Education Expenditure and Preventive Dental Care Use for Medicaid-Enrolled Children

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Abstract

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Purpose: The aim of this retrospective, cross-sectional analysis of school district expenditure and Medicaid claims data was to evaluate the relationship between public education expenditure and preventive dental care use in Medicaid-enrolled children in Washington

Methods: We obtained publicly available per-pupil public school district-level expenditure data in Washington state in U.S. dollars (2019-2020 academic year) from the Washington Office of Superintendent of Public Instruction. School-aged children ages 5 to 18 years who were enrolled in Washington State Medicaid in calendar year 2019 with a valid mailing address were identified and geocoded into a unique public school district. School district-level preventive dental care use for Medicaid enrollees ages 5 to 18 years

was calculated from the Medicaid claims data. The primary outcome was school district-level preventive dental care use. The main predictor variable, school district-level per-pupil public school expenditure, was classified into quartiles. Associations were evaluated using unadjusted and confounder-adjusted linear regression models with robust standard errors (α=0.05). We also ran stratified models to examine whether results differed for urban and rural school districts.

Findings: There were 296 school districts in Washington state with a mean per-pupil expenditure of $17,265 (standard deviation: $6,468; range: $10,784 to $52,335), and there were 735,457 children ages 5 to 18 years enrolled in Washington state Medicaid in 2019. Mean enrollee age was 11.2 years (standard deviation: 4.1 years), 49% were female, 50% were white, and 84% lived in a rural community. About 42.7% of Medicaid enrollees utilized preventive dental care in 2019. In the unadjusted analyses, Medicaid-enrolled children in the highest school district expenditure quartile utilized preventive dental care (40%, SD 0.09) significantly less frequently than those in the lowest, second lowest and third lowest expenditure quartiles (44%, 45% and 45%, respectively; p<0.01). The confounder-adjusted models yielded the same results. Furthermore, in the stratified models the observed association remained statistically significant only for rural school districts.

Conclusions: Public school spending is associated with preventive dental care use for school-aged children in Medicaid but only in rural communities. Future research should continue to explore how district-level public school expenditure data could be used to

target preventive dental care interventions for the most vulnerable school-aged children enrolled in Medicaid.

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I. Introduction:

While dental caries (tooth decay) is largely preventable, it remains the most common chronic disease of childhood.[1] The consequences of childhood tooth decay include pain,[2] difficulty eating, impaired growth, and decreased overall quality of life.[3-5] Preventive dental care in childhood helps prevent tooth decay, yet nearly one-in-three low-income U.S. children and adolescents from households that earn less than 200% of the federal poverty line (FPL) failed to utilize preventive dental care in 2020-2021, which is 11.2% higher than the Healthy People 2030 goal of 20.1%.[6, 7] By comparison, in 2020, three times fewer high-income (>400% FPL) U.S. children and adolescents did not utilize preventive dental care (12.7%).[8]

The World Health Organization (WHO) recognizes education as a primary social determinant of health (SDOH) due to its influence on the conditions in which people are born, grow, live, work, and age. Educational attainment is associated with reduced population mortality and improved general health.[9-16] In 2019, $752.3 billion was spent on U.S. public elementary and secondary education, averaging $15,500 per pupil.[17, 18] In comparison, per-pupil expenditure by the United States in 2019 was $1,700 higher, $1,800 higher, $2,700 higher and $4,800 higher than that in Sweden, Germany, Canada and Japan, respectively.[17] Publicly funded school-based health initiatives have been shown to be a cost-effective mechanism for improving the overall health of school aged children.[19-21] Of note, school-based sealant programs have historically been successful and cost effective in delivering preventive dental care to low-income U.S. children.[22, 23]

