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Air Pollution Around Schools Is Linked To Poorer Student Health And Academic Performance

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ABSTRACT Exposing children to environmental pollutants during important times of physiological development can lead to long-lasting health problems, dysfunction, and disease. The location of children's schools can increase their exposure. We examined the extent of air pollution from industrial sources around public schools in Michigan to find out whether air pollution jeopardizes children's health and academic success. We found that schools located in areas with the highest air pollution levels had the lowest attendance rates—a potential indicator of poor health—and the highest proportions of students who failed to meet state educational testing standards. Michigan and many other states currently do not require officials considering a site for a new school to analyze its environmental quality. Our results show that such requirements are needed. For schools already in existence, we recommend that their environmental quality should be investigated and improved if necessary.

There are more than fifty-three million schoolchildren and more than 135,000 public and private schools in the United States.[1] Are these schools safe and healthy places for children to grow, play, and learn? Or are we exposing children to unhealthy pollution?

Children are known to be more vulnerable than adults to the effects of pollution. Exposure to environmental pollutants during important times of physiological development can lead to long-lasting health problems, dysfunction, and disease.[2] Children's lung functioning is not yet fully developed.[3–5] Compared to adults, they breathe in greater levels of polluted air relative to their weight and spend more time outside when air pollution levels are the highest.[5] And because of differences in metabolism, mouthing behavior—such as the tendency to put their hands and objects in their mouths—and respiratory rates, children are often exposed to higher levels of lead, arsenic, pesticides, and other pollutants.[4] Moreover, children have little or no choice about where they live or go to school.

Childhood is a critical period for brain formation. Researchers have shown that children exposed to air pollution perform worse on cognitive functioning tests[6] and have impaired neurological function[7–9] and lower IQ scores[10] compared with other children. Also, children exposed to high levels of nitrogen dioxide—a common air pollutant generated by the burning of fossil fuels—have been found to have "decreases of 6.71, 7.37 and 8.61 points in quantitative, working memory and gross motor areas, respectively."[11]

Similarly, children with high levels of exposure to nitrogen dioxide and particles 10 micrometers or less in the air—a standard used by the Environmental Protection Agency (EPA) to measure air quality—perform significantly worse on neurobehavioral tests, even after confounding variables are controlled for.[6] In one example of this kind of test, to measure line discrimination,

the subject is instructed to hit the space bar on a computer keyboard within a second after seeing a long line, when being presented with long and short lines. And children with high levels of estimated exposure to black carbon—tiny particles released into the air by diesel exhaust, for example—have a decreased ability to perform well on both verbal and nonverbal intelligence and memory assessments, such as the Kaufman Brief Intelligence Test and the Wide Range Assessment of Memory and Learning.[10]

A large and growing body of evidence shows that pollution burdens fall disproportionately on low-income and racial or ethnic minority communities.[12–15] There is little evidence of disproportionate pollution burdens on children in these groups. However, a recent study by Manuel Pastor and his colleagues[16] found that California students in these categories were disproportionately exposed to high levels of respiratory risks from outdoor air pollution. Furthermore, the authors found that such exposure was associated with lower performance on standardized tests, even after controlling for important confounding variables such as school size, suburban—as opposed to urban or rural—location, and demographics of the student body.

The risks of air pollution around public schools were highlighted in a series of articles in *USA Today*.[17] The series provided estimates of air pollution from industrial sources for more than 125,000 schools in the United States, using data from the EPA. Schools were ranked based on the estimated pollution burdens around them. The *USA Today* analysis prompted the EPA to conduct a study of its own, and it selected sixty-four schools nationwide (two were in Michigan, where we conducted our study) for air quality monitoring, the results of which have been posted online by the agency.[18] However, neither *USA Today* nor the EPA examined the links between air pollution, health, and academic performance. Nor did they examine demographic disparities related to pollution burdens around schools.

School siting policies should protect children from their vulnerability to environmental pollution. However, many states do not have any school siting policies.[19] According to a 2006 survey, only fourteen states prohibit or severely restrict school districts from siting schools on or near sources of pollution or hazards that might pose a risk to children's health.[20] Twenty-one states have policies suggesting that officials "avoid" siting schools on or near specified manmade or natural environmental hazards, or "consider" those hazards when selecting school sites.

