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School Factors Associated With the Implementation of Integrated Pest Management-Related Policies and Practices

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Abstract

BACKGROUND: Schools are particularly vulnerable to pests, but integrated pest management (IPM) can address pest problems. This study describes IPM policies and practices and the extent to which they are associated with school characteristics.

METHODS: We analyzed data from the 2014 School Health Policies and Practices Study, a nationally representative survey of schools in the United States (N = 568, response rate = 69%). Pairwise comparisons assessed differences in pest prevention strategies by school characteristics.

RESULTS: Nationwide, 55.3% of schools conducted campus-wide inspections for pests at least monthly; 35.6% of schools notified staff, students, and families prior to each application of pesticides; and 56.1% of schools required custodial or maintenance staff to receive training on pest management practices that limit the use of pesticides. During the 12 months before the study, 46.5% of schools almost always or always used spot treatments and baiting rather than widespread applications of pesticides, and 36.8% of schools almost always or always marked indoor and outdoor areas that had been treated with pesticides. No clear pattern emerged for school characteristics associated with IPM policies and practices.

CONCLUSIONS: The variation in implementation of IPM-related policies and practices suggest opportunities for targeted education among school staff about IPM principles.

Keywords

environmental health; child and adolescent health; chronic diseases; school environment

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Human Subjects Approval Statement

SHPPS 2014 was reviewed by the Institutional Review Boards at both CDC and ICF International (contractor who conducted fieldwork for SHPPS 2014) and determined to be exempt.

Schools are particularly vulnerable to pest problems because of the nature of school buildings: they are large and serve a large number of people; there may be food stored and prepared on site and consumed in a variety of locations; and deferred maintenance, especially in older schools, may result in disrepair and provide entry for pests.[1] Once pests gain entry, schools have many potential habitats for pests, eg, in and around classrooms (such as cubbies, desks, lockers, and closets), basements, kitchens, and locker rooms.[1,2] Likewise, schools must temporarily store waste (eg, in classrooms, dumpsters, kitchens, and trash cans) and often have landscaping and athletic fields to maintain which require unique pest management practices. Exposure to pests is unappealing, but also carries health risks such as diseases carried by insects or rodents, anaphylaxis resulting from bee stings, or exacerbation of asthma symptoms resulting from exposure to cockroach or rodent infestations.[3]

Pesticides and herbicides (hereafter referred to as pesticides), used in and around school buildings to control pests such as rodents, insects, and weeds, are best used in such a way that reduces exposure to children by avoiding unnecessary use.[3] School-aged children and adolescents, with their unique physiology and behaviors, may be more at risk to adverse outcomes than adults when exposed to pesticides, although due to a dearth of data, it is not possible to quantify the risk of pesticide exposure at school.[4] Nonetheless, exposure to pesticides is associated with deleterious health effects[5–7] and pesticide exposure at school has been shown to result in acute illness among both staff and students.[5] Integrated pest management (IPM) focuses on pest prevention and using pesticides only as needed rather than relying on calendar-based spraying or applications.[3,8] IPM primarily relies on routine inspection for pests and removing conditions that attract pests: food, water, and shelter.[3,8,9]

Little is known about the extent to which schools have IPM policies or use various IPM strategies. The 2012 School Health Policies and Practices Study found IPM-related policies vary considerably among school districts nationwide.[10] For example, campus-wide inspections for pests were required weekly in 8.4% of districts and monthly in 44.6% of districts. In 21.5% of districts, notifications prior to the application of pesticides were not required. Other strategies were more commonly required such as pest-resistant storage of food (81.3%) and food waste (74.5%) or use of spot treatments and baiting rather than widespread application of pesticides (80.9%). Though not nationally representative findings, a 2012 to 2013 school district survey conducted by the IPM Institute of North America suggests about half of districts lack a written IPM policy, a written IPM plan, and an IPM coordinator (Green TA, personal communication). In this study, we identify the prevalence of IPM strategies in a nationally representative sample of elementary, middle, and high schools nationwide, and determine whether IPM-related strategies differed across school characteristics.

