagnoses during kindergarten - original and expanded sample

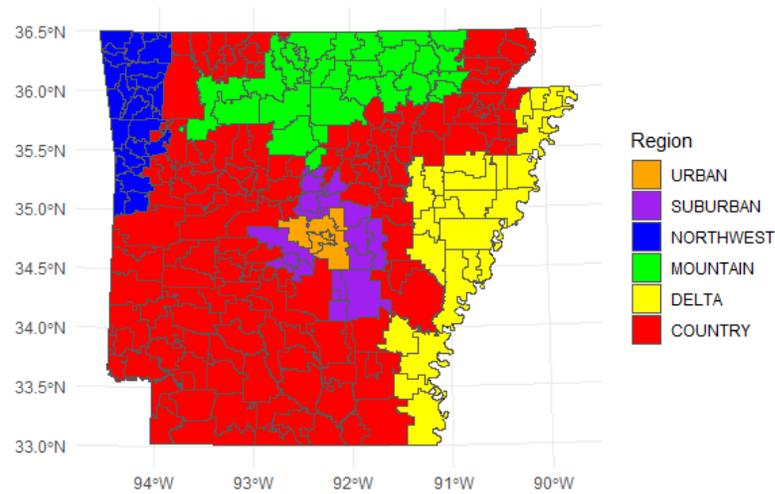
eTable 6. Adjusted odds ratios from multilevel model for the outcome of ADHD diagnoses during kindergarten – different model specifications

eTable 1. International Classification of Diseases (ICD), 9th and 10th Revisions, Clinical Modification (CM) used to identify ADHD and co-occurring conditions.

Condition	ICD-9-CM	ICD-10-CM
Attention-deficit/hyperactivity disorder	314.00, 314.01, 314.0	F90.0, F90.1, F90.2, F90.8, F90.9
Oppositional defiant disorder	313.81	F91.3
Other disruptive behavioral disorders	312.81, 312.82, 312.89	F91.1, F91.2, F91.9
Autism spectrum disorder	299.00	F84.0
Major depressive disorder	296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35	F32.0, F32.1, F32.3, F32.4, F32.9, F33.0, F33.1, F33.2, F33.3, F33.41, F33.9
Anxiety disorders	309.21, 313.23, 300.29, 300.23, 300.01, 300.22, 300.02, 293.84, 300.09, 300.00	F93.0, F94.0, F40.218, F40.228, F40.230, F40.231, F40.232, F40.233, F40.248, F40.298, F40.10, F41.0, F40.00, F41.1, F06.4, F41.8, F41.9
Stress disorders	309.81, 308.3	F43.10, F43.0
Specific learning disorders	315.00, 315.2, 315.1	F81.0, F81.81, F81.2
Tic disorders	307.23, 307.22, 307.21, 307.20	F95.2, F95.1, F95.0, F95.8, F95.9

ICD codes provide a standardized system to code medical diagnoses. They appear in claims data because they are used for billing purposes. The codes receive major revisions periodically. The study period covered the transition from ICD-9 revisions to the ICD-10 revisions in the Arkansas All-Payer Claims Database.