In November 2010 the EPA released a draft of voluntary school siting guidelines.[1] The draft guidelines recommend an initial assessment of air quality around a potential school site using existing data, such as the agency's air quality monitoring data or data from its National Air Toxics Assessment.[21] Although the guidelines do not propose maintaining minimum distances between schools and highways, factories, airports, rail lines, or other potential environmental hazards, they do recommend mitigating the effects of such hazards by using noise barriers, vegetation, or buildings. The agency says that "the guidelines are intended to assist communities and community members in making the best possible school siting decisions."[1] However, one critic has expressed concern that the voluntary guidelines might not be strong enough and could be ignored by many school districts.[22]

Children's health and well-being are viewed by many as top priorities in American society, but links between air pollution and children's school performance and health have received little attention and are not well understood. Our study started with three questions: Do public schools tend to be located in areas of less or more air pollution, compared to average or median levels for the state, the metropolitan area, and the school district? Are disparities in pollution burdens related to the demographic characteristics of the student body? And are levels of air pollution linked to student performance and health?

Study Data And Methods

We examined air pollution concentrations from industrial sources within one, two, and three kilometers of the 3,660 public elementary, middle, junior high, or high schools in Michigan. We based our estimates of air pollution deposition from industrial sources on the EPA's Risk-Screening Environmental Indicator geographic microdata.[23] The data set is modeled from emissions data in the EPA's Toxic Release Inventory to estimate pollution burdens in cells on a one-kilometer grid covering most of the continental United States (see "Data and Methods" in the online Appendix for a more detailed discussion).[24]

As a school performance measure, we used the 2007 Michigan Educational Assessment Program scores, a standardized test that all third to ninth graders in Michigan public schools are required to take.[25] More specifically, we used the percentage of students not meeting the state standards for English and math because, unlike other subjects, English and math are consistently tested from third to eighth grades (see "Data and Methods" in the online Appendix for a more detailed discussion).[24]

We downloaded information about school

demographics from the website of Michigan's Center for Educational Performance and Information.[26] This information included the number of students in each school, school expenditures, the racial and ethnic makeup of the school, and the number of students eligible for the free lunch program. We obtained address information and attendance rates for the schools from the Michigan Department of Education. We used ArcView geographic information system software, version 3.3, to digitally map the locations of the 3,660 schools.

We overlaid the school locations with the EPA's geographic microdata and estimated the total air pollution concentrations within one, two, and three kilometers of each school. Because these distances produce circular areas, and the EPA microdata pollution estimates are available only for one-kilometer squares, we used so-called areal apportionment to estimate pollution concentrations within the circular areas around the schools. That is, we determined the percentage of the area of a circle located within a microdata grid cell and multiplied this percentage by the pollution value for the cell. After the pollution estimates for all grid cells intersected by the circle were weighted by their respective percentages, we summed these weighted values over all of the grid cells to produce pollution estimates for the circular areas.

We determined the pollution concentrations at varying distances to see how robust the results of our analyses would be. We found that the results obtained at the varying distances were very consistent with each other. Because of space limitations, we thus report only the results of our analyses using the distance of two kilometers from the schools. This distance (approximately 1.2 miles) also serves as a proxy for the area that children are required to walk to school in most states—as opposed to being eligible for school buses—which exposes them to the pollution in this area.

Study Results

Exhibit 1 displays the 155,140 grid cells in Michigan sorted into deciles based on their estimated total air pollution concentration. The green areas have the lowest concentrations, while the red areas have the highest. Although the EPA's microdata are not designed to provide thresholds of health risk, they can be used to assess relative risk. Thus, people living in the areas with the lowest concentrations are at lower potential risk, compared to people in areas with the highest concentrations, of diseases associated with air pollution.

As Exhibit 1 indicates, although several places in Michigan's Upper Peninsula fall in the tenth, or most polluted, decile, most of the cells in this decile are in the lower part of Michigan, where the state's population is also concentrated. Exhibit 1 also indicates the locations of the public schools in Michigan for which Michigan Educational Assessment Program English and math scores are available. Because high schools do not consistently test for English and math, only elementary and middle schools are included. We provide a more detailed discussion about the links between pollution levels and performance on the standardized tests below.

LINKS BETWEEN SCHOOL LOCATIONS AND AIR POLLUTION In our analyses we first addressed the question of whether schools tend to be located in the less or more polluted areas of a particular region. Because more than 33 percent (1,221) of all public schools in Michigan are in the Detroit metropolitan area (Macomb, Oakland, and Wayne Counties), we began by comparing the median pollution levels around the schools in the metropolitan area with the median pollution levels in the metropolitan area as a whole (Exhibit 2).

