

RESEARCH ARTICLE

The Role of School Design in Shaping Healthy Eating-Related Attitudes, Practices, and Behaviors Among School Staff

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ABSTRACT

BACKGROUND: Schools have increasing responsibility to address healthy eating, but physical barriers influence their ability to adopt and sustain recommended strategies. We took advantage of a natural experiment to investigate the role of the physical environment in shaping healthy eating attitudes and practices among school staff members.

METHODS: A school district consolidated its elementary schools and incorporated architectural features to support healthy eating into a building renovation. Surveys along with structured, in-depth interviews were administered prior to and at 12 months postoccupancy. Paired *t*-tests and McNemar's tests were used to analyze changes in survey indices and interview data were coded for themes.

RESULTS: The school implemented new policies and programs, including staff wellness activities. There was a significant decrease in the percent of teachers with a high-fat diet (from 73.68% to 57.14%, $p < .05$). Many physical barriers were removed but new challenges emerged, and staff varied in their awareness and comfort with using the new healthy eating features.

CONCLUSIONS: We found promising evidence that school architecture can support a school to address healthy eating. To enhance influence of the physical environment, more research is merited to test complementary strategies such as improving ownership of space and increasing self-efficacy to manage space.

Keywords: diet; schools; environment design; teachers.

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Schools are a priority setting for childhood obesity prevention,¹ and there is increasing responsibility placed on them to address issues of healthy eating. Unfortunately, schools often face structural and physical environment barriers to adopting recommended curricular and food service changes.²⁻⁴ A transdisciplinary team of architects and public health researchers developed the theory- and evidence-based Healthy Eating Design Guidelines for School Architecture that aim to address such barriers.⁵ Yet, research is lacking regarding the role of the physical environment in shaping schools' and their staff's healthy eating attitudes, practices, and policies.

Evidence from school-based healthy eating interventions to address childhood obesity are inconclusive,⁶

and issues of adoption and sustainability of healthy eating programming and practices remain present.⁷ Most school-based healthy eating interventions focus on student outcomes; however, school staff are often central to adopting and implementing programs and practices. Policy approaches are promising, but while a high proportion of schools adopt wellness policies, subsequent implementation and enforcement are problematic.⁸⁻¹¹ School staff often note barriers, including lack of space and appropriate facilities, hinder their ability to implement healthy eating programs and practices.^{2,3,12} For example, a national survey of school food service directors found that 88% required new equipment to help them meet the newly updated U.S. Department of Agriculture dietary

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guidelines for school meals.¹² School staff members' healthy eating-related attitudes and behaviors also have important implications in regard to their personal health and social influence on students.¹³

Theoretical and empirical evidence indicates school architecture and design strategies have a role in addressing healthy eating through mechanisms such as reducing structural barriers to program implementation and enhancing visibility of health-related values.¹⁴ Within a school's socioenvironmental system, however, the physical environment cannot be disconnected from social and policy environments. Research from fields of proxemics and environmental psychology has shown that individuals and their social interactions are influenced and shaped by perceptions and use of physical settings and space.¹⁵⁻¹⁸ Interconnections among social, policy, and physical environments have potential to be mutually reinforcing. For example, school design in the 1970s shifted to open-space planning as educational policies shifted toward supporting collaborative and flexible teaching styles,¹⁹⁻²¹ and changes to school design can alter teaching methods.²²

There is mounting evidence that the physical environment influences student healthy eating, but there is limited research on the influence of the physical environment on school and staff level processes and outcomes.²³ The purpose of this study was to take advantage of a natural experiment to investigate the role of the physical environment in shaping school policies, programs, and practices around healthy eating. The aims of this study were to (1) identify and describe patterns and themes regarding school staff perceptions, experiences, and use of the school food environment prior to and following a school renovation; (2) evaluate the impact of the school renovation on the adoption of school policies, programs, and practices that promote healthy eating; and (3) evaluate the impact of the school renovation on healthy eating-related attitudes, classroom practices, and personal behaviors among school staff.

METHODS

Intervention and Approach

Three elementary schools in a rural county school district in Virginia consolidated and integrated into one fully renovated school building, completed in the fall 2012. Two of the schools were originally slated for

consolidation, and the third was unexpectedly closed near completion of the new building. The building renovation followed strategies from the Healthy Eating Design Guidelines for School Architecture.⁵ The renovated building houses a primary school (grades K-2) and elementary school (grades 3-5), which maintain separate organizational structures but share building space that includes many Healthy Eating Design Guideline features including a commercial kitchen, teaching kitchen, and school garden. The Healthy Eating Design Guidelines range from having features that require limited management such as removal of vending machines and signage that promotes healthy choices, to others that require active management on behalf of school staff, such as a teaching kitchen and flexible cafeteria serving equipment to display healthy foods. A synergistic mixed methods approach was used, which included using in-depth interviews to inductively explore the staff's perceptions and experience of the physical environment in relation to deductive testing of impacts measured with validated quantitative surveys and structured interviews (Figure 1).²⁴