While associations between SDOH and health outcomes have been observed, the causal pathways between education and improved health are less well understood.[24] This is largely due to the lag time involved for health effects to manifest. Link and Phelan's Fundamental Cause Theory proposes that education affects health by improving access to resources such as income, safe neighborhoods, and healthier lifestyles.[25, 26] This theory is supported by large, longitudinal studies from the U.S. and Europe indicating that increased educational attainment leads to decreased mortality.[27, 28] Recently Braveman and Gottlieb published a simplified conceptual model based on the Fundamental Cause Theory.[24] It proposes three pathways linking educational attainment to health outcomes: (1) education increases knowledge and skills that facilitate healthier behaviors; (2) education increases working wages and better jobs that improve many health outcomes; and (3) education modulates health through psychobiological processes such as control beliefs, subjective social status, and social networks. In 2007, Fisher-Owens et al. presented a conceptual model that included links between education and children's oral health,[29] and more recently it has been observed in Europe that increased country-level public education expenditure is associated with increased frequency of dental visits when schooled children become adults.[30]

Braveman and Gottlieb's application of the Fundamental Cause Theory supports a hypothesized link between education expenditures and dental care use, but to date no studies have explored these links. Furthermore, as current evidence demonstrates the impact of rurality on dental care use, the effects of education expenditure may be

dampened in rural areas that have well-documented barriers to dental care. [31-36] The purpose of the present study was to test the hypothesis that increased public education expenditure in Washington state would be associated with greater preventive dental care use for Medicaid-enrolled children, regardless of known confounding variables that influence child preventive dental care.

II. Methods:

Study Design and Data Sources. This was a retrospective, cross-sectional, secondary data analysis. School district-level public education expenditure data for the 2019-2020 academic year were obtained from the Washington Office of Superintendent of Public Instruction (U.S. dollars, 2019-2020 academic year).[37] We obtained Medicaid enrollment and claims files for school-aged children ages 5 to 18 years enrolled in Medicaid for 11-12 months in 2019 from the Washington State Health Care Authority. The enrollment file included child's date of birth, race, ethnicity, and residence data with corresponding street address, city, zip code, and county. The claims files included a listing of all dental services received by the child through American Dental Association Current Dental Terminology (CDT) codes and for which a dentist billed the Medicaid program.

Geocoding into school districts. To ensure that our outcome measure was operationalized at the school district-level, valid Washington state Medicaid enrollee addresses were geocoded using the PostGIS [version 3.3] extension for PostgresSQL [version 15.1] [PostGIS] to obtain latitude and longitude coordinates.[38] Public school district geographic bounds were obtained from the Washington Geospatial Open Data Portal for the 2021 school year.[39] The enrollee addresses with a corresponding latitude and longitude coordinate were matched to a school district using a spatial join to place the coordinate point inside of a school district boundary.

Independent variable. The main independent variable was school district level per-pupil expenditure in the 2019-2020 academic year (U.S. dollars). Expenditure was categorized into quartiles with cuts at the 25th, 50th, and 75th percentiles ($13,867.50, $15,020.50, and $17,538.00, respectively).

Outcome. The outcome measure was school district-level preventive dental care use for Medicaid-enrolled school-aged children. We defined preventive dental care using the following CDT codes: D0120 (periodic oral evaluation), D0150 (comprehensive oral evaluation), D1110 (adult prophylaxis), D1120 (child prophylaxis), D1206 (topical fluoride varnish), D1206 and D1208 (topical fluoride varnish), D1330 (oral hygiene instruction), and D1351 and D1354 (silver diamine fluoride). If a child had any of these CDT codes, they were considered to have utilized preventive dental care in 2019. School-district level preventive dental care use was calculated within each school district as the sum of all children having any preventive dental care divided by the total number of children enrolled in Medicaid in 2019.