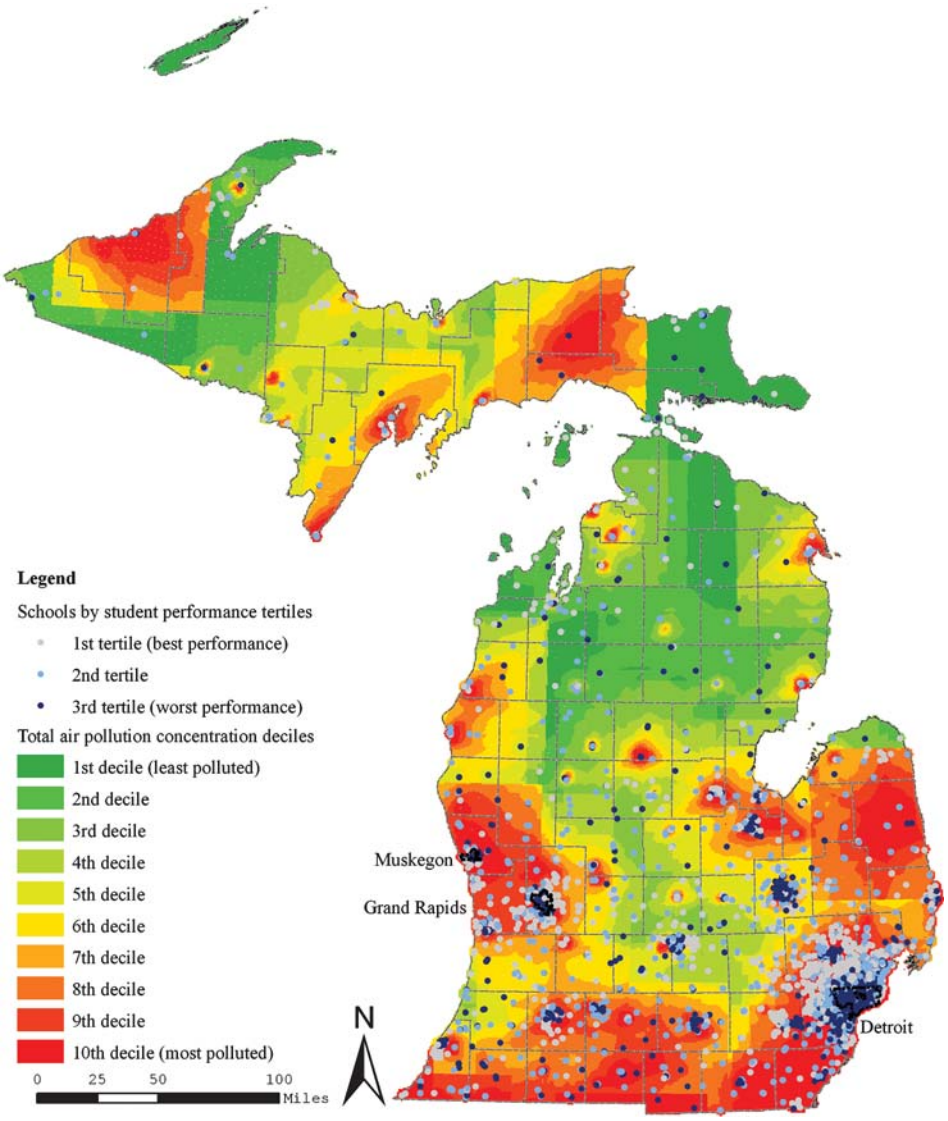
We found that the median air pollution concentrations of the areas within two kilometers of the schools in the metropolitan area were greater than the concentrations in the one-kilometer squares in the metropolitan area as a whole for every year from 1999 to 2006. Likewise, the median air pollution concentrations of the areas within two kilometers of the schools in the City of Detroit were higher than the concentrations in the one-kilometer squares in the city for the entire period.

Next we examined the distribution of all 3,660 schools in the state. We found that 62.5 percent of them were located in grid cells in the ninth and tenth deciles—the 20 percent of the cells with the greatest pollution from industrial sources (Exhibit 3). Almost half of the state's schools (48.4 percent) were in grid cells in the tenth decile. In addition, 67.3 percent of all schoolchildren in the state attended schools in the two most polluted deciles; more than half (53.0 percent) were in schools in the top decile.