METHODS

The School Health Policies and Practices Study (SHPPS) is a national survey conducted periodically by the US Centers for Disease Control and Prevention (CDC) to assess school health policies and practices at the state, district, school, and classroom levels. SHPPS 2014, conducted from February through June 2014, examined 10 components of school

health identified in the Whole School, Whole Community, Whole Child (WSCC) model.[11] This report examined school level data primarily from the SHPPS 2014 Healthy and Safe School Environment questionnaire; one question was used from the Nutrition Services questionnaire.

Sample and Survey Administration

A detailed description of the SHPPS 2014 methods has been published previously.[12] Briefly, a 2-stage sampling design was used to select a nationally representative sample of schools. All public, state-administered, Catholic, and non-Catholic private schools with any of grades K through 12 were eligible, but alternative schools, schools providing services to a "pull-out" population who were provided services at another eligible school, schools run by the Department of Defense or Bureau of Indian Education, and schools with fewer than 30 students were excluded. The number of sampled schools was 828. The Healthy and Safe School Environment questionnaire was comprised of 3 modules that grouped related items so schools could identify a respondent who was responsible for or most knowledgeable about the items covered in that module. For the module containing questions about IPM, the response rate was 69% ($N = 568$). One question from Nutrition Services questionnaire was used to address food storage. The response rate for that questionnaire was 69% ($N = 554$ [25 schools were ineligible because they did not provide nutrition services]). Approximately 90% of the data were collected via computer assisted in-person interviews; the remaining 10% of respondents used paper questionnaires.

Study Measures

SHPPS 2014 asked about strategies, practices, and policies that could reduce student exposure to pesticides: conducting inspections for pests; notifying staff, students, and families prior to pesticide applications; marking areas treated with pesticides; using spot treatments and baiting rather than widespread pesticide application; and training custodial and maintenance staff on pest management practices that limit the use of pesticides. In addition, other SHPPS items addressed pest prevention strategies. Question wording, response options, and responses of interest for each of these questions are provided in Table 1.

To analyze pest prevention strategies, a pest prevention scale was created using 12 applicable items. An item was coded as 1 if the response was the response of interest or a not applicable response. Otherwise, the item was codes as 0. Not applicable responses were coded as 1 because a not applicable response meant that the issue was not a problem for that school and by default the school was engaged (purposefully or not) in pest prevention. For example, if there were no openings in walls, floors, doors, and windows, pests could not gain entry. If there were no vegetation, shrubs, or wood mulch outside the school, such pest habitats would be unavailable. If there were no cracks in pavement, need for herbicides or pesticides could be reduced. If there were no infested or diseased plants, no herbicides would be required. If there were no lockers (among middle or high schools) or there were no desks with storage (among elementary schools), food and habitat would not be available for pests there. All items were summed; the possible range of scores for each school was 0 to 11

after accounting for the 2 items that were asked only of middle and high schools and only of elementary schools.

SHPPS data were linked with extant data from the Market Data Retrieval (MDR) database. The MDR database is updated annually and contains information about individual US schools. The MDR variables included in this analysis were the percentage of students eligible for free or reduced-price meals, percentage of white students, number of students enrolled in the school, metropolitan status, and region. The percentage of students eligible for free or reduced-price meals (range: 0–100%; mean = 50.4% [95% confidence interval (CI) = 46.5–54.2]) and the percentage of white students (range: 1–100%; mean = 58.9% [95% CI = 53.4–64.3]) were collapsed into 3 categories: 0–32% of students, 33–65% of students, and 66–100% of students. School enrollment (range: 30–3948; mean = 479.4 [95% CI = 442.3–516.5]) was collapsed into tertiles based on the frequency distribution: 30–279 students, 280–517 students, and 518–3948 students. Metropolitan status was categorized as city, suburb, town, or rural, and region was categorized as West, Midwest, Northeast, and South.

Two additional school characteristic variables were collected as part of SHPPS 2014: school level (elementary, middle/junior high, and senior high) and age of the school's main instructional building (range: 1–163 years; mean = 47.6 [95% CI = 44.3–50.8]) which was collapsed into tertiles based on the frequency distribution: newest tertile (1–33 years), middle tertile (34–57 years) and oldest tertile (58–163 years).

Data Analysis

Data were weighted to account for the probability of selection and for nonresponse to produce national estimates[12] and analyses were conducted using SUDAAN statistical software (version 11.0.1) to account for weighted data and the complex sampling design. SUDAAN computes a *t* test to compare percentage estimates allowing for an analysis of an association between school characteristics and IPM-related strategies, practices, and policies. Differences were considered statistically significantly different when $p < .05$.