Participants

Surveys, structured interviews, and semistructured in-depth interviews were conducted prior to and at 12 months postoccupancy in the renovated school building. An electronic survey was administered to all teachers and staff in the 3 existing schools pre-occupancy and in the renovated school at 12 months postoccupancy. There was a total of 110 and 89 staff at pre- and postoccupancy, respectively. Due to considerable turnover in school staff following the renovation due to the consolidation process, only 46 staff members were present at both pre- and post-occupancy. At pre- and postoccupancy, structured interviews were conducted with each school's principal (or their designee) and the school's food service director to conduct an audit of relevant policies. In-depth interviews were conducted with 1 school administrator, 1 food service staff, and 3 randomly selected teachers at preoccupancy (N = 4). There were 9 total 12-month postoccupancy interview participants, including all preoccupancy and 5 new interview participants. Due to staffing shifts that resulted from the school consolidation process, a purposive sampling strategy was used to identify an additional administrator, 2 food service staff, and 2 teachers for postoccupancy interviews to ensure

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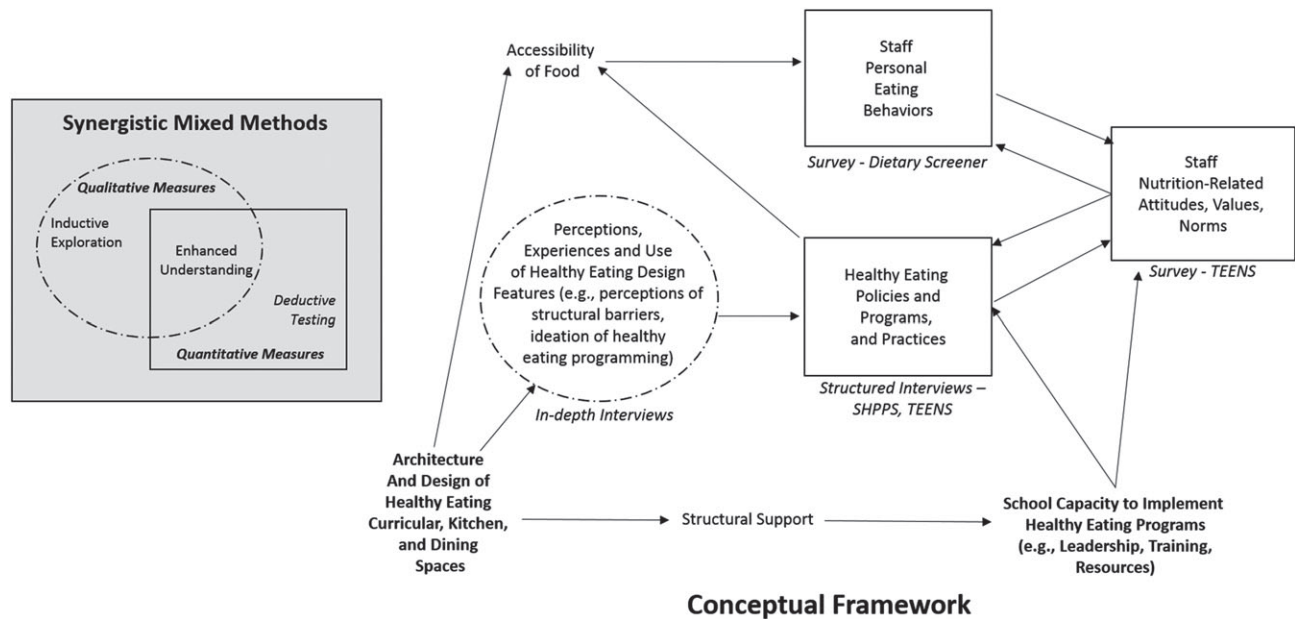
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Figure 1. Conceptual Framework for Synergistic Mixed Methods Study of the Role of the Physical Environment in Addressing School and Staff Healthy Eating



adequate data saturation.²⁵ All in-depth interviews were conducted in person and audio-recorded.

Instrumentation

Survey measures. This current study used the following validated scales from the Teen Eating for Energy and Nutrition at School (TEENS) survey, which was designed to measure classroom food practices and support for healthy food environments.²⁶ An 8-item scale (Healthy School Food Environment) measured support for healthy school food environments, with lower scores indicative of greater support (Cronbach's alpha = 0.70).²⁶ The index included items such as, "students should be able to buy soft drinks and candy at school" with Likert-type responses ranging from 1 = strongly disagree to 5 = strongly agree. Responses were coded as 0 to 4 and summed for a possible range of 0 to 32.

A 6-item scale (Children and Healthy Eating) measured beliefs regarding the influence of children's eating behaviors on health (Cronbach's alpha = 0.68).²⁶ The index included items such as, "children's food habits affect their health as adults" with Likert-type responses ranging from 1 = strongly disagree to 5 = strongly agree. Responses were coded as 0 to 4 and summed for a possible range of 0 to 24.