We further found that the majority of schools in the two most polluted deciles were located in the more polluted parts of their respective school districts, thus further compounding the pollution burdens for students attending those schools. Specifically, 326 of the 514 schools in the ninth decile were in the more polluted parts of their school districts, as were 1,623 of the 1,773 schools in the tenth decile (Exhibit 3). Overall, 2,328 of the 3,660 public schools in Michigan, or 63.6 percent, were located in the

EXHIBIT 1

Deciles Of Total Air Pollution Concentrations From Industrial Sources In Michigan, With School Locations, By Student Performance Tertiles



SOURCE Authors' analysis of geographic microdata for 2006 from Note 23 in text. **NOTES** Only locations of elementary and middle schools are shown. Schools are sorted into three groups (tertiles) based on the percentage of students (grades 3–8 combined) who do not meet the Michigan Educational Assessment Program standards for English. The schools in the first tertile ("best performance") have the lowest percentage of students failing to meet the standards. For more details about the values of air pollution, see the Appendix (see Note 24 in text).

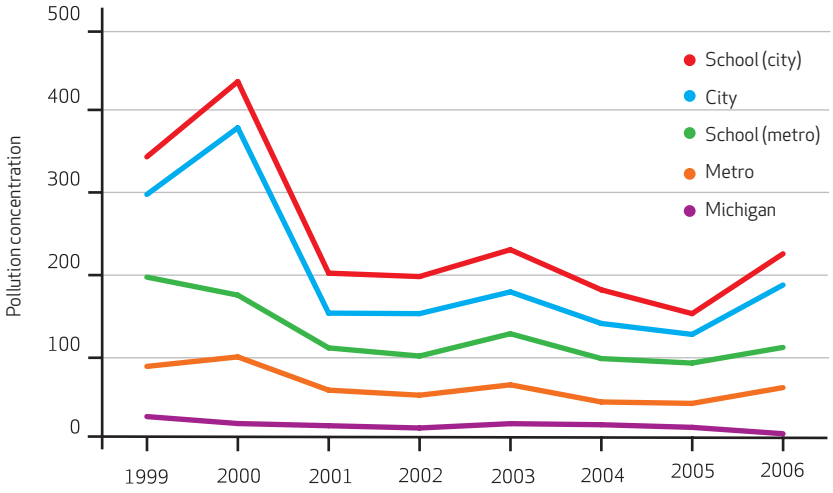
more polluted parts of their districts.

AIR POLLUTION AND SCHOOL DEMOGRAPHICS The demographics of the schools' student bodies followed a similar pattern. We found that 44.4 percent of all white schoolchildren in the state attended schools located in grid cells in the 10th (most polluted) decile, but 81.5 percent of all African American schoolchildren and 62.1 percent of all Hispanic schoolchildren did so. In those schools, 62.2 percent of all students were enrolled in the free lunch program, our chief socioeconomic indicator (Exhibit 3).

AIR POLLUTION, HEALTH, AND ACADEMIC PERFORMANCE Are air pollution burdens around schools linked to student health and performance? Although we cannot conclusively establish cause and effect linkages from our macro-level analysis, we can nevertheless examine associations and rule out obvious confounding variables, such as school demographics, school expenditures, and locations (suburban versus urban or rural) of schools.[16] And we can deter-

EXHIBIT 2

Median Total Air Pollution Concentrations Within Two Kilometers Of Schools And In Larger Areas, 1999–2006



SOURCE Authors' analysis of geographic microdata for 1999–2006 from Note 23 in text. **NOTES** Metro is the Detroit metropolitan area. City is the City of Detroit. Schools (metro) is areas within two kilometers of schools in the Detroit metropolitan area. Schools (city) is areas within two kilometers of schools in the City of Detroit. Median air pollution concentration values for Michigan, the Detroit metropolitan area, and the City of Detroit are for the one-kilometer squares in the respective areas. Median air pollution concentration values for schools in the Detroit metropolitan area and the City of Detroit are for the circular areas within two kilometers of the schools in those locations.

mine how robust the associations are, and whether they warrant concern.