RESULTS

Pesticide Exposure Reduction

Overall, 55.3% of schools conducted campus-wide inspections for pests at least monthly (Table 1). Such inspections were more common among schools in the Northeast (63.4%) and Midwest (59.2%) than among schools in the West (44.1%) but did not differ by any other school characteristics (Table 2).

Overall, 35.6% of schools notified staff, students and families prior to each application of pesticides (an additional 30.2% of schools reported that the schools do not apply pesticides). These notifications were more common among schools in the West (52.4%) than among schools in the Northeast (27.8%) and Midwest (23.3%), more common among the largest schools (51.4%) than among midsized schools (32.2%) and smallest schools (21.8%), and more common among midsized schools (32.2%) than among the smallest schools (21.8%).

During the 12 months before the study, 46.5% of schools almost always or always used spot treatments and baiting rather than widespread applications of pesticides (an additional 14.7% of schools gave a response of “not applicable”). There were no differences in using spot treatments and baiting by any of the school characteristics.

During the 12 months before the study, 36.8% of schools almost always or always marked indoor and outdoor areas that had been treated with pesticides (an additional 30.0% of schools gave a response of “not applicable”). Marking areas treated with pesticides was more common among high schools (46.0%) than among elementary schools (33.7%); more common among the largest schools (46.5%) than among midsized schools (33.2%) and the smallest schools (29.5%), and more common among midsized schools (33.2%) than among the smallest schools (29.5%). It also was more common among the newest schools (43.1%) than among the oldest schools (28.7%).

Overall, 56.1% of schools required custodial or maintenance staff to receive training on pest management practices that limit the use of pesticides. This requirement was more common among schools in the West (63.9%) and South (60.3%) than among schools in the Midwest (43.2%), and was more common among the largest schools (62.7%) than among the smallest schools (47.9%).

There were no significant differences in pesticide exposure reduction strategies by the percentage of students eligible for free or reduced-price meals or by the percentage of white students.

Pest Prevention

More than three-fourths of schools engaged in 5 items that addressed pest prevention strategies: conducted periodic inspections of the building foundation, walls, and roof for cracks, leaks, or past water damage (96.1%) and for clutter that prevents effective cleaning and maintenance (92.9%); almost always or always stored food (84.5%) and food waste (79.8%) in plastic, glass, or metal containers with tight lids so that it was inaccessible to pests; and almost always or always removed infested or diseased plants (79.2%) (Table 1). Overall, schools engaged in a mean of 6.8 of the 11 strategies.

The mean number of pest control strategies was higher among elementary schools (7.0) than among middle schools (6.5), higher among rural (7.1) and suburban (6.9) schools than among city (6.4) schools, higher among schools in the West (7.1) than among schools in the Midwest (6.6), higher among the largest schools (7.1) than among the smallest schools (6.4), and higher among the newest schools (7.2) than among the oldest schools (6.5). The mean number of pest control strategies did not differ significantly by the percentage of students eligible for free or reduced-price meals or by the percentage of white students.

DISCUSSION

The goal of IPM is to reduce pest populations by interfering with their source of food, water, and shelter such that use of pesticides can be reduced.[2,3,8,9] Thus, the first step in any IPM strategy is to determine where, when, and what kinds of pest prevention

activities are needed.[2,3,8,9] This is achieved though campus-wide inspections of the school building and grounds.[2] Although more than 9 of 10 schools conducted periodic inspections of the building envelope for cracks, leaks, or past water damage and for clutter that prevents effecting cleaning and maintenance, fewer schools (55.3%) conducted campus-wide inspections for pests at least monthly.