Confounders. Based on previous work, there were 5 school district-level variables conceptualized as model confounders: household income,[34, 40-42] parental education,[34, 42] race,[42, 43] special healthcare needs,[44, 45] and regionality.[46-48] School district-level household income, parental education, race and special healthcare needs variables were obtained for the 2020 calendar year from the US Census Bureau. Household income was defined as the mean school district-level household income.[49] Parental education was defined as the percent of adults ages 25-64 living within school

district geographic bounds who were high school graduates.[50] Race was dichotomized into race and ethnicity, where race was defined as the percent of school district-level Medicaid enrollees who were white and ethnicity was defined as the percent of school district-level Medicaid enrollees who were non-white and Hispanic. Rurality of public school districts were defined in accordance with the Washington state Office of Financial Management Education and Research Data Center based on Urban-Centric Locale and dichotomized into Urban (Large Metro, Metro Suburb, Mid-size and Urban Fringe) and Rural (Distant).[51, 52]

Effect Modifier. School districts were stratified into Urban (Large Metro, Metro Suburb, Mid-size and Urban Fringe) and Rural (Distant) based on their Urban-Centric Locale.

Data analysis. Descriptive statistics (means, standard deviations, counts, and percentages) were calculated for child and school-district level variables. School districts for which all pertinent school district-level variables were not available at the Washington State Report Card housed by the Washington Office of Superintendent of Public Instruction, US Census Bureau, and Education and Research Data Center were excluded from the analyses. Unadjusted and adjusted linear regression with robust standard errors was used to evaluate the association between school-district level per-pupil expenditure quartiles and school-district level percent of Medicaid children with any preventive dental care. All analyses were performed in Stata 14.1 and a significance level was set to 0.05.

III. RESULTS

Study population. In total, 735,457 children ages 5 to 18 years old enrolled in the Washington State Medicaid program were included in our analysis. Demographic information of enrollees is shown in Table 1. Mean enrollee age was 11.2 years (standard deviation: 4.1 years), 49.0% were female, 51.0% were white, and 83.8% lived in a rural area.

School district data. Table 2 describes school district level summaries of per-pupil expenditure and percentage of Medicaid children's utilization of preventive dental care for 2019. There were 296 school districts. Per-pupil school district expenditure ranged from $10,784 to $52,335. Most school districts were in the highest expenditure quartile (54.1%). About 61.2% of school districts were rural. Most rural school districts were in the highest spending quartile, whereas spending was more evenly distributed in the urban school districts.

Preventive dental care use. School district-level percentage of preventive dental care use ranged from 17% to 66% with a mean of 42.7% (SD=8%).

Association between per-pupil expenditure and preventive dental care use. Figure 1 illustrates the main study model portraying the relationship between quartiles of per pupil expenditure and school district-level percentage of Medicaid children who utilized preventive dental care. School districts reporting per-pupil expenditures in the highest spending quartile (75%+) had lower percentages of Medicaid-enrolled children

who utilized preventive dental care. The mean percentage of preventive dental care was significantly lower in the 75%+ per-pupil expenditure quartile compared to all other quartiles (Tukey $p<0.01$ for all).

When school districts were stratified into rural and urban locations as shown in Figure 2 a similar relationship was observed, but only in rural school districts. In rural school districts, the mean percentage of preventive dental care was significantly lower in the 75%+ per-pupil expenditure quartile compared to the 25%-<50% and the 50-<75% quartiles. Upon one-way ANOVA and a subsequent Tukey's t-test, this difference in preventive dental care use was found to be statistically significant on the $p<0.01$ level. No such association was observed between per-pupil expenditure quartiles and percentage of Medicaid children with preventive dental care in urban school districts.

Upon creation of a stratified model (rural vs. urban) analyzed with linear regression shown in Table 3, both unadjusted and adjusted models demonstrated that Medicaid-enrolled children in the highest per-pupil expenditure spending rural school districts utilized preventive dental care significantly less frequently than their counterparts in lower spending rural school districts (Unadjusted: $\beta=-0.04$, $p<0.01$; Adjusted: $\beta=-0.04$, $p<0.01$). Again, no such significant associations were observed across Washington state's urban school districts.

IV. DISCUSSION

In this study, we examined the relationship between public education expenditure and preventive dental care use for Medicaid-enrolled children in Washington state. Inconsistent with our hypothesis, the final regression models indicated that public education expenditure (per-pupil) was significantly, but negatively, associated with preventive dental care use for Medicaid-enrolled children. Furthermore, this observed negative association was only significant in rural public school districts.

