

RESEARCH ARTICLE

Comparison of Indoor Air Quality Management Strategies Between the School and District Levels in New York State

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ABSTRACT

BACKGROUND: Good school indoor air quality (IAQ) can affect the health and functioning of school occupants. Thus, it is important to assess the degree to which schools and districts employ strategies to ensure good IAQ management. We examined and compared the patterns of IAQ management strategies between public elementary schools and their school districts in New York State.

METHODS: District-level information obtained from surveys of district facilities managers in 326 districts was described and stratified by district size and socioeconomic status. School-level information obtained from surveys of head custodians in 770 elementary schools was then compared with the district-level information in 241 districts.

RESULTS: About 47% of participating school districts reported having a district-wide IAQ program, with a large range in the prevalence of specific IAQ management strategies. Airing out newly painted areas was the most commonly reported (92%) and having a classroom animal policy was the least commonly reported (29%). Larger districts and districts with a district-wide IAQ program were more likely to report certain IAQ strategies than other districts. Elementary schools and their districts were most likely to report airing out newly painted areas (76%). The most common area of disagreement was construction after hours (50%). The top strategy not reported at either level was having an IAQ coordinator (53%).

CONCLUSIONS: Many school districts lack key IAQ management strategies, and differences exist between district-level policy and school-level practice. Districts and schools should work together to formalize and expand existing IAQ policies and inform stakeholders about these strategies.

Keywords: environmental health; indoor air quality; policy; research.

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Children and school staff spend much time in and around school buildings. On average, school-age children spend over 32 hours per week in school.¹ Like other structures, school buildings are susceptible to leaks, mold, vermin infestations, allergen

accumulation, diesel exhaust intrusion, and malfunctioning heating, ventilation, and air conditioning (HVAC) systems. Proper management of these and other conditions that affect a school's indoor air quality (IAQ) is important for the health of those who work

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and learn in them. However, approximately 11 million school-age children nationwide attend schools that are in less-than-adequate condition.²

Children are particularly susceptible to negative health effects from poor IAQ because they breathe in 50% more air per kilogram of body weight than adults,³ and their breathing space is closer to the ground where larger particles and pesticides tend to settle.⁴ Poor IAQ can exacerbate asthma^{5,6} and some school environments have been linked to impaired student performance and increased school absence.⁷⁻¹⁰ These problems can be prevented or ameliorated through policies and practices aimed at maintaining a healthy indoor environment. Such policies or practices may target specific exposures (eg, New York State [NYS] anti-idling regulations)¹¹ or be comprehensive in scope, for example, the US Environmental Protection Agency's (EPA) Tools for Schools (TfS) IAQ management program.

Although a few studies have assessed the implementation or existence of IAQ management strategies at the school and/or district level,^{12,13} none has compared the degree of agreement in the reporting of these matters among these different administrative levels, or examined the degree to which having a comprehensive IAQ policy/program translates into having specific IAQ management strategies. In other words, little is known about the consistency of practices, policies, or programs relating to school IAQ in NYS schools and their districts. To explore these relationships with respect to IAQ policies and practices according to our preliminary findings,¹⁴ we (1) examined the prevalence of district-wide IAQ policies and programs by district size and socioeconomic status (SES); (2) assessed whether districts with a district-wide, comprehensive IAQ policy more often report the existence of specific IAQ management practices and program components; and (3) conducted a detailed comparison of IAQ management strategies between custodians at the school level and facilities managers at the district level.

METHODS

Participants

To ascertain IAQ policies and practices at the school level, the NYS Department of Health (DOH) sent surveys to 2277 head custodians in elementary (pre-kindergarten through grade 6) schools across NYS in summer 2003. To ascertain IAQ policies and practice at the district level, a second survey was sent to 744 NYS school district facilities managers (DFMs) across NYS in 2004. New York City (NYC) was not included in these surveys because DOH did not have access to the necessary data.