A 5-item scale (Negative Classroom Food Practices) measured the frequency of classroom practices unsupportive of healthy eating patterns (Cronbach's alpha = 0.70).²⁶ The scale included questions such as, "how often do you use candy as a reward, incentive,

or as a special treat for students?" with 6 response categories of "never," "1 time or less per month," "2-3 times per month," "1-3 times per week," "1 time per day," and "2 or more times per day." The responses were assigned values of 0 to 5 and summed for a possible range of 0 to 20.

The survey also included a 17-item fat and a 7-item fruit and vegetable screener to estimate fat and fruit and vegetable intake.²⁷ Response categories ("1 time a month or less," "2-3 times a month," "1-2 times a week," "3-4 times a week," and "more than 5 times a week") for high-fat items and fruit and vegetable items were assigned values of 0 to 4 and summed. These scales have been validated to measure total daily dietary fat intake ($r = .69$) and fruit and vegetable servings ($r = .71$).²⁷

Structured interview measures. The TEENS Principal Interview,^{28,29} a structured interview tool, was used to assess healthy food policies and practices. The tool's content validity has been confirmed by nutrition and school-based research experts.^{28,29} In addition, the 'Nutrition Services Component' from the School Health Policies and Programs Study (SHPPS),³⁰ was used to assess school and cafeteria policy and practices (kappa = 0.35 to 0.45).³¹

In-depth interview measures. An interview guide was developed with open-ended and probe questions. The questions were designed to elicit perceptions among school staff regarding the school food environment, their experience with implementing nutrition programs, the influence of the school's physical

Table 1. Demographics of School Staff Survey Participants

	Intervention School Prospective Cohort (N = 41)	Preoccupancy Entire Sample (N = 83)	Postoccupancy Entire Sample (N = 82)
Sex (% N)			
Women	90.24% (37)	90.48% (76)	87.80% (72)
Men	9.76% (4)	8.33% (7)	7.32% (6)
Race (% N)			
White	87.80% (36)	82.72% (67)	81.71% (67)
African American/other	12.20% (5)	17.28% (14)	18.3% (15)
Age (mean, SD)	43.32 (12.45)	43.36 (12.53)	42.32 (13.22)
Position (% N)			
Teacher	68.29% (28)	67.47% (56)	71.60% (58)
Support staff	19.51% (8)	19.28% (16)	13.58% (11)
Administrator/other	12.2% (5)	13.25% (11)	14.81% (12)
Highest degree (% N)			
Master's	35.00% (14)	25.61% (21)	33.75% (14)
Bachelor's	42.50% (17)	52.44% (43)	48.75% (39)
Associate's/High school	22.50% (9)	21.95% (18)	17.50% (27)
Number of years in position (mean, SD)	11.08 (8.28)	9.97 (8.89)	9.51 (10.60)
Number of years teaching (mean, SD)	14.24 (9.15)	14.99 (10.23)	15.05 (11.81)

features on their ability to provide nutrition-related programs and curricula, and the impact of the school food environment on students' eating behaviors.

Data Analysis

Survey data were analyzed using SAS 9.3 (SAS Institute, Cary, NC). Response distributions of the survey indices were assessed for normality and variable values were transformed as appropriate. Paired sample *t*-tests and McNemar's tests were used to analyze differences in mean survey indices and proportions with high fat and low fruit and vegetable diets among staff present both pre- and postoccupancy (ie, prospective analysis). As indicated previously, there was considerable turnover in school staff following the renovation. Thus, analysis of covariance and logistic regression was also used to assess pre- to postoccupancy differences using the entire pre- and postoccupancy intervention school sample (ie, pre-/post-group comparison), adjusting for original school status, sex, race, position, age, and highest degree.

Policy and program data from the structured interviews were summarized and described. Interview audio files were transcribed and analyzed using NVivo 10 (QSR International, Burlington, MA). The analysis was based in the paradigm of phenomenology, which involves analyzing and describing findings as individuals' and groups' "lived experience" of particular phenomenon where meaning is created through the experience of moving through space and across time.^{25,32} Within and across case analytic strategies were used to account for potential biases introduced by adding new interview participants at postoccupancy.³³

An iterative process was used to develop a coding scheme in consultation with the research team.²⁵ One

member of the team led the analysis and developed an initial coding scheme by conducting a line-by-line coding of 3 transcripts. A second research team member reviewed transcripts and made suggestions for adjustments to the coding scheme. Subsequently, the 2 team members independently coded a random selection of 4 interviews. Interrater reliability was assessed with Cohen's kappa and found acceptable (kappa = 0.64-0.83).

RESULTS

Demographics

The response rate for the surveys was 75.5% (N = 83) at preoccupancy and 92.1% (N = 82) at post-occupancy. Of the preoccupancy staff remaining at postoccupancy, 89.1% (N = 41) completed the postsurvey. The majority of the staff members across all samples were women, White, and teachers (Table 1).