▶ **CHEMICALS IN THE AIR:** We found that 95 percent of the estimated total air pollution concentrations around the schools came from twelve chemicals: diisocyanates, manganese, sulfuric acid, nickel, chlorine, chromium, trimethylbenzene, hydrochloric acid, molybdenum trioxide, lead, cobalt, and glycol ethers. The chemicals are listed in order, with diisocyanates contributing the most to pollution, and glycol ethers the least. These chemicals come from a variety of sources, including the motor vehicle, steel, and chemical industries; power plants; the manufacturers of rubber and plastic products; and the manufacturers of wood products. The chemicals are suspected of producing a wide variety of health effects, including increased risk of respiratory, cardiovascular, developmental, and neurological disorders, as well as cancer.[27]

Some of the chemicals, such as lead and manganese, may have direct effects on brain functioning and hence children's ability to perform well in school.[28] However, chemicals that have other health effects, including carcinogens and those that increase the risk of respiratory disorders, may also result in absences from school and otherwise impair students' ability to perform well.

▶ **SCHOOL ATTENDANCE RATES:** Because direct measures of health at the level of the individual school are not available in Michigan, we used school attendance rates as a proxy for health outcomes. We found that attendance rates were lower in schools with greater concentrations of pollution around them. This relationship was not linear, so we sorted the schools into quintiles based on the total estimated air pollution concentration within two kilometers. Although attendance rates did not vary appreciably for schools in the first three quintiles, we found statistically significant decreases in these rates for schools in the fourth and fifth quintiles. This was true even after we controlled for confounding variables, such as the rural, suburban, or urban location of the school; average expenditure per student; size of the student body; student-teacher ratio; and percentage of students enrolled in the free lunch program (see Appendix Exhibit 1).[24]

▶ **STUDENT PERFORMANCE IN ENGLISH AND MATH:** Our next step was to determine whether a relationship existed between pollution levels around the schools and the percentage of students who failed to meet the Michigan Educational Assessment Program standards for English and math. We first examined the overall pattern between pollution levels around the schools and the percentages of students failing to meet the state standards. As with attendance rates, we found that this relationship was not linear, so again we looked at quintiles of schools based on the total estimated air pollution concentration within two kilometers.

We first examined performance on the English tests. For each grade level for the schools in each quintile of pollution, we determined the average percentage of students who failed to meet the standards. As Exhibit 4 shows, there was no appreciable difference in the average percentages of students failing to meet the standards for English among the schools in the first, second, and third quintiles. However, there were distinct increases in these percentages for schools in the fourth and fifth quintiles. This was true for every grade level. We next examined performance on the math tests and obtained nearly identical results (Exhibit 5).

We investigated whether these patterns were statistically significant and whether they persisted after we controlled for school attendance rates and school locations, expenditures, and demographics. We used ordinary least squares regression, with the percentages of students in a school failing to meet the state standards in English and in math as the dependent variables and dummy variables representing each of the five quintiles of air pollution concentration around the schools as the independent variables.

EXHIBIT 3

School Demographics By Deciles Of Total Air Pollution Concentrations

		Students					
	Schools[a]	All[a]	White[a]	African American[a]	Hispanic[a]	In free lunch program[a]	Proportion of schools with higher concentrations than their districts[b]
DECILE 1							
Number	65	16,754	13,228	170	129	5,732	0/65
Percent	1.78	1.03	1.14	0.05	0.17	1.19	0.00
DECILE 2							
Number	78	23,118	21,793	193	405	7,043	8/78
Percent	2.13	1.42	1.88	0.06	0.53	1.46	10.26
DECILE 3							
Number	95	32,269	30,354	337	537	9,441	11/95
Percent	2.60	1.98	2.61	0.10	0.71	1.96	11.58
DECILE 4							
Number	147	50,165	46,124	1,173	1,370	11,666	26/147
Percent	4.02	3.08	3.97	0.36	1.81	2.43	17.69
DECILE 5							
Number	182	71,208	63,349	2,074	3,274	15,978	35/182
Percent	4.97	4.37	5.45	0.64	4.32	3.32	19.23
DECILE 6							
Number	233	100,045	89,117	4,064	3,921	21,319	95/233
Percent	6.37	6.14	7.67	1.26	5.18	4.43	40.77
DECILE 7							
Number	268	109,229	87,444	14,545	3,946	28,470	84/268
Percent	7.32	6.70	7.53	4.51	5.21	5.92	31.34
DECILE 8							
Number	305	129,906	113,023	8,315	4,700	30,525	120/305
Percent	8.33	7.97	9.73	2.58	6.21	6.35	39.34
DECILE 9							
Number	514	233,399	181,574	28,641	10,413	51,645	326/514
Percent	14.04	14.32	15.63	8.89	13.75	10.74	63.42
DECILE 10							
Number	1,773	863,629	515,839	262,685	47,046	298,984	1,623/1,773
Percent	48.44	52.99	44.40	81.53	62.11	62.18	91.54
TOTAL							
Number	3,660	1,629,722	1,161,845	322,197	75,741	480,803	2,328/3,660 (63.60%)

SOURCE Authors' analysis of geographic microdata for 2006 from Note 23 in text and school demographic data for 2007 from Note 25 in text. [a]Percentage of the total in the respective column. [b]Percentage of the total number of schools in the decile (row).