Instrumentation

The DFM survey asked DFMs questions about district-level IAQ management strategies, including

bus idling policy, precautions taken to minimize exposures during construction/renovation, integrated pest management (IPM), Health and Safety Committees, airing out new carpets and newly painted areas, using green-rated cleaning products, using vacuum cleaners equipped with high-efficiency particulate air (HEPA) filters, chemical hygiene programs, and policies regarding animals in classrooms. Respondents were also asked about IAQ programs, including the US EPA's TfS. Facilities managers reported whether there was a district-wide IAQ program, whether individual schools within the district had implemented or planned to implement an IAQ program, and whether specific components of such a program were in place, including having an IAQ coordinator, completing IAQ checklists, and developing an IAQ management plan to fix existing problems, increase awareness, and facilitate preventive actions.

Head custodians in NYS elementary schools were asked about the existence of environmental triggers and irritants in the school building. In addition, they were asked questions about IAQ management strategies, similar to those included in the DFM survey. This overlap in content allowed for comparison of IAQ management strategies reported at the school level, by custodians, and at the district level, by facilities directors. Prior to distribution, both surveys were pilot tested and reviewed by individual custodians, facilities directors, and representatives of the NYS Education Department (NYSED).

Procedure

For the custodian survey, a database of elementary schools was obtained from the NYSED. Ahead of the survey, cover letters describing it were mailed to school district superintendents. To increase efficiency and to lend the survey legitimacy through local distribution, packets containing a cover letter and survey were then mailed to school DFMs, with instructions for distributing the surveys to the head custodians in their district. Custodians were asked to complete the survey and return it in the postage-paid envelope provided. Two follow-up reminders were mailed to DFMs.

The DFM survey was distributed to DFMs at their annual meeting in September 2004. Surveys and cover letters were also mailed to DFMs in NYS (excluding NYC) public school districts. Survey materials for each survey were posted on the NYSED website, and cover letters were cosigned by NYSED's director of Facilities Planning.

Data Analysis

The data were cleaned and analyzed using SAS version 9.1 (SAS Institute Inc., Cary, NC). A district-level analysis of DFM survey questions was conducted, followed by a comparison of large versus small school

Table 1. Prevalence of District-Level Indoor Air Quality (IAQ) Management Strategies, Overall, and Stratified by District Size and SES*

	All Districts [‡] (Total N = 326)		District Size [†]		District SES [†]	
			Large (Total N = 154)	Small (Total N = 155)	Low SES (Total N = 154)	High SES (Total N = 155)
	N	%	%	%	%	%
District-wide IAQ program exists [¶]	154	47.2	73.1	61.2	62.3	74.3
At least 1 school in district uses						
Environmental Protection Agency's Tools for Schools IAQ program	156	47.9	62.3	34.8	46.8	50.3
Another type of formal IAQ program	45	13.8	17.5	11.0	11.7	16.8
District IAQ-related policies/actions						
Newly painted areas aired out	300	92.2	90.6	98.7	94.7	94.7
Health and Safety Committee formed	299	91.7	96.6	97.3	98.6	95.3
Formal mechanism for IAQ complaints	289	88.7	94.1	86.7	88.7	92.1
Major construction/renovation after hours only	279	85.6	81.8	89.0	83.8	87.1
Maintenance log kept	276	84.7	90.6	86.6	88.7	88.5
District practices integrated pest management	266	81.6	96.6	90.9	92.1	95.7
Chemical hygiene program	250	76.7	89.0	90.8	92.5	87.2
New carpets aired out [§]	221	69.1	75.6	81.1	81.4	75.4
Anti-idling policy for school buses	194	59.5	71.0	63.5	66.7	67.9
Green-rated cleaning products used	176	54.0	67.1	55.2	59.9	62.6
HEPA filters used for cleaning	169	51.8	60.0	52.9	55.4	57.7
Named an IAQ Coordinator	121	37.1	58.2	50.0	50.0	59.6
Developed IAQ management plan [¶]	97	29.8	51.3	42.1	43.6	51.5
Policy on animals in classrooms [¶]	93	28.5	37.2	40.7	39.0	38.9

HEPA, high-efficiency particulate air; SES, socioeconomic status.

*Bolded percents indicate significant differences (χ^2 analysis, $p < .05$) between large and small districts, and low- and high-SES districts in the respective percentages of having an IAQ management strategy (missing excluded).

[†]Large districts were defined as having enrollments above the median of 1688 students, and low SES as having more than 18.43% of students eligible for a free lunch.

[‡]Missing included.

[§]Total N = 320, excluding 6 who said "not applicable."