School Staff Perceptions and Experiences of the School Food Environment (In-Depth Interviews)

Themes within 6 domains emerged from the interviews. Four domains: (1) perceptions of environmental influence; (2) cafeteria experiences; (3) nutrition programming and practices; and (4) student food choice and preference were found at both pre- and post-occupancy, but the themes within each domain varied between pre- and postoccupancy. Two additional domains: (1) staff health and wellness; and (2) community involvement, were not prevalent in pre-occupancy interviews and emerged postoccupancy. Table 2 describes each domain, major themes, and illustrative quotes.

Table 2. Pre- and Postoccupancy In-Depth Interview Themes and Illustrative Quotes

Thematic Domain	Pre-Renovation Theme “Illustrative Quotes”	Post-Renovation Theme “Illustrative Quotes”
Perceptions of environmental influence	<p><i>Tensions of physical features versus human influence</i></p> <p>“I think it has a potential to matter a great deal. But I think at the same time, you’re going to have to balance that with staff.”</p>	<p><i>Tensions of physical features versus human influence</i></p> <p>“I think once we get the gardens established and we get the outside squared away, being able to eat outside, um, there’s something about eating outside, where you want to eat fresh things, you know, you want to eat fruits, you want to eat vegetable salads. Um, that part of the design, I think would definitely influence those kinds of decisions.”</p>
Cafeteria experiences	<p>“I don’t think it’s the design of the school that made the difference, it was, um, how the food was fixed that made the difference.”</p> <p><i>Negative spatial qualities</i></p> <p>“It is not very inviting—small, cramped, hot”</p> <p>“And there’s no space to display. I don’t know if you’ve ever seen our breakfast and lunch, but when they have choices, usually we have them stacked up along this little window, and I’m holding piles of them.”</p> <p><i>Space inadequate match for occupant size</i></p> <p>“You can do more from scratch stuff, if you don’t have as many students coming through the line. Um, but like at (preoccupancy school), it would have been hard to do a lot, because there wasn’t a lot of room in that little kitchen.”</p> <p><i>Barrier of time and expediency</i></p> <p>“So in a half hour, we serve over 300 kids in a space that’s not designed for it.”</p> <p><i>Limited choice</i></p> <p>“No, they had no choice, everyone got the exact same tray with the exact same stuff on it.”</p>	<p>“No . . . I can’t think of how the design of the, the cafeteria itself would influence it, because I think that’s decided by the . . . nutrition staff.”</p> <p><i>Positive spatial qualities</i></p> <p>“This cafeteria’s beautiful, I love this cafeteria. It’s gorgeous.”</p> <p>“. . . like the fresh fruits and all, they are sitting right out there in the open for them to see as they are going through the line.”</p> <p><i>Space inadequate match for occupant size</i></p> <p>“It’s too many, too many children right around 1000 children, we feed close to both sides about 900 a day.”</p> <p><i>New spatial barriers</i></p> <p>“We weren’t used to being combined like that, you know . . . we [were] both used to having our own space.”</p> <p>“I think the storage is a very small space for two cafeterias to be there.”</p> <p><i>Barrier of time and expediency</i></p> <p>“That’s why you have to have something quick for breakfast, you can’t have nothing too long.”</p> <p><i>Concern of food waste/student dislike</i></p> <p>“I see a lot of fresh stuff going in the trash, which bothers me.”</p> <p>“And, and, you know, she says well kids just aren’t buying it, they don’t want it.”</p> <p><i>Limited choice</i></p> <p>. . . “say, if they are having say pizza, corn, peaches and salad, they can say I just want the pizza or the corn and the peaches. They can choose to leave things off their tray, but there’s no different choices.”</p> <p><i>Improvements in healthfulness of school meals</i></p> <p>“I have noticed they do the wheat bread now, there are some choices of fruit very often, which in the past, you didn’t get that as often as you do now.”</p> <p>“Still doing salads every Friday, that’s going well.”</p> <p><i>Space promoting positive social experiences</i></p> <p>But I do think it’s nice when I see those little tables of 4 as I walk through there. They seem to be having; well it stands to reason, when you are at a table when you have 4 people sitting around a small table, you are able to have a conversation, talk more and see what the person beside you is eating.</p> <p>But I think they enjoy it more by having, you know, space like this and seeing this open space and the seating arrangements, the way they’re sitting. I think they prefer that more than the tables we used to have back in the old schools.</p>
Healthy eating programs and practices	<p><i>Descriptions of programs and practices</i></p> <p>“We did, in our after school program, we offered a couple cooking classes and during that time, cause it was a small group only about 4 or 5 kids, and they did a couple times, go down and use the kitchen.”</p> <p>“And so we would give them a snack. And they would, they would talk about it a bit.”</p>	<p><i>Descriptions of programs and practices</i></p> <p>“The after school programs (use the teaching kitchen), we’ve had a few cooking classes and they’ve used it.”</p>