We found that air pollution concentrations are statistically significant predictors of student performance, even after controlling for confounding variables. The results of this analysis are presented in the Appendix.[24]

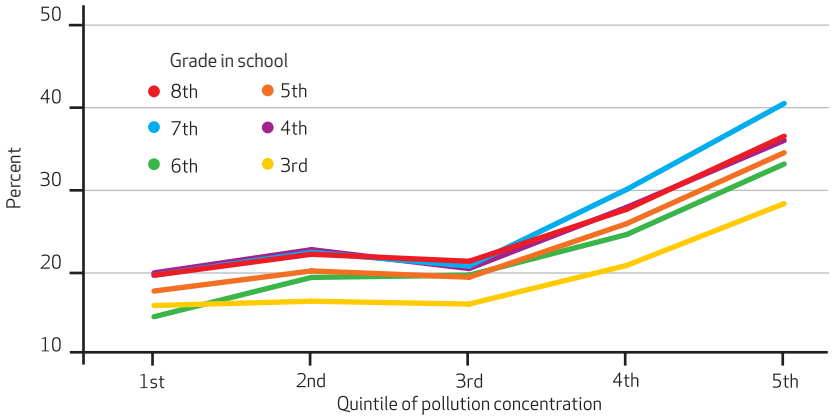
ROBUSTNESS OF FINDINGS Space limitations do not allow us to display the results here, but we found nearly identical patterns when we analyzed the 2005 National Air Toxic Assessment data.[21] This data set includes air pollution estimates from multiple sources. In addition to the major industrial sources in the EPA's Risk-Screening Environmental Indicator microdata—which refer to square kilometers rather than entire census tracts, and which were thus more suitable for our purposes—the National Air Toxic Assessments include minor industrial sources and on-road mobile sources, such as cars, trucks, and buses, as well as nonroad mobile sources, such as airplanes, tractors, and lawn mowers. We also found very similar patterns when we analyzed actual distances from schools to major industrial facilities and major highways.

Conclusions And Policy Implications

Our findings show that schools in Michigan were disproportionately located in places with high levels of air pollution from industrial sources, whether the basis of comparison was the median level for the state or the school's metropolitan area or school district. Fewer than half of the

EXHIBIT 4

Average Percentage Of Students Not Meeting Michigan Educational Assessment Program Standards In English, By Quintile Of Total Air Pollution Concentration



SOURCE Authors' analysis of geographic microdata for 2006 from Note 23 in text and Michigan Educational Assessment Program scores for 2007 from Note 25 in text. **NOTE** For each quintile, the average percent of students not meeting the test-score standard is based on the average percentage across all schools in the quintile.

white students in the state (44 percent)—but substantial majorities of African American students (82 percent), Hispanic students (62 percent), and students enrolled in the free lunch program (62 percent)—attended schools in the most polluted (by industrial sources) 10 percent of the state.

Furthermore, schools located in areas with the highest pollution levels also had the lowest attendance rates (a potential indicator of poor health) and the highest proportions of students failing to meet the state's educational testing standards. These associations remained statistically significant even when we controlled for important confounding variables such as schools' locations (urban, suburban, or rural), spending per student, and school socioeconomic characteristics. Because of the lack of available data, we could not control for all possible confounding variables. Future studies should include variables such as parental education levels; language and cultural differences; and crowding, natural versus artificial light, and ventilation in the classroom, which might influence children's school performance as well.