Healthy People 2020,[13] national objectives focused on improving the health of the nation's people, includes objective EH-16: "Increase the proportion of the Nation's elementary, middle, and high schools that have official school policies and engage in practices that promote a healthy and safe physical school environment." Under objective EH-16 are 3 sub-objectives meant to promote a healthy and safe physical school environment by "using spot treatments and baiting rather than widespread application of pesticide" (EH-16.4), "reducing exposure to pesticides by marking areas to be treated with pesticides" (EH-16.5), and "reducing exposure to pesticides by informing students and staff prior to application of the pesticide" (EH-16.6). SHPPS 2014 data suggest progress is needed to address these Healthy People 2020 objectives. In 2014, 46.5% of schools almost always or always used spot treatments and baiting rather than widespread applications of pesticides (with an additional 14.7% reporting not applicable), 36.8% almost always/always marked indoor and outdoor areas that had been treated with pesticides (with an additional 30.0% reporting not applicable); and 35.6% of schools, each time, notified staff, students, and families prior to the application of pesticides (with an additional 30.2% reporting not applicable).

One might expect that the schools with the greatest number of students would have the most difficult time controlling pests. Yet, the largest schools were more likely than the smallest schools to notify staff, students, and families prior to each application of pesticides; almost always or always mark indoor and outdoor areas that had been treated with pesticides; require custodial or maintenance staff to receive training on pest management practices that limit the use of pesticides; and engage in a greater mean number of pest prevention strategies. Perhaps larger schools have more developed communication systems allowing for notifications, a more effective parent or community voice (or school staff with expertise such as a school nurse or facilities manager) calling for IPM, or more students with sensitivities to pests and pesticides. Additional research could identify underlying reasons for such differences and provide insights for encouraging more schools to adopt IPM strategies. Although schools serving a disproportionate number of disenfranchised populations tend to have schools in disrepair resulting from deferred maintenance,[14,15] SHPPS 2014 found that the proportion of white students and the proportion of students eligible for free or reduced-price meals was not associated with any IPM strategies examined in this study.

Limitations

The results of this study should be considered in the context of several limitations. First, SHPPS data are cross-sectional. Causal relationships between school IPM practices and school characteristics cannot be determined. Second, although SHPPS procedures were designed to have the most knowledgeable respondent complete a SHPPS questionnaire or module, it is possible there was some under- or overreporting resulting from poor respondent knowledge or social desirability. Third, respondents were asked about the existence of

policies and practices related to IPM, but were not observed to determine the quality or extent to which they engaged in such policies and practices. Fourth, although SHPPS data were weighted for probability of selection and nonresponse, it was not possible to determine the school characteristics or IPM practices of nonresponding schools and subsequent bias associated with nonresponse.

IMPLICATIONS FOR SCHOOL HEALTH

Because schools are particularly vulnerable to pests[1] they must inevitably address pest problems. Not only are pests in and around school buildings unappealing, but also pests can carry health risks such as diseases carried by insects or rodents, anaphylaxis resulting from bee stings, or exacerbation of asthma symptoms resulting from exposure to cockroach or rodent infestations.[3] This study suggests many schools could benefit from both awareness of and training about the importance of pest control and the benefits of IPM as a pest management approach.

Relying only on pesticides can be problematic because exposure to pesticides is associated with deleterious health effects[5–7] and pests and pesticide exposure at school has been shown to result in acute illness among both staff and students.[5] IPM creates a “safer and healthier learning environment”[16] in that it primarily relies on routine inspection for pests and removing conditions that attract pests: food, water, and shelter.[3,8,9] Such an approach in some schools might be initially more labor intensive than conventional use of pesticides, but IPM practices are economically advantageous because they reduce future pest difficulties by addressing the underlying causes of the problem.[16] One way to promote the implementation of IPM practices in schools is to have school district commitment to such practices. Data from the IPM Institute of North America’s study and the 2012 School Health Policies and Practices Study suggest school district policies for many aspects of IPM are not widespread. Thus perhaps it is not surprising that although there was some variation in IPM practices by school characteristics, the prevalence of many of the school level IPM practices examined in this study were low. EPA’s “Model Pesticide Safety and IPM Guidance Policy for School Districts” was developed for use among school districts and provides recommendations for best management practices for schools serving grades K-12.[17]

Another important aspect of pest prevention is to have staff who are trained on IPM techniques.[3] This study found that only 56.1% of schools required custodial or maintenance staff to receive training on pest management practices that limit the use of pesticides. These data suggest a need for increased training among key school staff who can then educate other school personnel on how to prevent pests in and around their school. An EPA, grant funded, and peer-reviewed IPM training and certificate program called “Stop School Pests” was developed to address such a need (http://cals.arizona.edu/apmc/StopSchoolPests.html).