Table 2. Continued

Thematic Domain	Pre-Renovation Theme “Illustrative Quotes”	Post-Renovation Theme “Illustrative Quotes”
Student food choice and preferences	<p><i>Need for training/engagement</i></p> <p>“I think, even at the manager level, would have to have more support and education in why these choices are, what they are. And some say in how they’re being made. And then follow up with that staff. Because the women who work in the kitchen, they don’t have any say about it. And they work really, really, really hard. And they have, for a long time.”</p>	<p><i>Need for training/engagement</i></p> <p>“Cause if we know what we’re doing, if we know how to do it and what it is, we feel more confident about scheduling, or taking the time to make a lesson that revolves around that . . .”</p>
	<p><i>Preference for healthy</i></p> <p>“I mean, you know, I have no problem, the kids will eat the greens, the collard greens and the turnip greens . . .”</p>	<p><i>New programs and practices</i></p> <p>“We started this summer with the gardening and trying to connect them.”</p> <p><i>Potential future programs and practices</i></p> <p>“Like, the superintendent and I were talking, we still think there’s a lot more we can do with the farm to school program.”</p> <p>“But . . . like they may have grown tomatoes or whatever (in the school garden), and we can say, well we got tomatoes here (during school meals). This is what y’all had in your own garden.”</p> <p><i>Preference for healthy</i></p> <p>“They like vegetables, they really do . . . Raw vegetables, you know . . .”</p> <p>“They want to do what’s right. They want to do what’s healthy. Um, they will read the signs, I’ve seen that.”</p>
	<p><i>Importance of taste, exposure, and choice</i></p> <p>“Because kids would have been exposed to different fresh fruits and vegetables. And then if those choices had been given to them, they would have been able to make a suitable choice.”</p>	<p><i>Importance of taste, exposure, and choice</i></p> <p>“Uh, it’s, you eat your food at home, your vegetables, your whatever, and that’s basically, I see it, because I know that’s how she’s been raised.”</p> <p>“If they come to the line and they look at something and it doesn’t look good, that older child’s going to leave that sit there. Well it’s the same with a kindergarten student. We eat with our eyes.”</p> <p><i>Improvement in healthy choices</i></p> <p>“So then when I go eat with the children at lunch, they’re telling me, I ate carrots today! Or I ate this! You know, so I mean, it’s just got the kids talking more about eating fruits and vegetables.”</p> <p>“Uh, especially the grapes and the strawberries, the oranges and the apples and the bananas. And kiwi is coming along. Um, and I see them eating more of the fresh fruit.”</p>
Staff health and wellness		<p><i>Staff wellness activities</i></p> <p>“. . . teachers come to her office at the elementary school and we weigh in and we bring a fruit and whoever has lost the most weight by, um, percentage, um, gets the whole fruit basket at the end of the, the time. And then Tuesday after school, they just meet for maybe 15-20 minutes and they sometimes she’ll tell you to bring a recipe, sometimes we’ll just share about a success or a temptation, or something like that. And it’s just, it’s kind of like Weight Watchers, but it’s free and it’s here.”</p> <p>“I mean, you’ve always had, you know, the ones that do it every year, me included. Um, but they’re exercising more, eating better. So if they can share those experiences with the kids, maybe that would help with their habits.”</p>
Community involvement	<p><i>Staff personal wellness</i></p> <p>“I mean, there’s a lot of people who switched their . . . going on diets, eating healthier . . .”</p>	<p><i>Staff personal wellness</i></p> <p>“Um, but . . . I mean, having all the stairs, you know, you think about it, every time you go up there, you think, oh I need to quit eating the Twinkies. Or I could (go) up these (stairs) a lot easier.”</p>
	<p><i>Community pride in the building</i></p> <p>“And when they come in and they see all this newness, it’s just exciting to see that and you can just see the people light up, they’ll share memories that they had when they attended here . . . and they still have that sense of pride in that building, I think it helps connect the community to us more.”</p>	<p><i>Community pride in the building</i></p> <p>“And when they come in and they see all this newness, it’s just exciting to see that and you can just see the people light up, they’ll share memories that they had when they attended here . . . and they still have that sense of pride in that building, I think it helps connect the community to us more.”</p> <p><i>Lack of full understanding/awareness</i></p> <p>“And I don’t think the community really realizes what they have . . .”</p> <p>“I do think that they, as far as the specifics I don’t know if they really understand just exactly how wonderful the building is.”</p>

Perceptions of environmental influence. Beliefs regarding the potential for the physical environment to influence student healthy eating were mixed. Across both pre- and postoccupancy interviews, a tension emerged regarding the influence of the physical building versus how its occupants interact with and make use of the space. Some participants perceived the physical environment as creating new options and opportunities that enhanced their ability to impact healthy eating. Conversely, others viewed the power to influence student's healthy eating was predominantly shaped by other factors, and did not appear to perceive the potential facilitative role of the building's features.

Cafeteria experiences. Themes of positive and negative experiences related to the physical design of the cafeteria emerged pre- and postoccupancy; however, the specific themes shifted. Poor comfort, lack of display and serving space, and lack of equipment were primarily noted at preoccupancy. The opposite of these spatial qualities became positive themes at postoccupancy, but new challenges related to physical design arose. Participants noted a lack of sufficient storage space and inefficiencies with the kitchen layout.