^{||}More than 10% missing (missing excluded from bivariate analysis).

[¶]More than 20% missing (missing excluded from bivariate analysis).

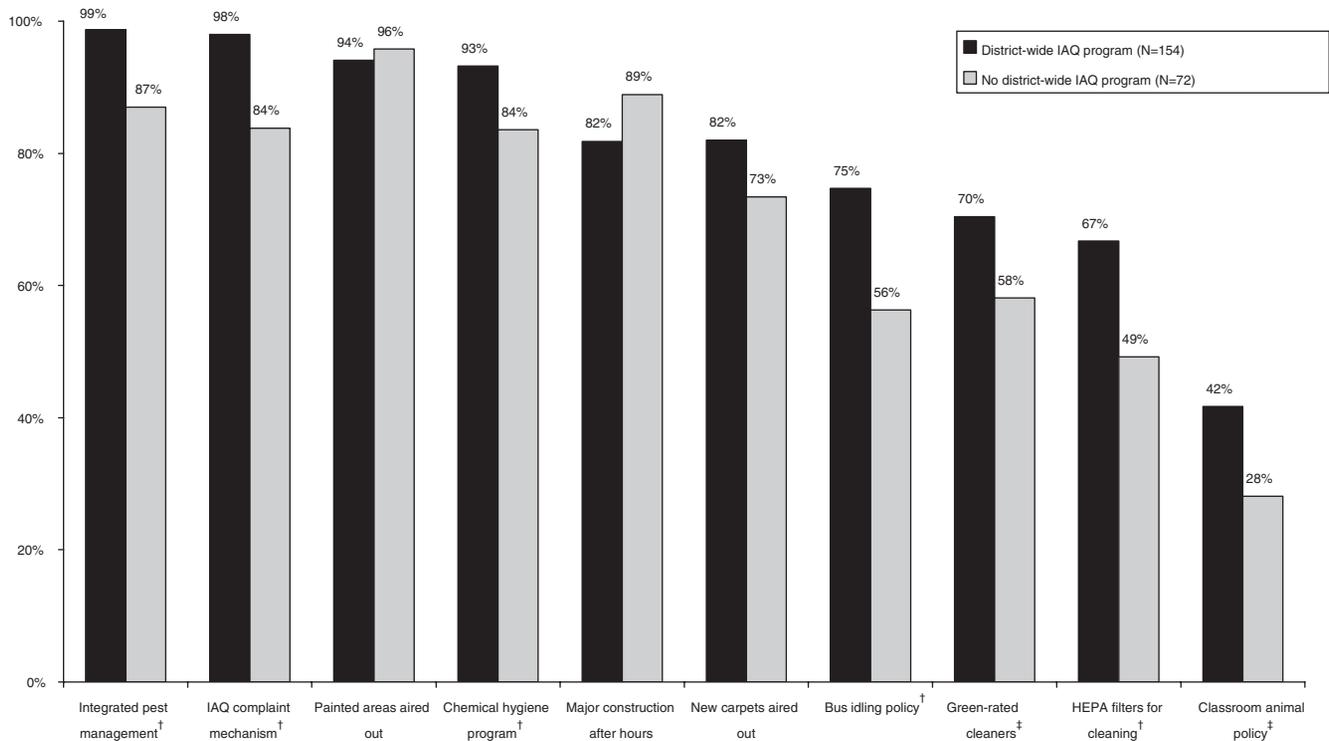
districts (above or below the median of 1688 students per district in NYS) and low-SES versus high-SES districts (above or below the NYS median of 18.4% of students eligible for a free or reduced lunch) using the χ^2 test statistic. Using the school as the unit of analysis, we first examined the reporting of a formal IAQ program by custodians by whether the district reported a district-wide program, controlling for district sociodemographics using logistic regression analysis. Next, to assess the concordance between district level and school level reporting of IAQ management strategies, schools were linked to their corresponding districts, and head custodian and DFM survey responses were compared. The percentage of schools were reported for which (1) both the school and the district reported a given strategy; (2) only the school or the district reported the strategy; and (3) neither the school nor its district reported the strategy. In addition, for each IAQ activity, the composition of discordant answers in (2) was reported to indicate how much discordance was due to the school reporting an IAQ activity in the absence of the district reporting it, and conversely, how much was due to a district reporting an activity not reported by the school.