An IPM approach to pest management addresses pests’ sources of food, water, and shelter so that pest infestation is minimized or prevented entirely, and the need for pesticides is limited. SHPPS found that there was wide variation in the extent to which schools engaged in different IPM-related policies and practices and, thus, suggest opportunities for targeted education among school staff on methods to prevent pests.

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Table 1.

Integrated Pest Management-Related Questions and Prevalence, School Health Policies and Practices Study, 2014

Integrated Pest Management-Related Questions	Response Options	Response of Interest	Response of Interest Prevalence % (95% CI)
Potentially reduce pesticide exposure			
How often does the school conduct a campus-wide inspection (ie, inside buildings and on school grounds) for pests such as ants, roaches, bees, mice, or rats?	Weekly, monthly, quarterly, every 6 months, once per year, only as needed, or other time frame	Weekly or monthly	55.3 (50.1–60.5)
How often does the school notify staff, students, and families prior to the application of pesticides?	Never, each time, once per year, other time frame, or NA (school does not apply pesticides [*])	Each time	35.6 (29.6–42.0)
During the past 12 months, how often were indoor and outdoor areas that had been treated with pesticides marked?	Never, rarely, sometimes, almost always or always, or NA (there was no pesticide application during the past 12 months [†])	Almost always or always	36.8 (31.3–42.6)
During the past 12 months, how often were spot treatments and baiting used rather than widespread applications of pesticides?	Never, rarely, sometimes, almost always or always or NA (there was no pesticide application during the past 12 months [†])	Almost always or always	46.5 (41.2–51.8)
Are custodial or maintenance staff at this school required to receive training on pest management practices that limit the use of pesticides?	Yes or no	Yes	56.1 (50.5–61.5)
Pest prevention strategies			
Does the school conduct periodic inspections of the building foundation, walls, and roof for cracks, leaks, or past water damage?	Yes or no	Yes	96.1 (90.9–96.1)
Does the school conduct periodic inspections for clutter that prevents effective cleaning and maintenance?	Yes or no	Yes	92.9 (89.8–95.1)
During the past 12 months, how often were openings in walls, floors, doors, and windows sealed with caulk or weather stripping?	Never, rarely, sometimes, almost always or always, or not applicable (there were no openings in walls, floors, doors, or windows [§])	Almost always or always or not applicable	58.2 (52.6–63.7)
During the past 12 months, how often were vegetation, shrubs, and wood mulch kept at least 1 foot away from buildings to control pests?	Never, rarely, sometimes, almost always or always, or not applicable (there was no vegetation, shrubs, or wood mulch outside the school [‖])	Almost always or always or not applicable	64.2 (59.5–68.6)
During the past 12 months, how often was eating allowed only in designated areas to control pests?	Never, rarely, sometimes, almost always or always	Almost always or always	49.6 (44.1–55.2)
During the past 12 months, how often was food waste stored in plastic, glass, or metal containers with tight lids so that it is inaccessible to pests?	Never, rarely, sometimes, almost always or always	Almost always or always	79.8 (76.1–83.0)
During the past 12 months, how often were cracks in pavement and sidewalks repaired?	Never, rarely, sometimes, almost always or always, or not applicable (there were no cracks in pavement or sidewalks [¶])	Almost always or always or not applicable	60.5 (55.6–65.2)
During the past 12 months, how often were infested or diseased plants removed?	Never, rarely, sometimes, almost always or always, or not applicable (there were no infested or diseased plants [#])	Almost always or always or not applicable	79.2 (74.9–82.9)

Integrated Pest Management-Related Questions	Response Options	Response of Interest	Response of Interest Prevalence % (95% CI)
During the past 12 months, how often was food stored in plastic, glass, or metal containers with tight lids so that it was inaccessible to pests?	Never, rarely, sometimes, almost always or always	Almost always or always	84.5 (79.8–88.3)
How often does the school clean desk tops?	Daily, weekly, monthly, quarterly, every 6 months, once per year, only as needed, other time frame	Daily	42.0 (36.6–47.6)
How often does the school require students to clean their **lockers**? (asked among middle and high schools only)	Daily, weekly, monthly, quarterly, every 6 months, once per year, only as needed, other time frame, school does not have lockers**	Daily or weekly or does not have lockers	6.0 (3.5–10.1)
How often does the school require students to clean the **inside of their desks**? (asked among elementary schools only)	Daily, weekly, monthly, quarterly, every 6 months, once per year, only as needed, other time frame, school does not have this type of desk††	Daily or weekly or does not have this type of desk	42.4 (35.1–50.0)
Mean number of pest prevention strategies (possible range 0–11)			6.8 (6.6–7.0)

*Not applicable for an additional 30.2% of schools.