Two positive themes related to cafeteria experiences were prominent at postoccupancy: (1) perceived improvements in nutritional meal quality and (2) positive social experiences in the cafeteria environment. While the improved nutritional quality of meals was noted postoccupancy, a concern also emerged regarding student dislike and waste of food. Two challenges and negative experiences were consistent across time: (1) lack of sufficient time for meals; and (2) lack of or limited healthy food choices.

Healthy eating programs and practices. At both pre- and postoccupancy, staff described several healthy eating programs and practices. Similar programs were found at both time points such as staff promotion of healthy eating, and nutrition-related after-school programming. At postoccupancy, several programs took advantage of the Healthy Eating Design Guideline features. For example, use of the garden surfaced, and the after-school program used the teaching kitchen. In addition, participants at postoccupancy expressed a desire to implement an expanded range of programming, including initiating a farm-to-school program.

Themes related to program barriers were found. At preoccupancy, competing priorities and limitations of space and physical features were commonly noted. Competing priorities remained at postoccupancy, but spaces such as the garden and teaching kitchen were seen as an opportunity and positive quality. Conversely, participants noted challenges due to unfinished or incomplete Healthy Eating Design Guideline features. For example, the teaching kitchen

space was available but lacked needed equipment. Finally, at both pre- and postoccupancy, participants noted a significant need for more engagement in the design and renovation process as well as additional and expanded professional development and training opportunities.

Student food choice and preferences. At both pre- and postoccupancy, themes regarding student food choice and preferences were consistent. Staff relayed beliefs that many students enjoy healthy foods, though, at postoccupancy several participants perceived an improvement in healthy food preferences. The importance of exposure to healthy foods, increasing healthy options, and improving the taste and quality of healthy items were each indicated at both pre- and postoccupancy.

Staff health and wellness. In the renovated school, staff health and wellness became a significant focus. Employee wellness activities developed such as a "biggest loser" weight loss contest, an after-school fitness/wellness group, and designation of "nutrition" leaders during staff meetings who were responsible for providing a healthy snack. In addition, participants expressed a desire for programs that would help them eat healthier, and shared stories that expressed personal health and wellness challenges.

Community involvement. Themes related to community perceptions and involvement were found at postoccupancy. Staff believed that the community had a sense of pride in the school and excited about the "inviting" spatial qualities of the building. However, another theme emerged that the community was not fully aware of the building's healthy eating design features.

Impact on School Policies and Practices (Structured Interviews)

Table 3 provides a summary of key programs and policies at pre- and postoccupancy. A few new programs were noted at postoccupancy including a summer garden program (Primary School), incorporation of nutrition messages during morning announcements (Primary School), after-school nutrition programming, and several programs and activities for staff.

The preoccupancy schools met the minimum nutrition standards based upon USDA school meal guidelines, and improvements were noted at postoccupancy in alignment with USDA guideline changes (eg, 5 or more whole grains each week, greater use of fresh vegetables), which occurred at the same time. At postoccupancy, the primary and elementary schools operated separate cafeteria service lines and offered different items on an à la carte basis. Both lines offered fruit drinks and bottled water. The elementary line offered high-sugar items, low-fat and

Table 3. Summary of School Food-Related Policies and Programs Pre- and Postoccupancy

	Pre-Renovation	Postoccupancy
Student assemblies	<p>Programs noted:</p> <ul style="list-style-type: none"> • Health Promotion Assemblies (eg, local farmer/agriculture speaker, “Jump Rope for Heart” event) • Activities related to the USDA Fresh Fruits and Vegetables Grant 	<p>Programs noted:</p> <ul style="list-style-type: none"> • Misc. Assemblies (eg local farmer/agriculture speaker, “Jump Rope for Heart” event) • Activities related to the USDA Fresh Fruits and Vegetables Grant suspended due to loss of funding • After school programming—nutrition education through county extension office • Summer Garden Program (Primary School only) • School Garden Workshop • Biggest Loser Contest • Group “cross-fit” activities after school
Staff programs	None noted	<ul style="list-style-type: none"> • Improvements in line with USDA guideline changes (eg increase in whole wheat servings, increased use of fresh produce and low-sodium canned vegetables) • Nutrition committee established • Collected suggestions from students, staff, and parents regarding food service programs
School meals/cafeteria	<ul style="list-style-type: none"> • Met USDA guidelines for school meal practices 	<ul style="list-style-type: none"> • Primary School Line <ul style="list-style-type: none"> • Juice (100% and fruit drinks) • Water • Fresh fruit* • Elementary School Line <ul style="list-style-type: none"> • Juice (100% and fruit drinks) • Water • Salty snacks (regular and low fat) • High-sugar snacks
À la carte lines	<p>1 of 3 schools offered à la carte line items:</p> <ul style="list-style-type: none"> • Juice (100% and fruit drinks) • Salty snacks (regular and low-fat) • High-sugar snacks • Ice cream <p>(Two schools did not offer any items)</p>	
Vending machines	Vending machines available for staff only	None available in the new school
Messaging and promotions	<ul style="list-style-type: none"> • Miscellaneous posters and signage (eg, “got milk”) 	<ul style="list-style-type: none"> • Miscellaneous posters and signage • Renovation included permanent healthy eating signage • Healthy eating messages during morning announcements (Primary School)
Policies	No formal policies noted	No formal policies noted
Fund-raising	Food items used in fund-raising included cookie dough and pizza	Some nonfood fund-raising attempted (Primary School), but several fund-raising events continued to include cookie dough and pizza