eFigure 1. Description of regions and region characteristics

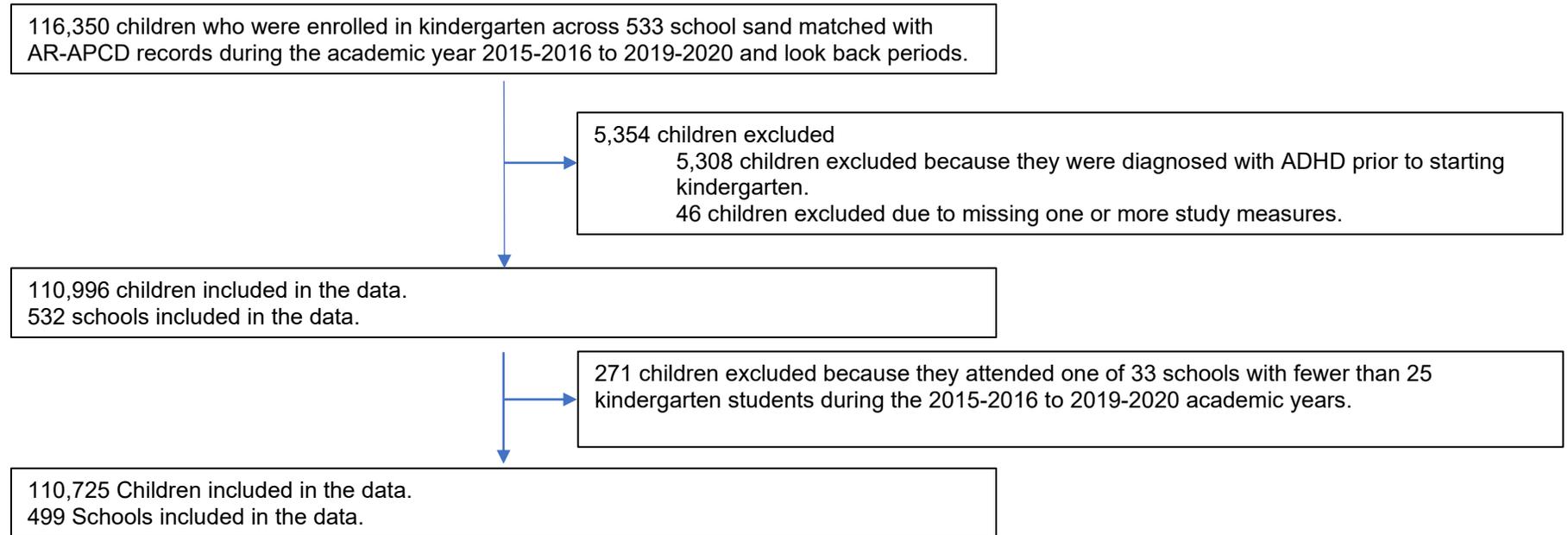


In the manuscript, 6 region indicators were used to capture broad differences in rurality and economic opportunity across the state. These regions include (1) Delta, a largely rural region of the state falling within the Mississippi Delta; (2) Northwest, a rapidly urbanizing and more affluent region of the state; (3) Mountain, the predominantly rural regions of the Ozark Mountains; (4) Urban, Little Rock and its immediate vicinity; (5) Suburban, districts within the Little Rock commuting vicinity, and (6) Country, which is comprised of the remaining rural regions of Arkansas.

eTable 2. Selected characteristics of kindergarteners, by region (N=87,383)

	Country N=36,256	Delta N=6,529	Mountain N=4,743	Northwest N=18,373	Suburban N=10,521	Urban N=10,961	P value
Race/ethnicity, %							
Hispanic	9.6	3.9	2.5	24.1	5.7	8.1	<0.001
Non-Hispanic African American	17.0	61.8	0.4	4.2	26.6	57.0	
Non-Hispanic other race	5.0	2.7	2.6	12.0	4.5	5.1	
Non-Hispanic White	68.5	31.6	94.4	59.7	63.2	29.8	
Individual level meal status, %							
Meal status – free meal	71.1	89.6	71.2	58.2	57.6	72.5	<0.001
Meal status – reduced price	8.1	3.2	9.5	9.4	7.7	5.3	
Meal status - full-price paid	20.8	7.3	19.3	32.5	34.7	22.3	
Child opportunity index score (1-100), mean							
Overall COI	41.43	22.06	38.51	64.01	60.24	43.85	<0.001
Education (ED)	44.06	20.77	42.66	61.63	61.37	43.71	<0.001
Health and environment (HE)	45.34	28.66	48.81	61.21	55.18	37.46	<0.001
Social and economic (SE)	41.17	23.72	37.46	63.77	59.50	45.30	<0.001

eFigure 2. Subject Attrition diagram with relaxed continuous coverage requirement