Our main finding was that Medicaid-enrolled students in the highest spending school districts utilized preventive dental care significantly less frequently than their peers in lesser spending school districts. This is inconsistent with findings from Kino et al., who observed a non-statistically significant improvement in health-related behaviors, a component of which was described to be increased dental visit frequency, when compared to increased public school district expenditure.[30] One explanation for these inconsistent findings may have to do with differing study design features. Uniquely, our study (1) limited outcome analysis to preventive dental care use, (2) based our outcome variable on claims data, and (3) limited analysis to school districts within a single state and adjusted for school district-level confounders accordingly. Kino et al., on the other hand, (1) reported non-specific outcome variables and grouped increased dental visit frequency into a single variable with other behaviors regarded as improved health behaviors, (2) based their outcome variable on a survey instead of healthcare claims data, and (3) attempted to analyze 27 different European countries, each with their unique

characteristics that influence health behaviors – which could introduce (1) operational confounding, (2) recall bias, and (3) residual confounding bias, respectively.

When school districts were stratified into rural and urban groupings, preventive dental care use by children attending the highest spending rural school districts was significantly lower than by children attending lesser spending rural public school districts. These stratified results may be explained by several evidence-based factors that, in combination, moderate the effect of education spending on preventive dental care use in the United States. These factors include (1) higher spending school districts are located in high-income areas, (2) low-income children residing in high-income areas face unique health-related challenges, and (3) fewer pediatric dentists treat children in rural regions.

First, ever since public education finance research gained traction in the U.S. following the 1966 publication of the Coleman Report, evidence has identified persistent household-income driven disparities in public education spending across the country.[53, 54] Second, although limited, evidence suggests that for low-income children, living in a high-income neighborhood can negatively influence their health.[55] This affect may be moderated by (1) psychological distress in comparing oneself to higher-income peers, (2) concentration of health-promoting resources, such as dental offices, closer to where higher-income children reside, and (3) the inability of low-income children to afford fee-based resources provided in high-income neighborhoods.[55-58] Third, U.S. children living in rural areas are less likely to have a pediatric dentist serving their community and utilize preventive dental care significantly less frequently than their urban counterparts.[33, 59] Several factors, including poverty, decreased dentist density, increased travel distances

to dental offices, and challenges related to the COVID-19 pandemic may moderate this affect.[34-36, 60] Future study should seek to assess mechanisms that may moderate Medicaid-enrolled child preventive dental care use in high-income neighborhoods, particularly in those that are rural.

Our findings are relevant for future public health surveillance and intervention. Our initial hypothesis, which if confirmed, would have indicated the need to target low expenditure school districts for programs to improve preventive dental care use for Medicaid-enrolled children. However, our findings suggest that resource investment and intervention development designed to increase preventive dental care use by Medicaid-enrolled children may be most equitably distributed by targeting low-income children attending high-spending school districts in rural areas. As most available health science literature related to child social determinants of health focus on low-income children living in low-income neighborhoods, it's important not to overlook low-income children living in high-income neighborhoods. According to our analysis, low-income children living and attending school in high-income neighborhoods may be the most vulnerable children in Washington state. Incorporating the Fisher-Owens conceptual model, efforts to improve preventive dental care use among Medicaid-enrolled children could target interventions at the child level, family level, and community level.[29] At the child level, school based sealant and preventive dental service programs may offer a cost effective way to deliver preventive dental services to vulnerable children directly;[22, 23] at the family level, promotional campaigns designed to improve parental oral health literacy may facilitate healthier decisions by parents for their children when it comes to their oral health;[61] and at the community level, support for a 'wellness coordinator' that can aid in

connecting low-income families with dentists offering publicly available services may help bridge the gap between families and publicly available resources in high-income areas.[62] The efficacy of such targeted interventions could confirm if public school district per-pupil expenditure can serve as a true proxy for Medicaid-enrolled child preventive dental care use.