†Not applicable for an additional 30.0% of schools.

‡Not applicable for an additional 14.7% of schools.

§There were no openings in walls, floors, doors, or windows during the past 12 months (17.8%).

‖There was no vegetation, shrubs, or wood mulch outside the school (16.2%).

¶There were no cracks in pavement or sidewalks during the past 12 months (19.6%).

#There were no infested or diseased plants during the past 12 months (43.1%).

**School did not have lockers (0.4%).

††School did not have this type of desk (8.4%).

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Table 2.

Integrated Pest Management-Related Strategies by School Characteristics, School Health Policies and Practices Study, 2014

	Conducts Campus-wide Inspection for Pests at Least Monthly % (95%CI)	Notifies Staff, Students, and Families Prior to Each Application of Pesticides* % (95%CI)	Almost Always/Always Use Spot Treatments and Baiting Rather Than Widespread Applications of Pesticides* % (95%CI)	Almost Always/Always Mark Indoor and Outdoor Areas That Had Been Treated With Pesticides* % (95%CI)	Pest Prevention Mean (95%CI)	Custodial or Maintenance Staff Were Required to Receive Training on Pest Management Practices That Limit the Use of Pesticides % (95%CI)
School level						
Elementary (E)	55.0 (47.1–62.7)	34.4 (26.2–43.5)	46.3 (38.5–54.3)	33.7 (25.9–42.6)	7.0 (6.7–7.3)	57.6 (49.7–65.2)
Middle (M)	55.2 (46.8–63.4)	34.9 (27.8–42.9)	45.0 (37.7–52.6)	35.5 (28.8–42.7)	6.5 (6.2–6.8)	52.7 (45.0–60.3)
High (H)	56.3 (47.1–65.1)	39.4 (30.9–48.7)	48.8 (40.2–57.5)	46.0 (37.4–54.9)	6.8 (6.5–7.0)	56.9 (48.1–65.4)
Pairwise comparisons	NS	NS	NS	**E < H** †	**E > M**	NS
Metropolitan status						
City (C)	57.3 (47.2–66.8)	34.0 (23.0–47.0)	45.2 (35.5–55.3)	34.6 (24.7–46.0)	6.4 (6.1–6.8)	55.2 (44.2–65.8)
Suburb (S)	50.5 (41.4–59.5)	38.8 (28.5–50.2)	52.2 (41.9–62.3)	39.4 (30.3–49.3)	6.9 (6.6–7.2)	57.6 (47.8–66.9)
Town (T)	59.5 (42.4–74.5)	40.1 (24.9–57.5)	51.0 (34.9–67.0)	34.2 (19.3–53.0)	6.7 (6.1–7.3)	50.1 (35.1–65.0)
Rural (R)	56.6 (47.1–65.6)	32.1 (22.2–44.0)	39.9 (32.2–48.1)	37.7 (27.8–48.8)	7.1 (6.8–7.5)	58.2 (48.4–67.5)
Pairwise comparisons	NS	NS	NS	NS	**C < S, R**	NS
Region						
Northeast (N)	63.4 (49.7–75.2)	27.8 (17.5–40.8)	49.3 (35.6–63.1)	35.0 (24.9–46.5)	7.0 (6.6–7.3)	57.0 (46.0–67.3)
Midwest (M)	59.2 (48.4–69.2)	23.3 (15.8–33.0)	45.4 (35.1–56.0)	33.3 (23.1–45.4)	6.6 (6.2–6.9)	43.2 (33.7–53.2)
South (S)	56.1 (47.8–64.8)	37.0 (26.6–48.8)	47.5 (39.8–55.3)	33.6 (25.3–43.0)	6.7 (6.3–7.0)	60.3 (50.8–69.1)
West (W)	44.1 (35.1–53.6)	52.4 (38.8–65.8)	44.1 (33.6–55.2)	45.5 (32.8–58.9)	7.1 (6.7–7.5)	63.9 (50.5–75.4)
Pairwise comparisons	**W < N, M**	**W > N, M**	NS	NS	**W > M**	**M < S, W**
School enrollment						
30–279 (Smallest tertile) (S)	56.9 (48.8–64.8)	21.8 (15.0–30.7)	39.6 (31.4–48.4)	29.5 (21.9–38.4)	6.4 (6.1–6.7)	47.9 (39.3–56.7)
280–517 (Middle tertile) (M)	55.7 (46.4–64.6)	32.2 (23.3–42.7)	51.2 (42.0–60.3)	33.2 (24.5–43.2)	6.9 (6.5–7.3)	57.6 (48.5–66.3)
518–3948 (Largest tertile) (L)	52.6 (44.7–60.2)	51.4 (42.3–60.4)	48.7 (40.6–56.8)	46.5 (37.0–56.2)	7.1 (6.8–7.4)	62.7 (52.8–71.7)
Pairwise comparisons	NS	**S < M < L**	NS	**S < M < L**	**S < L**	**S < L**
School age (years)						
1–33 (newest tertile) (N)	57.2 (48.9–65.2)	42.4 (32.8–52.6)	45.1 (36.9–53.6)	43.1 (34.1–52.5)	7.2 (6.9–7.5)	55.0 (46.5–63.2)