eTable 3. Sociodemographic of study population

Characteristic	Study sample (N=87,383)		Expanded sample ^a (N=110,725)	
	N / Mean	% / SD	N / Mean	% / SD
ADHD diagnoses during kindergarten	4,520	5.2	5,179	4.7
Sex, n (%)				
Female	42,773	49.0	54,538	49.3
Male	44,610	51.0	56,187	50.7
Race/ethnicity, n (%).				
Hispanic	9,779	11.2	12,050	10.9
Non-Hispanic African American	20,021	22.9	23,927	21.6
Non-Hispanic White	52,240	59.8	67,401	60.9
Non-Hispanic other race	5,343	6.1	7,347	6.6
Other individual characteristics, n (%).				
Went to a school-based health center	2,130	2.4	2,732	2.5
Active in special education program	14,794	16.9	17,404	15.7
Mobile	10,051	11.5	12,823	11.6
Young for grade	18,060	20.7	23,018	20.8
Individual level meal status, n (%).				
Meal status – free meal	59,699	68.3	72,032	65.1
Meal status – reduced price	6,707	7.7	8,517	7.7
Meal status - full-price paid	20,977	24.0	30,176	27.3
<u>Co-occurring</u> conditions of interest, n (%)				
Oppositional defiant disorder (ODD)	1,713	2.0	1,922	1.7
Other disruptive behavioral disorder	3,855	4.4	4,296	3.9
Autism (AUT)	1,635	1.9	1,772	1.6
Depression (DEP)	297	0.3	333	0.3
Anxiety (ANX)	3,229	3.7	3,636	3.3
Post-traumatic stress disorder (PTSD)	782	0.9	930	0.8
Specific learning disorder (SLD)	193	0.2	216	0.2
Tic disorder (TIC)	223	0.3	251	0.2
Ever use of stimulants	3,684	4.2	4,260	3.9
Received at least 1 disciplinary referral, n (%)	6,793	7.8	8,337	7.5
Region, n (%)				
Country	36,256	41.5	44,966	40.6
Delta	6,529	7.5	7,914	7.2
Mountain	4,743	5.4	5,950	5.4
Northwest	18,373	21.0	24,905	22.5
Suburban	10,521	12.0	13,438	12.1
Urban	10,961	12.5	13,552	12.2
Child opportunity scores, mean (sd)				
Overall	47.14	27.87	48.24	27.87
Education	47.98	27.85	48.95	27.90
Health and environment	47.81	28.02	48.72	27.97
Social and economic	47.14	27.97	48.19	27.94
School level meal program, n (%)				
Universal free meal	19,431	22.2	23,635	21.4
Breakfast after bell	29,851	34.2	37,775	34.1
No.	87,383		110,725	

^a. [Expanded sample uses the relaxed continuous coverage requirement.](#)

eTable 4. School level child and school characteristics, by quintile of proportion of children newly diagnosed with ADHD during kindergarten – Expanded sample

	Quintile of ADHD diagnoses rate during kindergarten						Q5/Q1 Ratio	
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5			
Proportion of children newly diagnosed with ADHD during kindergarten (%)	1.6	3.2	4.2	5.5	8.9	5.54	+	
Number of schools	100	100	100	100	99	NA		
Number of students	18,267	22,385	23,365	26,090	20,618	NA		
Child characteristics aggregated to the school level (%)								
Female	49.2	49.1	49.2	49.0	49.1	1.00		
Male	50.8	50.9	50.8	51.1	50.9	1.00		
Hispanic	14.3	10.5	10.0	9.2	6.8	0.48	-	
Non-Hispanic African American	13.3	17.9	20.5	27.2	37.9	2.85	+	
Non-Hispanic White	63.8	65.3	63.5	58.7	50.7	0.79	-	
Non-Hispanic other race	8.6	6.3	6.1	4.9	4.6	0.53	-	
Went to a school-based health center	3.4	3.2	3.1	1.8	1.9	0.55	-	
Active in special education program	14.5	15.2	16.7	16.5	16.5	1.14	+	
Mobile	10.6	11.3	10.8	13.0	14.0	1.31	+	
Young for grade	20.7	20.4	20.7	21.3	21.5	1.04	+	
Meal status – free meal	62.9	61.3	64.0	70.7	76.4	1.21	+	
Meal status – reduced price	8.5	8.4	7.7	7.2	6.3	0.74	-	
<u>Co-occurring</u> conditions of interest (%)								
Oppositional defiant disorder (ODD)	1.0	1.2	1.4	1.8	3.0	2.96	+	
Other disruptive behavioral disorder	2.3	3.0	3.5	4.5	6.3	2.81	+	
Autism (AUT)	1.6	1.5	1.7	1.6	1.3	0.83		
Depression (DEP)	0.3	0.3	0.3	0.3	0.4	1.56		
Anxiety (ANX)	3.1	3.0	2.9	3.2	3.8	1.23	+	
Post-traumatic stress disorder (PTSD)	0.8	0.7	0.8	1.0	1.1	1.48	+	
Specific learning disorder (SLD)	0.2	0.3	0.2	0.2	0.2	1.37		
Tic disorder (TIC)	0.2	0.2	0.2	0.2	0.2	0.78		
Ever use of stimulants	1.6	2.7	3.4	4.8	7.0	4.52	+	
Any disciplinary infraction, %	5.3	6.4	6.7	9.0	10.3	1.96	+	
Student Region (%)								
Country	33.3	29.4	33.8	40.1	45.9	1.38	+	
Delta	1.0	7.9	4.0	9.7	16.0	15.58	+	
Mountain	10.7	6.6	9.6	5.1	1.1	0.10	-	
Northwest	38.0	30.0	21.6	11.1	5.1	0.13	-	
Suburban	7.9	15.3	12.3	17.0	7.4	0.94	-	
Urban	9.1	10.8	18.9	17.1	24.4	2.68	+	
Child opportunity index (1-100)								
Overall COI	51.60	50.46	50.22	42.26	36.09	0.70	-	
Education (ED)	49.08	49.33	49.56	44.29	37.54	0.76	-	
Health and environment (HE)	52.72	51.27	47.89	43.21	36.93	0.70	-	
Social and economic (SE)	52.35	50.57	50.69	41.99	37.00	0.71	-	
School characteristics								
Total number of enrolled students	182.67	223.85	233.65	260.90	208.26	1.14		
Universal free meal (%)	16.0	17.5	22.9	29.6	34.1	2.14	+	
Breakfast after bell (%)	33.3	31.2	36.1	36.4	31.9	0.96		