There are a number of study limitations. First, while statistically significant associations were observed in our analyses, one cannot infer causality from associations observed in our cross-sectional analysis. Second, the undifferentiated nature of reported school district expenditure data prevented our ability to assess the effect of any direct health-related expenditures in public school systems on preventive dental care use. A future study utilizing differentiated quantitative school spending data would enable one to assess the potential effects of health-related education spending directly on child preventive dental care use. Third, only Medicaid-claims data were available for use in the present study. Future study of disparities in preventive dental care use among high and low-income children attending higher-spending school districts would require private dental insurance claims data in addition to Medicaid-claims data.

V. CONCLUSION

We observed that the Medicaid-enrolled children attending the highest spending rural public school districts utilized preventive dental care significantly less frequently than their peers in lesser spending rural school districts. Future research should include (1) longitudinal study of public education expenditure's effect on a child's preventive dental care use as an adult, (2) quantitative analysis of differentiated education expenditure and its effect on child preventive dental care use, and (3) stratified study of high and low-income children enrolled in both public and private insurance systems in high spending, rural school districts.

VI. TABLES

Table 1 – Demographic data for Washington Medicaid-enrolled children ages 5-18 for 11-12 months in calendar year 2019 (N=735,457)

Characteristic	N	%
Sex		
Female	**361,054**	**49.1%**
Male	**374,403**	**50.9%**
Race		
White	**364,385**	**49.6%**
Black	**55,971**	**7.6%**
American Indian/Alaskan Native	**26,771**	**3.6%**
Asian	**27,466**	**3.7%**
Hawaiian/Pacific Islander	**25,683**	**3.5%**
Other/Multiple	**164,498**	**22.4%**
Missing	**70,683**	**9.6%**
Hispanic Ethnicity		
Hispanic/Latinx	**233,257**	**31.7%**
Not Hispanic/Latinx	**427,722**	**58.2%**
Missing	**74,478**	**10.1%**
Regionality		
Urban	**118,974**	**16.2%**
Rural	**616,346**	**83.8%**
Missing	**137**	**0.0%**

Table 2 – Quartile division of Washington state public school districts by per-pupil expenditure and percentage of total included enrollees utilization of preventive dental care

	School Districts N=296	**Urban***	**Rural**		
		N (%)	**N (%)**	**Mean (SD) ($)**	**[range] ($)**
Per-Pupil Expenditure	-	114 (38.5%)	181 (61.2%)	17,265.4 (6,468.1)	[10784, 52335]
***Quartiles** (by per-pupil expenditure)*					
<25%	71 (24%)	41 (36.0%)	30 (16.6%)	13,129.6 (503.2)	[10784, 13781]
25-<50%	37 (13%)	23 (20.2%)	14 (7.7%)	14,123.3 (185.1)	[13788, 14412]
50-<75%	70 (24%)	31 (27.2%)	39 (21.6%)	14,927.7 (336.1)	[14418, 15623]
75% +	118 (40%)	19 (16.7%)	98 (54.1%)	22,125.8 (8,041.2)	[15719, 52335]

*Note: 1 school district is missing regionality (Urban or Rural)

Figure 1 – Preventive dental care use for Medicaid-enrolled in Washington state by quartiles of their associated public school district per-pupil expenditure