*Fresh fruit was offered occasionally but was not a regular offering.

regular salty snacks, and the primary line occasionally offered fresh fruit. During the first year postoccupancy, the primary school principal led the establishment of a nutrition committee for both schools that had not previously existed. This committee collected surveys from students, parents, and staff to generate suggestions for healthy foods to offer during meals and as à la carte items.

Impact on School Staff Attitudes, Practices, and Behaviors (Survey)

There were no significant changes in children and healthy eating, negative classroom practices, or healthy school food environment indices in either the prospective cohort or pre-/post-group comparison (Table 4). Among the prospective cohort, there was a significant decrease in dietary fat intake. At pre-occupancy, 73.65% had a high-fat diet compared with 57.14% at post ($p < .05$). Fruit and vegetable intake did not significantly change. There were no significant differences observed among the pre-/post-comparison group.

DISCUSSION

In recent years, several schools have undertaken architectural renovations of their food environments.³⁴⁻³⁶ This study is the first to include a significant evaluation component, however, and the results provide new evidence regarding the potential of physical environment interventions to influence change at social and organizational levels. The prospective cohort of school staff had a significant decrease in dietary fat intake and several staff health and wellness activities were initiated. Positive shifts in healthy eating programming and policies were also observed, which were often tied directly to the Healthy Eating Design Guideline features.

Participants in this study had varying perceptions regarding the influence of and their ability to interact with the physical environment, and also expressed a desire for greater inclusion in the design process itself. Similarly, a study of the classroom environment and teacher practices found that some teachers

Table 4. Pre- and Postoccupancy Survey Findings Regarding Teacher Attitudes, Practices, and Behaviors

	Pre-Mean (SD) (N = 41)	Post-Mean (SD) (N = 41)	p-Value
Prospective cohort			
Attitudes and classroom practices			
Children and healthy eating	19.23 (2.96)	18.23 (3.27)	.132
Negative classroom food practices	3.56 (2.74)	3.20 (2.51)	.626
Healthy school food environment index	17.36 (3.70)	18.21 (5.30)	.268
Dietary intake	% (n)	% (n)	
Low fruits and vegetables (1-2 servings per day)	27.50% (11)	35.90% (11)	.366
High fat (> 35% calories)	73.68% (28)	57.14% (20)	.034*
<hr/>			
Pre- and Post-Group Comparison	Pre-Mean (SD) (N = 83)	Post-Mean (SD) (N = 82)	p-Value[†]
Attitudes and classroom practices			
Children and healthy eating	18.65 (3.21)	18.15 (3.14)	.255
Negative classroom food practices	3.65 (2.62)	3.32 (2.83)	.235
Healthy school food environment	18.35 (4.42)	18.81 (4.95)	.614
Dietary intake	% (n)	% (n)	
Low fruits and vegetables (1-2 servings per day)	31.33% (26)	36.14% (30)	.852
High fat (> 35% calories)	71.79% (56)	63.75% (51)	.263

*p < .05.

†p-Values are from analysis of covariance and logistic regression models adjusted for original school status, sex, race, position, age, and highest degree and performed on transformed variables when appropriate.

noted a high degree of ownership of and considerably interacted with classroom space while others appeared to lack awareness of their surroundings and viewed physical features as immutable.³⁷ Research outside of school settings has found that changes to office environments do not always have expected effects (eg, open-plan offices leading to increased socializing), which was attributed to lack of user ownership of space and a corresponding tendency to cope with—rather than actively manage—their environment.^{38,39} In this study, “ownership” and leadership also appeared to influence outcomes. For example, the primary school—under the leadership of a principal involved from the outset of the renovation and redesign process—implemented more policy and program changes than the elementary school—under leadership of a principal new to the position at occupancy in the renovated building.

The in-depth interviews revealed that the school’s physical changes were perceived as a source of opportunity. Notably, the physical changes brought about new possibilities for community engagement. The importance of community and parent engagement to the success of school-based obesity prevention is well documented.⁴⁰ It is positive that the renovation appeared to instill a sense of community pride, but more communication and outreach specific to the school’s health features was needed to achieve community-level focus on healthy eating.