+/-: significant at 0.05 level.

eTable 5. Adjusted odds ratios from multilevel model for the outcome of ADHD diagnoses during kindergarten -original and expanded sample

Factor	Original sample (N=87,383)		Expanded sample (N=110,725)	
	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Sex (ref: Male)				
Female	0.39 (0.36 - 0.41)	<0.001	0.39 (0.36 - 0.41)	<0.001
Race/ethnicity (ref: Non-Hispanic White)				
Hispanic	0.41 (0.36 - 0.47)	<0.001	0.42 (0.37 - 0.48)	<0.001
Non-Hispanic African American	0.94 (0.86 - 1.03)	0.20	0.94 (0.86 - 1.02)	0.15
Non-Hispanic other race	0.67 (0.58 - 0.77)	<0.001	0.69 (0.60 - 0.79)	<0.001
Other individual characteristics				
Went to a school-based health center	1.10 (0.89 - 1.35)	0.37	1.09 (0.9 - 1.32)	0.39
Mobile	1.50 (1.38 - 1.62)	<0.001	2.10 (1.94 - 2.29)	<0.001
Young for grade	1.25 (1.16 - 1.34)	<0.001	1.58 (1.39 - 1.79)	<0.001
Individual level meal status (ref: Full-price paid)				
Meal status – free meal	2.13 (1.94 - 2.34)	<0.001	1.51 (1.40 - 1.63)	<0.001
Meal status – reduced price	1.67 (1.46 - 1.92)	<0.001	1.25 (1.17 - 1.33)	<0.001
Child opportunity levels (ref: Very low)				
Education – low	1.02 (0.91 - 1.15)	0.68	1.04 (0.94 - 1.16)	0.47
Education – moderate	1.14 (1.00 - 1.29)	0.04	1.14 (1.01 - 1.28)	0.03
Education – high	1.14 (0.99 - 1.30)	0.07	1.12 (0.99 - 1.27)	0.08
Education – very high	1.15 (0.98 - 1.36)	0.10	1.12 (0.96 - 1.30)	0.16
Health and environment – low	0.94 (0.84 - 1.05)	0.26	0.93 (0.84 - 1.03)	0.18
Health and environment – moderate	0.90 (0.79 - 1.02)	0.11	0.88 (0.79 - 1.00)	0.04
Health and environment – high	0.90 (0.78 - 1.03)	0.13	0.89 (0.78 - 1.01)	0.07
Health and environment – very high	0.91 (0.78 - 1.06)	0.22	0.90 (0.78 - 1.04)	0.16
Social and economic – low	0.87 (0.78 - 0.97)	0.01	0.86 (0.78 - 0.96)	0.01
Social and economic – moderate	0.86 (0.76 - 0.97)	0.01	0.87 (0.77 - 0.97)	0.01
Social and economic – high	0.84 (0.74 - 0.96)	0.01	0.83 (0.73 - 0.94)	0.002
Social and economic – very high	0.78 (0.66 - 0.92)	0.003	0.77 (0.66 - 0.90)	0.001
School level meal program				
Universal free meal	0.79 (0.71 - 0.88)	<0.001	0.78 (0.71 - 0.87)	<0.001
Breakfast after bell	0.98 (0.91 - 1.07)	0.70	0.98 (0.90 - 1.06)	0.54
	Random effect (variance)		Random effect (variance)	
School (Intercept)	0.112		0.104	
Student region (Intercept)	0.028		0.031	
Provider (Intercept)	0.052		0.054	
N	87,383		110,725	
N of schools	490		499	
N of providers	3,579		3,766	
N of regions	6		6	

eTable 6. Adjusted odds ratios from multilevel model for the outcome of ADHD diagnoses during kindergarten – alternative model specifications