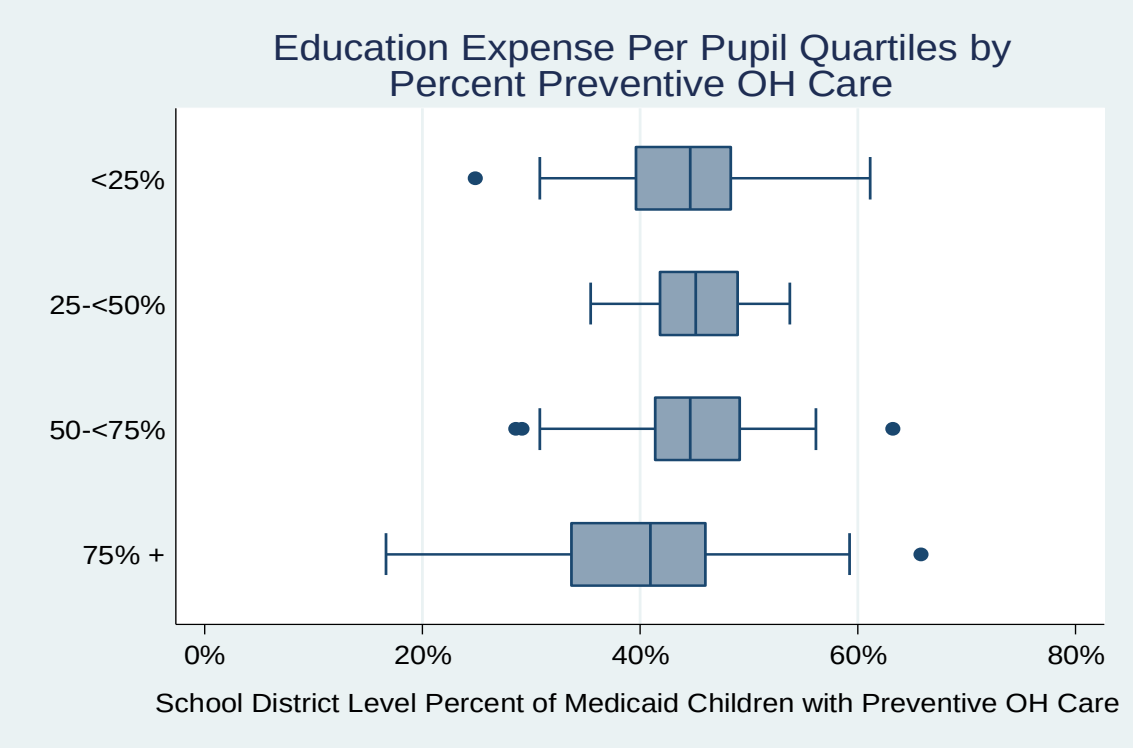

Figure 2 – Preventive dental care utilization for Medicaid-enrolled in Washington state by quartiles of their associated public school district per-pupil expenditure stratified by regionality (urban vs. rural)