What explains these patterns, and what should be done about them? Because little attention to date has been given to the environmental quality of where schools are located, it is difficult to pinpoint all of the possible causes of the patterns we found. The large amount of land that a school requires and the costs of land acquisition probably mean that officials searching for new school locations focus on areas where property values are low, which may be near polluting industrial facilities, major highways, and other potentially hazardous sites.[29]

A recent survey of Michigan school superintendents verified the fact that land availability and cost are a major consideration in school siting decisions. When the superintendents were asked to rank various considerations in school boards' decisions about where to locate new schools, the two most important considerations were the availability of land and whether the school district already owned the land.[30]

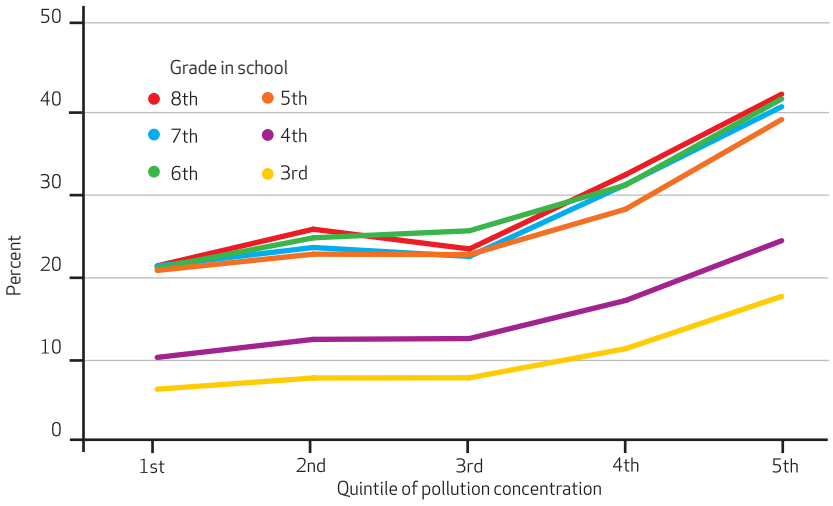
Half of the states, including Michigan, do not require any evaluation of the environmental quality of areas under consideration as sites for new schools, nor do they prohibit siting new industrial facilities and highways near existing schools. This makes it likely that new schools will be built in undesirable locations to keep the cost of land acquisition down.

Our findings underscore the need to expand the concept of environmental justice to include children as a vulnerable population. They are required to attend school and have little or no say in where they live or go to school, which makes them particularly dependent on governmental policies to protect them from harm. Moreover, as our findings show, children of color are disproportionately at risk.

There is a need for proactive school policies that will protect children from exposure to unhealthy levels of air pollution and other environmental hazards. To achieve that goal, we make

EXHIBIT 5

Average Percentage Of Students Not Meeting Michigan Educational Assessment Program Standards In Math, By Quintile Of Total Air Pollution Concentration



SOURCE Authors' analysis of geographic microdata for 2006 from Note 23 in text and Michigan Educational Assessment Program scores for 2007 from Note 25 in text. **NOTE** For each quintile, the average percent of students not meeting the test-score standard is based on the average percentage across all schools in the quintile.

four policy recommendations, which we discuss in turn: site analysis, minimum distance requirements, environmental mitigation, and multilevel cooperation.

ANALYZE POTENTIAL SCHOOL SITES Our first policy recommendation is that potential school sites be thoroughly analyzed. The analysis should include testing the quality of the soil, water, and air; inventorying nearby sources of pollution, such as highways, industrial facilities, power plants, and airports; investigating previous and current uses of the land; and studying the local climate—that is, characteristics such as usual wind direction and wind tunnels—topography, and other physical aspects of the site.

The quality of the environment around existing schools should also be evaluated, and steps taken to address unsafe conditions.

REQUIRE MINIMUM DISTANCES BETWEEN SCHOOLS AND POLLUTION SOURCES Second, policies need to be enacted that insist on a minimum distance between sources of pollution and school locations. The locations of existing schools need to be taken into account when considering new highways, industrial facilities, and other potential sources of contamination. Currently, only seven states (California, Florida, Indiana, Kentucky, Mississippi, Utah, and West Virginia) prohibit locating schools near sources of pollution such as factories, plants, stables, mills, and stockyards. Six of the seven states do not mandate any specific distance. Only Indiana specifies a minimum distance: 500 feet from a school to a source of pollution, a distance too small to completely protect children from environmental hazards. Even though no previous research indicates what is a safe distance, pollution levels generally decrease with greater distance from the sources of the pollution.[31,32]

ADOPT POLICIES TO REDUCE EXPOSURE Third, environmental mitigation policies should be adopted, to reduce children's potential exposure to pollution. It may be particularly important to implement mitigation approaches in urban settings where land is scarce, and where sites for schools away from sources of pollution are difficult to find. California and Florida allow schools to be built on previously polluted sites if the pollution has been cleaned up and removed, and children attending the school will not be exposed to contaminants.