RESULTS

Of the 2277 mailed custodian surveys, 1434 (63%) were completed. These respondents represented elementary schools in 71% of non-NYC school districts, and which were similar to these districts as a whole with respect to poverty, district type, and race. DFMs from 326 (44%) of 746 NYS public school districts completed a DFM survey. Despite the relatively low response rate, the responding districts were similar to the target area in terms of poverty, district type, and race. Together, 770 custodian surveys in 241 districts were linked with their corresponding district surveys.

Information in Table 1 describes the district-level IAQ management strategies reported by DFMs. Of the 326 respondents, 47.2% reported having a district-wide IAQ program, 47.9% indicated that at least one school in their district used the EPA's *TfS* IAQ program, and 13.8% indicated that one or more schools used some other type of formal IAQ program. Most of the IAQ management activities and policies were reported by more than half of responding districts. Among these, airing out newly painted areas (92.2%), forming a Health and Safety Committee (91.7%), having a formal mechanism

Figure 1. Percentage of New York State Districts Reporting District-Level Indoor Air Quality (IAQ) Management Strategies, by Presence of District-Wide IAQ Program (226 Districts)*



*Out of the 326 districts, only districts with non-missing responses to the question about having a district-wide IAQ program were included. [†]p < .05, χ^2 test; [‡]p < .10, χ^2 test.

for handling IAQ complaints (88.7%), and avoiding major construction/renovation during the school day (85.6%) were most commonly reported. Developing an IAQ management plan (29.8%) and having a policy on animals in the classroom (28.5%) were the least commonly reported IAQ activities. Use of the IAQ Tfs checklists (ventilation, teacher, building maintenance and renovation, and repairs) was variable and ranged from 51.8% for the ventilation checklist to 16.0% for the teacher (classroom) checklist (data not shown).

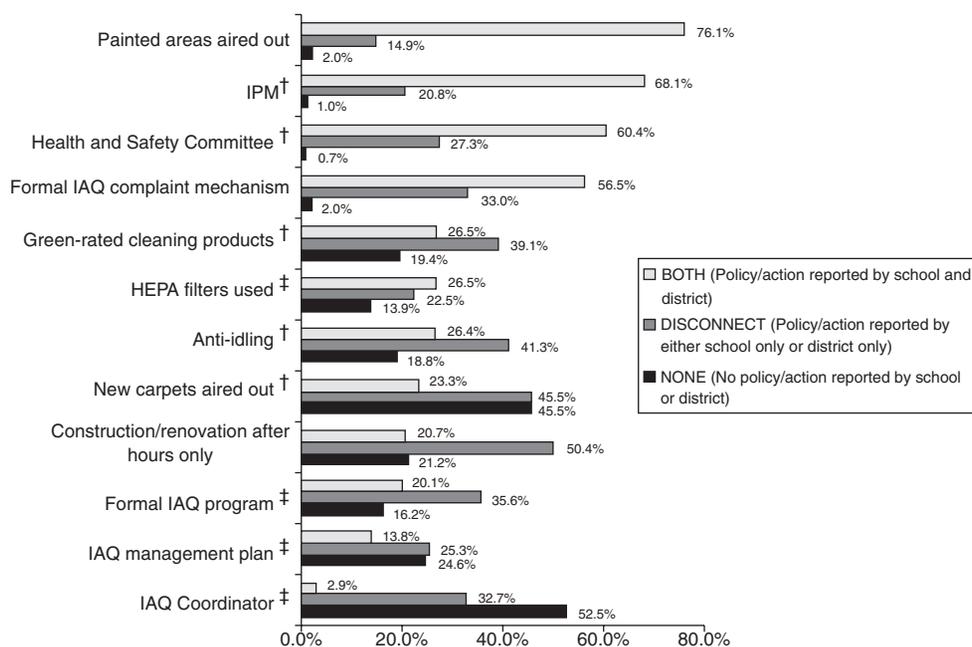
Table 1 also summarizes analyses for district size and SES to assess how these factors might relate to the district IAQ management strategies reported. We found (p < .05) that larger school districts were more likely than smaller districts to report having at least 1 school that uses EPA's Tfs IAQ program (62.3% vs 34.8%), having a formal IAQ complaint mechanism (94.1% vs 86.7%), and using green-rated cleaning products (67.1% vs 55.2%); but were less likely to report airing out newly painted areas (90.6% vs 98.7%). There were no significant differences between high- and low-SES districts.