Factor	Original model (N=87,383)		Model 2 (N=87,383)		Mode 3 (N=87,383)	
	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Sex (ref: Male)						
Female	0.39 (0.36 - 0.41)	<0.001	0.39 (0.36 - 0.41)	<0.001	0.39 (0.36 - 0.41)	<0.001
Race/ethnicity (ref: Non-Hispanic White)						
Hispanic	0.41 (0.36 - 0.47)	<0.001	0.41 (0.35 - 0.47)	<0.001	0.42 (0.37 - 0.48)	<0.001
Non-Hispanic African American	0.94 (0.86 - 1.03)	0.20	0.92 (0.84 - 1.01)	0.08	0.99 (0.91 - 1.08)	0.80
Non-Hispanic other race	0.67 (0.58 - 0.77)	<0.001	0.66 (0.57 - 0.76)	<0.001	0.68 (0.59 - 0.79)	<0.001
Other individual characteristics						
Went to a school-based health center	1.10 (0.89 - 1.35)	0.37	1.08 (0.88 - 1.33)	0.45	1.06 (0.87 - 1.28)	0.57
Mobile	1.50 (1.38 - 1.62)	<0.001	1.48 (1.36 - 1.61)	<0.001	1.50 (1.38 - 1.63)	<0.001
Young for grade	1.25 (1.16 - 1.34)	<0.001	1.25 (1.16 - 1.34)	<0.001	1.25 (1.17 - 1.35)	<0.001
Individual level meal status (ref: Full-price paid)						
Meal status – free meal	2.13 (1.94 - 2.34)	<0.001	2.15 (1.96 - 2.36)	<0.001	2.12 (1.93 - 2.32)	<0.001
Meal status – reduced price	1.67 (1.46 - 1.92)	<0.001	1.70 (1.48 - 1.95)	<0.001	1.66 (1.44 - 1.91)	<0.001
Child opportunity levels (ref: Very low)						
Education – low	1.02 (0.91 - 1.15)	0.68	1.04 (0.92 - 1.16)	0.55	0.99 (0.90 - 1.10)	0.85
Education – moderate	1.14 (1.00 - 1.29)	0.04	1.15 (1.02 - 1.31)	0.03	1.12 (1.01 - 1.25)	0.03
Education – high	1.14 (0.99 - 1.30)	0.07	1.16 (1.01 - 1.33)	0.03	1.16 (1.03 - 1.30)	0.01
Education – very high	1.15 (0.98 - 1.36)	0.10	1.18 (1.00 - 1.39)	0.05	1.17 (1.02 - 1.35)	0.02
Health and environment – low	0.94 (0.84 - 1.05)	0.26	0.94 (0.84 - 1.06)	0.31	0.92 (0.84 - 1.02)	0.13
Health and environment – moderate	0.90 (0.79 - 1.02)	0.11	0.91 (0.80 - 1.03)	0.14	0.89 (0.80 - 1.00)	0.06
Health and environment – high	0.90 (0.78 - 1.03)	0.13	0.91 (0.79 - 1.04)	0.17	0.90 (0.80 - 1.02)	0.09
Health and environment – very high	0.91 (0.78 - 1.06)	0.22	0.91 (0.78 - 1.07)	0.26	0.88 (0.77 - 1.02)	0.09
Social and economic – low	0.87 (0.78 - 0.97)	0.01	0.86 (0.77 - 0.96)	0.01	0.87 (0.78 - 0.96)	0.01
Social and economic – moderate	0.86 (0.76 - 0.97)	0.01	0.86 (0.76 - 0.97)	0.01	0.84 (0.75 - 0.94)	0.002
Social and economic – high	0.84 (0.74 - 0.96)	0.01	0.84 (0.73 - 0.96)	0.01	0.86 (0.76 - 0.97)	0.02
Social and economic – very high	0.78 (0.66 - 0.92)	0.00	0.77 (0.65 - 0.91)	0.00	0.79 (0.68 - 0.92)	0.00
School level meal program						
Universal free meal	0.79 (0.71 - 0.88)	<0.001	0.79 (0.71 - 0.88)	<0.001	0.82 (0.75 - 0.89)	<0.001
Breakfast after bell	0.98 (0.91 - 1.07)	0.70	0.98 (0.90 - 1.07)	0.66	0.99 (0.92 - 1.05)	0.68
	Random effect (variance)		Random effect (variance)		Random effect (variance)	
School (Intercept)	0.112		0.120		-	
Student region (Intercept)	0.028		0.029		0.023	
Provider (Intercept)	0.052		-		0.080	
AIC	33703.0		33814.7		33831.9	
BIC	33956.2		34058.5		34075.7	
N	87,383					
N of schools	490					
N of providers	3,579					
N of regions	6					