Improving indoor air quality and minimizing the infiltration of air pollution into school buildings are other mitigations that may reduce exposure to contaminants. The EPA created its voluntary Indoor Air Quality Tools for Schools Program[33] to improve indoor air quality for children. The program provides an action kit that describes best practices (such as painting with organic compounds that are not very volatile), industrial guidelines (cleaning carpets according to manufacturers' guidelines), sample policies (banning bus idling), and a sample management plan. Jerome Paulson and Claire Barnett recommend regulating indoor air quality for schools with standards that are "appropriate to children's higher respiration rate[, which] enhances vulnerability to toxins."[34]

These efforts should improve the current environmental conditions of schools, but they should not be used as a way to make up for poor school siting decisions.

ENSURE COOPERATION AMONG AGENCIES Finally, oversight and enforcement at the national, state, and local levels are needed to ensure better school environments. Until the EPA's recent draft voluntary school guidelines,[1] the federal government had little involvement in school siting policy. And although the guidelines address a wide range of issues, because the guidelines are voluntary, they may be ignored. Nevertheless, state and local agencies interested in creating healthier schools can benefit from the EPA's scientific knowledge, technical expertise, and environmental data.

State environmental agencies already cooperate with the EPA in regulating the redevelopment of brownfields—properties that contain or may contain some hazardous substance whose presence affects any future use of the properties. And brownfield redevelopment and school siting have been linked. Alison Cohen reports that because of the problem of land availability, brownfields are often considered as viable sites for schools.[35] However, building schools in previous brownfields requires great caution. The standards for cleaning brownfields up are not necessarily high enough; Michigan lowered its standards in 2000, for example.[36] Thus, state environmental agencies should develop stringent standards for cleaning up brownfields intended as school sites.

All relevant national, state, and local stakeholders—including school administrators and health officials, parents, teachers, industry and community leaders, public health professionals, environmental scientists, and educational policy makers—need to work together to develop policies that will ensure safe learning environments for schoolchildren. In states such as Michigan, school districts are mainly responsible for deciding where to build new schools.[30] However, previous cooperation between the EPA and state agencies demonstrates that different levels of government can work together on these issues. Indeed, they must, if we are to protect the health and enhance the learning environment of the nation's children. ■

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NOTES

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24 To access the Appendix, click on the Appendix link in the box to the right of the article online.

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Paul Mohai is a professor at the University of Michigan.

In their article in *Health Affairs* this month, Paul Mohai and coauthors recommend a checklist of considerations for use in the siting of schools to avoid exposing children to health-threatening pollution.

A professor in the School of Natural Resources and Environment at the University of Michigan, Mohai has long worked in the field of environmental justice. Yet he was surprised at the overwhelming number of Michigan schools that were near environmental hazards. The best explanation, he says, is that school systems often look for large parcels of land that are available cheaply—and land near industrial sites usually fits that bill. Unfortunately, he observes, at least twenty states "have no policy whatsoever in terms of taking into consideration environmental hazards when siting schools."

Mohai, who is also a faculty associate at the Institute for Social Research at the University of Michigan, was an early and major contributor to quantitative research examining the disproportionate environmental burdens in communities where residents are largely from racial or ethnic minority groups or of low income. His current research involves studies at the national level that examine the role environmental factors play in accounting for racial and socioeconomic disparities in health and student performance.

Mohai has a master of science degree in forest science and statistics from the State University of New York, Syracuse, and a doctorate in natural resource policy and sociology of natural resources from Pennsylvania State University.

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Byoung-Suk Kweon is a research investigator at the Institute for Social Research and an adjunct assistant professor in the School of Natural Resources and Environment at the University of Michigan. For the past ten years, she has been conducting research on environmental risks around public schools and their consequences. She has a master's degree in landscape architecture from Cornell University and a doctorate in natural resources and environmental sciences from the University of Illinois, Urbana-Champaign.

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Sangyun Lee is a postdoctoral research fellow in the School of Natural Resources and Environment at the University of Michigan. He has a master's degree in urban and environmental planning from the University of Virginia and a doctorate in environmental policy and behavior from the University of Michigan. His research interests include environmental justice, sustainable development, environmental policy and planning, and urban inequality.

Kerry Ard is a graduate student in sociology and environmental policy at the University of Michigan.

Kerry Ard is a doctoral student in sociology and environmental policy at the University of Michigan. The School of Natural Resources and Environment recently honored her with a Justin W. Leonard Award, which is given to students with superior academic credentials who are judged to have the greatest promise for leadership in the wise use of natural resources through the integration of natural and social sciences.