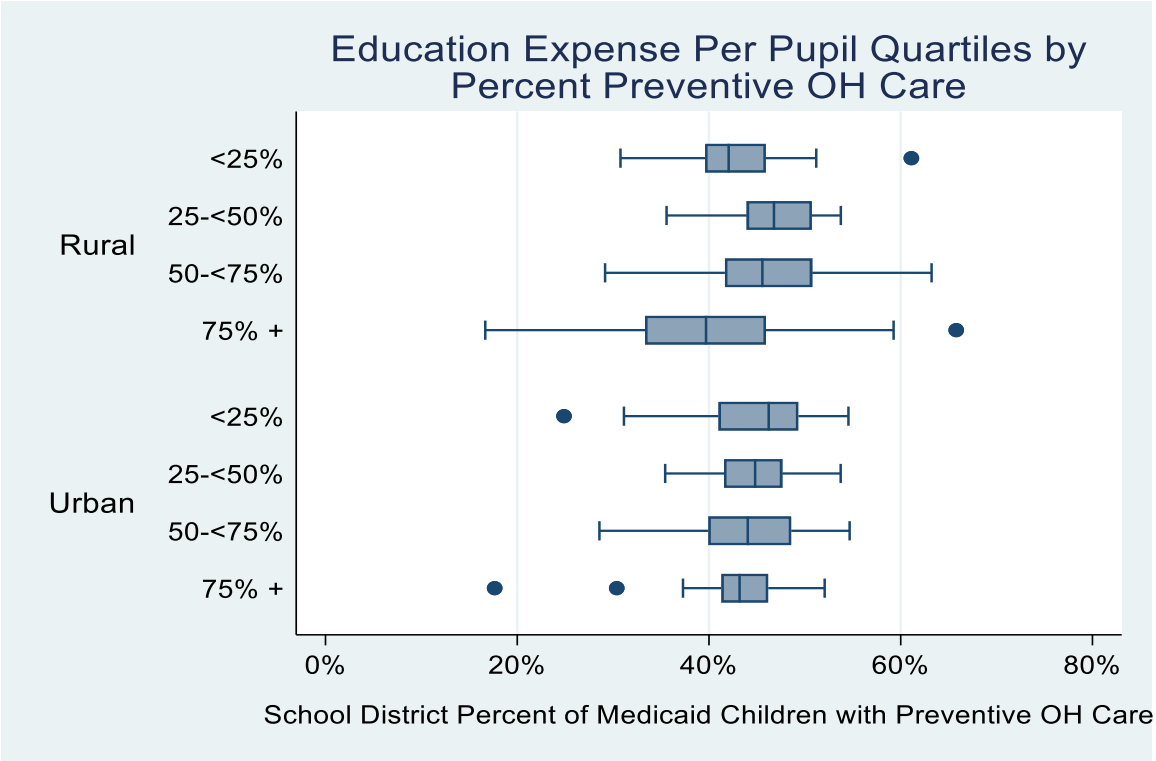

Table 3 – Multiple Variable Linear Regression Models for preventive dental care utilization among Medicaid-enrolled children in Washington state public school districts by per-pupil expenditure quartile, stratified by regionality (urban vs. rural)

	RURAL													
	Unadjusted		Adjusted		Adjusted		Adjusted		Adjusted		Adjusted		Adjusted	
	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p
Per Pupil Expenditure Quartiles		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01
<25%	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
25-<50%	0.04	0.03	0.04	0.04	0.03	0.09	0.04	0.03	0.04	0.03	0.04	0.03	0.02	0.19
50-<75%	0.03	0.02	0.03	0.06	0.03	0.07	0.03	0.02	0.04	0.02	0.03	0.02	0.02	0.26
75% +	-0.02	0.10	-0.03	0.06	-0.02	0.25	-0.02	0.11	-0.02	0.10	-0.02	0.11	-0.03	0.06
White Race %	--		0.00	0.30	--		--		--		--		0.00	0.02
Hispanic %	--		--		0.00	<0.01	--		--		--		0.00	<0.01
% of Federal Poverty Level for 4	--		--		--		0.00	0.86	--		--		0.00	0.84
% Children with Disabilities	--		--		--		--		0.04	0.68	--		0.05	0.60
% Adults with HS Education	--		--		--		--		--		0.00	0.96	0.01	0.85
	URBAN													
	Unadjusted		Adjusted		Adjusted		Adjusted		Adjusted		Adjusted		Adjusted	
	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p	Mean Diff	p
Per Pupil Expenditure Quartiles		0.47		0.47		0.28		0.85		0.67		0.80		0.46
<25%	Ref		Ref		Ref		Ref		Ref		Ref		Ref	
25-<50%	0.00	0.81	0.00	0.82	-0.01	0.41	-0.01	0.42	0.00	0.76	-0.01	0.41	-0.02	0.15
50-<75%	-0.01	0.41	-0.01	0.41	-0.02	0.30	0.00	0.70	-0.01	0.38	-0.01	0.47	-0.01	0.48
75% +	-0.03	0.14	-0.03	0.15	-0.04	0.06	-0.01	0.52	-0.02	0.28	-0.01	0.40	-0.02	0.21
White Race %	--		0.00	0.91	--		--		--		--		0.00	0.77
Hispanic %	--		--		0.00	<0.01	--		--		--		0.00	<0.01
% of Federal Poverty Level for 4	--		--		--		-0.02	<0.01	--		--		-0.02	<0.01
% Children with Disabilities	--		--		--		--		-0.01	0.19	--		-0.01	0.21
% Adults with HS Education	--		--		--		--		--		0.33	<0.01	0.14	0.16

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