There were positive findings related to school policy and programmatic changes, and findings from in-depth interviews indicated that many of the new programs were directly tied to the Healthy Eating Design Guideline features such as the school garden. Furthermore, the design features were perceived as potential facilitators of future programming. However, consistent with findings from previous qualitative studies that assessed school staff’s obesity prevention policy and practice perceptions, competing priorities and lack of time were persistent barriers.^{2,3} Unfortunately, new physical barriers emerged that were further compounded by the moving and consolidation processes, which were intricately tied together. For example, issues with kitchen storage space were in part tied to an unexpected increase in student enrollment due to consolidation and a “Fresh Fruits and Vegetables” program lost funding due to changes in the proportion of enrolled students who qualified for free and reduced lunch status.

Based on survey findings, there were no significant changes in staff support for healthy eating environments or beliefs regarding the influence of children’s diet on health. Other strategies may be more influential to create shifts in attitudes and beliefs. Indeed, staff revealed during in-depth interviews that more healthy eating-related training and engagement was needed.

The changes related to staff members’ health and wellness were consistent across in-depth and structured interviews as well as survey findings. The social environment surrounding healthy lifestyle

changes appeared to have strengthened as evidenced by the growth of staff wellness activities. While it is recognized that teachers are important role models for students,⁴¹ school-based interventions have lacked considerable attention toward how school environments shape and support staff wellness. In this study, the school implemented staff wellness programs such as the “biggest loser” contest that likely had a significant influence on the observed decrease in dietary fat. Features of the building also potentially contributed by increasing the salience of healthy eating (via signage prompting healthy choices) and reducing accessibility of unhealthy items (via elimination of vending machines), key factors that influence adult eating choices.⁴²

Limitations

This study has several limitations. The results are based on a study of 1 school, and may be limited in generalizability. The design was not experimental and lacks a comparison or control group. Changes were undoubtedly influenced by factors other than the healthy eating design renovation features. For example, changes in meal nutrition quality and practices were influenced by the recent updates to USDA school meal guidelines. The consolidation process resulted in considerable staffing changes that reduced power of the prospective analyses and introduced potential selection bias for pre-/post-comparisons. The findings related to staff eating behaviors were self-reported and may be influenced by social desirability bias. However, a strength of this study was the use of qualitative methods to triangulate data (eg, interview themes indicated staff did tie programmatic changes directly to Healthy Eating Design Guideline features) and enhance understanding regarding the importance of additional contextual influences for consideration in the design of school-based healthy eating interventions.

Conclusion

Our findings reveal promise that changes to the physical environment of a school can facilitate and support adoption of healthy eating policies and practices. The school in this study implemented new healthy eating policies and practices, and there was evidence that social interaction that placed value on healthy eating and active lifestyles emerged. These organizational changes, though neither rapid nor comprehensive, are significant given their potential to support ongoing adoption and long-term maintenance of programming and practices that can influence healthy eating-related outcomes for staff and students. The physical environment appeared to play a role in facilitating positive change; however, other factors such as leadership, resources, and competing priorities also influenced

outcomes. Combining physical environment changes with directed action that accounts for nonspace barriers has potential to create more comprehensive and rapid change. Future obesity prevention research should assess feasibility and effectiveness of integrating of architecture and design with community capacity-building strategies. Efforts should consider actively engaging schools in conducting community needs and readiness assessments in concert with processes to redesign their physical environments. For example, the process would involve enhanced engagement with staff in the redesign process combined with strategic planning to simultaneously consider internal and external policy and resource issues that may influence adoption of new programs and practices.

IMPLICATIONS FOR SCHOOL HEALTH

Environmental components of school-based healthy eating interventions often require staff to actively manage their space such as by using serving equipment to change how food is displayed and accessed by students. To improve implementation of these components, strategies may need to address varying perceptions regarding environmental influences. Schools should consider training that empowers staff to consider physical environment influences and increase their self-efficacy to interact and reshape space in order to support their own as well as student healthy eating. For example, evidence has accumulated regarding the positive impact of a range of simple and low-cost changes to school lunchrooms on healthy eating choice and consumption.⁴³ However, in order to help staff actively manage their environment to implement these strategies, training programs such as “Smarter Lunchrooms”⁴⁴ are needed that engage food service staff to consider their role in creating healthy food environments and encourage their interaction with the physical environment.

Schools should consider how the physical environment may facilitate or create barriers for their staff to adopt new healthy eating policies and programs. Complete renovations are not necessarily required and small-scale environmental changes can be considered. For example, school gardens have become of increased interest and have promising findings in terms of academic, behavioral, and health outcomes.⁴⁵ To implement school gardens, schools need to work in coordination with teachers and facility managers to identify and landscape outdoor spaces conducive to gardening and accessible for staff and students.

Finally, in the United States, school renovations cost over \$10 billion each year and are often at the forefront of a community’s attention.^{46,47} Schools undergoing renovation may have a critical opportunity to reach out to the broader community and direct attention

toward desirable health and social outcomes. It should be noted that adding the Healthy Eating Design Guideline features did not increase total renovation costs for this school. Engaging school staff and the broader community when redesigning or updating school facilities may further influence change and foster important connections.

Human Subjects Approval Statement

This study was approved by the institutional review boards at the University of Virginia (IRB# 2011-0422-00) and the University of Nebraska Medical Center (IRB# 677-11-ET).

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