To improve understanding of the effect of having a formal district-wide comprehensive IAQ program on the existence of individual district-level IAQ management strategies, a stratified analysis was conducted to compare reporting of specific IAQ management

strategies in districts with and without a district-wide IAQ program (Figure 1). Districts that reported having a district-wide IAQ program were significantly more likely than districts without such a program to report practicing IPM (99% vs 87%), having a formal mechanism for handling IAQ complaints (98% vs 84%), having a chemical hygiene program (93% vs 84%), having an anti-idling policy for school buses (75% vs 56%), and using vacuum cleaners equipped with high-efficiency particulate air (HEPA) filters (67% vs 49%). On the other hand, IAQ management practices such as airing out painted areas and conducting major construction after hours have already been widely implemented by school districts, even in the absence of a comprehensive district-wide IAQ policy.

In an logistic regression analysis of school-level IAQ program reporting (data not shown), we found that schools in districts reporting a district-wide program were more likely to report having a formal IAQ program, controlling for district size and district SES (adjusted odds ratio: 2.90; 95% confidence interval: 1.82-4.64). The concordance and discordance in reporting the existence of IAQ management strategies between the facility manager at the district level and the head custodian at the school level is described in Figure 2. Among more than half of the schools, airing out newly painted areas (76.1%), using IPM (68.1%),

Figure 2. Reporting of Indoor Air Quality (IAQ) Management Strategies Between Districts and Elementary Schools in Those Districts*



*Missing responses are included in denominator for calculation of percentages. [†]More than 10% missing from total schools; [‡]more than 25% missing from total schools.

having a Health and Safety Committee (60.4%), and having a formal IAQ complaint mechanism (56.5%) were reported by both the school and its corresponding district. However, agreement at the school and district level that a formal IAQ program was in place was reported for only 20.1%. Having an IAQ coordinator was the most common IAQ management practice where there was agreement between the school and the district about the absence of this practice (52.5% of schools), followed by airing out new carpets (45.5%). Disconnects between school-level and district-level reporting of IAQ-related strategies were greatest for having construction or renovations occur after hours (50.4% disagreement), airing out new carpets (45.5%), having an anti-idling policy (41.3%), and using green-rated cleaning products (39.1%).

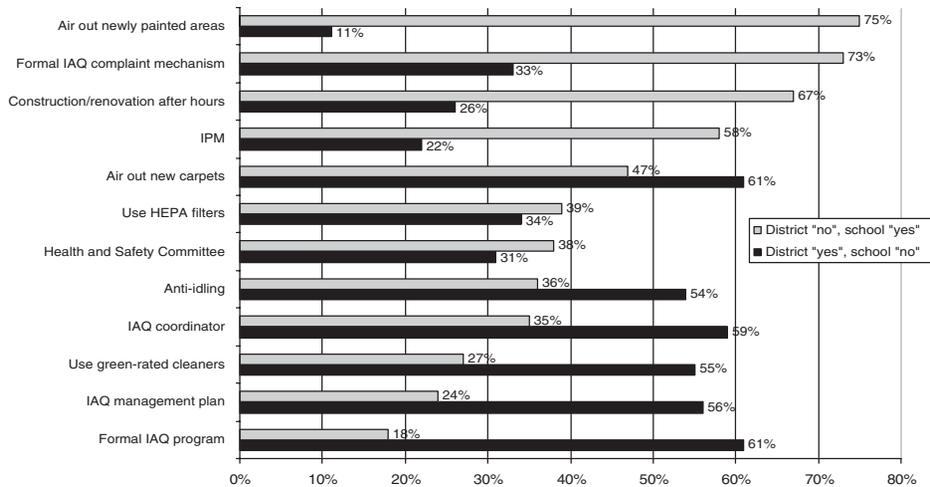
Figure 3 shows more detail about disconnects between schools and districts. Overall, for half of the strategies reported, the disconnect occurred more often because a policy reported by a school tended not to be reported by its district (airing out newly painted areas, formal IAQ complaint mechanisms, construction/renovation conducted after hours, IPM, vacuum cleaners equipped with HEPA filters, and Health and Safety Committees). For the remaining strategies, disconnects occurred more often because the school did not report a policy reported by the district (airing out new carpets, anti-idling policies, using green-rated cleaning products, and having IAQ coordinators, IAQ management plans, and formal IAQ programs).