	Conducts Campus-wide Inspection for Pests at Least Monthly % (95%CI)	Notifies Staff, Students, and Families Prior to Each Application of Pesticides* % (95%CI)	Almost Always/Always Use Spot Treatments and Baiting Rather Than Widespread Applications of Pesticides* % (95%CI)	Almost Always/Always Mark Indoor and Outdoor Areas That Had Been Treated With Pesticides* % (95%CI)	Pest Prevention Mean (95%CI)	Custodial or Maintenance Staff Were Required to Receive Training on Pest Management Practices That Limit the Use of Pesticides % (95%CI)
34–57 (middle tertile) (M)	58.1 (48.1–67.4)	34.1 (26.0–43.1)	48.8 (40.2–57.4)	38.2 (29.7–47.5)	6.9 (6.6–7.3)	57.1 (48.0–65.8)
58–163 (oldest tertile) (O)	53.2 (44.1–62.1)	32.4 (22.9–43.5)	45.8 (36.1–55.8)	28.7 (20.8–38.1)	6.5 (6.2–6.9)	54.9 (45.6–63.8)
Pairwise comparisons	NS	NS	NS	**N > O**	**N > O**	NS
Percentage eligible for free or reduced-price meals						
0–32%	52.1 (41.7–62.4)	46.3 (35.4–57.4)	45.5 (35.7–55.7)	41.2 (31.0–52.2)	7.2 (6.9–7.5)	66.9 (57.1–75.4)
33–65%	56.1 (46.5–65.3)	41.4 (32.0–51.4)	53.2 (43.9–62.3)	37.6 (28.7–47.5)	7.1 (6.8–7.4)	57.3 (48.5–65.6)
66–100%	56.4 (45.1–67.1)	37.1 (26.2–49.5)	44.5 (33.2–56.3)	44.5 (33.5–56.1)	6.7 (6.3–7.2)	61.5 (49.5–72.3)
Pairwise comparisons	NS	NS	NS	NS	NS	NS
Percentage of white students						
0–32%	50.2 (38.2–62.1)	48.4 (34.3–62.7)	45.8 (34.6–57.4)	45.8 (32.8–59.3)	6.8 (6.3–7.3)	70.3 (55.9–81.6)
33–65%	57.6 (46.0–68.5)	45.9 (32.0–60.5)	53.2 (39.0–67.0)	42.8 (29.3–57.4)	7.3 (6.8–7.8)	66.9 (52.5–78.7)
66–100%	55.2 (46.5–63.6)	38.5 (29.9–47.9)	46.2 (38.1–54.5)	38.5 (30.2–47.6)	7.0 (6.7–7.3)	56.1 (47.9–64.0)
Pairwise comparisons	NS	NS	NS	NS	NS	NS

*During the 12 months before the study.

†"<" or ">" indicates significant difference ($p < .05$).

CI, confidence interval; NS, not significant.

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