DISCUSSION

District IAQ Policies

This study found that about half of the NYS school districts (47.2%) reported having a formal district-wide IAQ program, higher than the 35.4% of US districts with such a program reported by Jones et al.¹² Almost half of districts in our study reported that 1 or more schools in their district used the EPA's *TfS* IAQ program, with another 14% reporting using another type of formal program. Moglia et al.¹³ reported that of the 10 EPA regions, region 2, which includes NYS, has the third highest percentage of schools using an IAQ management program at approximately 49%. The most frequently reported IAQ-related activities ($\geq 85\%$) reported by district facility managers in our study included airing out newly painted areas, avoiding major construction/renovation during school hours, having a Health and Safety Committee, and having a formal mechanism for IAQ complaints, which may be due to NYSED regulations mandating these committees, charged with addressing IAQ complaints.¹⁵ Our finding on district-level IPM practices (81.6%) was consistent with Jones et al's nationwide findings of the percentage of school districts requiring schools to conduct regular pest inspections (81.7%).¹² We found lower proportions of districts reporting the existence of key IAQ program components such as assigning someone to coordinate IAQ-related activities, having an IAQ management plan to prevent IAQ problems

Figure 3. Composition of Discordance Between School-Level and District-Level Reporting of Indoor Air Quality (IAQ) Management Strategies*



*The percentage of schools answering “yes” to an IAQ-related question when their district answered “no,” and the percentage of schools answering “no” or “unsure” to an IAQ-related question when their district answered “yes” was assessed using the total number of schools whose districts answered “yes.”

from developing, having an animal policy, which can be a source of allergens in classrooms, and completing teacher checklists, which may indicate a lack of involvement of teachers in school IAQ management.

Factors Influencing IAQ

Although there were no significant differences in the reporting of any IAQ activity between high- and low-SES districts, we found that large districts more often reported having certain IAQ policies than small districts. Although more specific to IAQ, this finding is consistent with that reported by Jones et al¹⁶ of more health-promoting programs and policies in larger school districts. It is possible that the larger districts have more infrastructure to support formal IAQ management strategies, and due to economies of scale, it may be easier for them to buy green-rated cleaning products. We found that districts reporting a district-wide IAQ program were more likely to also report having specific IAQ strategies such as an IAQ complaint mechanism, a chemical hygiene program, an anti-idling policy, and IPM. These are all important to ensuring good school IAQ, as diesel fumes from buses can intrude into the school through fresh air intakes, volatile organic compounds can pollute the indoor air, and IPM is important for controlling allergenic pests and reducing the use of pesticides. These findings make logical sense, because we would expect districts with a formal program to have more IAQ-related components, and this supports the public health approach taken by EPA to promote comprehensive specific programs rather than just specific policies.

District and School Agreement

This study found that over 50% of schools agreed with their districts in reporting that the following four IAQ management strategies are in place: airing out painted areas, IPM, a Health and Safety Committee, and a formal IAQ complaint mechanism. Jones et al¹² examined IAQ policies and practices at the state, district, and school levels using the Centers for Disease Control and Prevention School Health Policies and Programs Study. Although her study did not make direct comparisons between the district and component school levels, it found high percentages of US school districts requiring pest inspections (81.7%) and 94.2% of US schools conducting them. On the other hand, our study found that having an IAQ coordinator and airing out new carpets may be important areas for improvement in NYS schools, as the proportions of neither the districts nor the schools reporting these strategies were high.

District and School Disconnects

One of the most important findings from this study is that districts having a formal IAQ program, IAQ management plan, or certain IAQ policies did not necessarily mean that their schools use or know about these strategies. Although schools in districts having a district-wide IAQ program were more likely to report having a formal program, low proportions (<25%) were found of both district and school reporting having an IAQ management plan, formal IAQ program, IAQ coordinator, and conducting construction after hours, even though 47% of facility managers reported having

a district-wide IAQ program. Much of this discrepancy appeared to be due to head custodians not knowing if their school followed a given policy; for instance, about 44% of custodians in this study reported that they did not know if their school had a formal IAQ program. Our findings are consistent with those of Moglia et al¹³ who developed an IAQ Practice Index to measure the extent to which IAQ policies and procedures are implemented. They concluded that having IAQ programs is not equivalent to effectively implementing these IAQ policies and procedures, as the IAQ Practice Index scores varied widely for schools with IAQ management programs.

The differences in the degree to which both schools and their districts reported a given activity were reflected in the level of disconnect seen. Again, areas of greatest disparity in reporting included those policies for which many head custodians reported an uncertainty, including construction after hours, new carpet aired out, anti-idling regulations, and use of green-rated cleaning products. Previous studies have used either school or district-level information only and thus have not been able to compare differences. In studies looking separately at school districts and school IAQ policies and practices, only general trends of district IAQ policy and school practice can be seen. However, linking district and school-level responses, this study found that districts may report strategies that do not materialize at the school level (eg, airing out new carpets, anti-idling policy, use of green-rated cleaning products), while schools can independently implement IAQ practices in the absence of practice at the district level (eg, using IPM, having a formal IAQ complaint mechanism and airing out newly painted areas, construction after hours). Generally, districts were more likely to report the presence of IAQ program components (ie, IAQ coordinator, IAQ management plan), while practices concerning construction and building maintenance were more often reported by schools.

Limitations

This is one of the few studies examining and directly comparing IAQ management strategies at the district level and IAQ practice at the school level. The survey data enabled us to assess many important IAQ management strategies and IAQ components.

Despite our efforts to maximize the number of responses, relatively low response rates were obtained for the DFM survey. To estimate potential selection bias for each survey, we examined the demographic characteristics between participating districts/schools and non-NYC districts/schools as a whole and found that respondents were similar to NYS in terms of poverty, district type, and race. Still, it is possible that these respondents are more likely to have

IAQ management strategies in place than those not responding, which would result in our findings overestimating their use, which would lead to similar participation bias for both surveys.

The two surveys making up this study had slight wording differences and were administered approximately 12 months apart, possibly hindering a robust analysis of agreement between them. Different levels of knowledge or interpretation of questions may also have affected the accuracy of the data. However, with respect to the DFM survey, district facility manager job titles and responsibilities of respondents were fairly homogenous. Although this study is unique in that it linked data from elementary schools and districts, it also presented challenges since only elementary schools participated in the custodian survey, and some district policies were compared with just a few schools in the district and others to many schools. However, the majority of the districts (63%) had more than 1 school participating.

Beneficial health outcomes resulting from improved indoor environmental quality mediated through the use of various IAQ components are yet to be assessed but are currently being investigated by the NYSDOH research team. As schools with and without IAQ programs have varying degrees of policy implementation, an IAQ Practice Index as used by Moglia et al¹³ may be a useful way proceed. Improving communication between the districts and their schools should be a priority for these institutions, given disconnects between DFMs and school custodians found from this project.

Conclusion

Many school districts lack key IAQ strategies and components, and there appear to be differences between district-level policy and school-level practice. Districts and schools should work together to formalize and expand existing IAQ policies. Further examination of district-level IAQ policies and school enforcement may reveal opportunities to close gaps between policy and implementation.

IMPLICATIONS FOR SCHOOL HEALTH

Understanding the prevalence of district and school use of IAQ management strategies, especially weaknesses (low prevalence of policies on animals in classrooms, IAQ coordinators, IAQ management plans, and teacher involvement) and district-school disconnects (construction conducted after hours, new carpets aired out, anti-idling policies) can help district superintendents and facilities managers identify gaps and target areas of potential problems. Communication between districts and their schools and obtaining school “buy-in” should be a priority. District-level stakeholders can

work with school principals and head custodians to ensure that they are informed about and cooperate with district-level IAQ policies. Given the importance of good IAQ, other school staff members, including teachers, need to understand their role in promoting it, and their administrator can help in this effort. Adopting an IAQ program is a good way for schools to involve all staff in promoting healthy indoor air.

Human Subjects Approval Statement

We obtained approval from the NYSDOH Institutional Review Board to conduct the surveys used in this study.

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