

Designer Schools: The Role of School Space and Architecture in Obesity Prevention

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Abstract

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Spatial features of obesogenic environments studied on a broad community level have been associated with childhood overweight and obesity, but little research has focused on the effects of the design of micro spaces, such as schools, on individual health behaviors. This article aims to generate thinking and research on the link between school space and architecture and obesity prevention by reviewing and synthesizing available literature in architecture, environmental psychology, and obesity research, in an effort to propose promising ideas for school space design and redesign. The school environment is defined through 5 dimensions: physical, legal, policy, social, and cultural domains. Theories underlying environmental interventions and documented associations between the environment and health behaviors and outcomes are reviewed to illustrate how existing environmental research could translate to obesity prevention. Design strategies aimed at promoting physical activity and healthful eating are proposed, with particular emphasis on the design of cafeterias, activity spaces, connectivity with the larger community, and student health centers.

Key words: childhood obesity, environmental factors, prevention, public health, energy balance

Introduction

Efforts to identify factors contributing to rising obesity rates in the United States and beyond have implicated the burgeoning obesogenic environment as a key determinant of obesity-related health behaviors (1). Given the potential for long-term individual benefit and large population-level impact, prevention among school-age children has become critical (2). In today's society, schools are no exceptions: exposure to labor-saving technologies and access to unhealthful foods abound. Walks or bike rides to schools are increasingly displaced by car rides, as convenience and safety concerns prevail (3–5). Once at school, students have ready access to fast food and vending machines due to partnerships meant to offset school budget shortcomings (4,6,7). The lack of time, funding, access, and planning and increased competition with various academic demands have also reduced in-school opportunities for physical activity and healthful eating (2,6). The combination of these and other factors have resulted in an environment that steers health behaviors away from physical activity and healthful diets (2,8).

The role of school space design and redesign in obesity prevention is an area that merits consideration, as school sites have served as promising venues for both research and intervention efforts (9). School-based obesity interventions have demonstrated encouraging but often modest short-term results (10–13), an observation that underscores the need for new directions in school-based prevention efforts. Although the research community has begun studying the role of the larger environment on children's diets and physical activity, little research has focused on the intersection of school architecture and design and individual health behaviors within schools. Previous work on school designs, intended to influence outcomes such as attention or scholastic performance, documents the profound impact physical space can have on student behavior and development, providing much insight into how school space might be designed or redesigned to prevent obesity (14).

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Directing built environmental efforts into the school setting has the benefit of ensuring both sustained contact with target populations and access to large segments of youth (6). Indeed, both the number of hours spent in school each year and total enrollment are on the rise, while drop-out rates have declined since 1972 (15). In addition, a significant portion of students stay on campus after classes; recent surveys suggest that almost 1 in 5 students in grades K-8 engage in campus-based after-school activities (16). Similarly, studies suggest that anywhere from 19% to 50% of students' daily food intake occurs at school (6). The case for environmental interventions within schools is further supported by precedent; plans for novel school design and the redesign of existing spaces have been proposed and implemented to influence everything from academic performance to toxic environmental exposures (14). The goal of this paper is to generate thinking and research on similar obesity prevention interventions by reviewing and synthesizing available literature in architecture, environmental psychology, and obesity research in an effort to propose promising ideas for school space design and redesign.

The scope of the current paper focuses on feasible micro-level school design and redesign to promote healthful physical activity and diets. In our discussions on school design, one distinction should be drawn to distinguish between micro- and macro-level environments. The behaviors that take place in any school system are likely to be moderated by the broader macro-environment. Examples of macro-level changes include efforts to promote walking and bicycling to and from school through healthful urban planning. Geographic information system mapping technologies have allowed for the construction of detailed environmental maps that may prove useful in investigating the impact of macro-level factors, such as the location and density of fast food restaurants in a given community. Details on these macro-environmental investigations can be found elsewhere (5). In the current article, we discuss the larger built environment only in terms of optimizing the connectivity of schools with their exterior community context.

Defining School Spaces

It has been previously suggested that, for public health practices, the built environment may be conceptualized as containing 3 sub-domains, the physical, legal, and policy environments, each of which may operate on multiple levels to discourage or facilitate any given health behavior (5). For example, students' meal choices at school could be viewed as the result of these forces. In this case, the legal environment would include regulations regarding the nutritional content of foods sold on campus. Meals provided as part of the National School Lunch Program, for instance, are held to federal nutrition standards, while competing foods are not (6). In addition, the decision of which foods to eat could be affected by physical environment factors such as ease of

access to competing foods. Are these foods available through vending machines, cafeterias, or student stores? Furthermore, school policies, such as the amount of time allocated for lunch, may also influence children's decisions. In many cases, the influences of these domains interact, further strengthening their impact on health behaviors. For instance, in situations where cafeteria designs are inefficient or insufficient to handle growing enrollment rates, shorter lunch periods could be especially likely to steer children away from more nutritious cafeteria meals.

While these 3 domains provide the beginnings of a framework for public health researchers to describe environments, expanding on previous conceptualization to also include social and cultural domains, both critical components of the school environment, may be important. One field of study within environmental psychology that addresses the impact of space on social domains is proxemics, the study of how physical space passively influences and is actively used in social interactions. Proposed by Edward T. Hall in the 1960s (17), the study of proxemics grew from the concept of territoriality and revolves around measuring the distance maintained between individuals. Hall maintained that the distance between 2 or more people could be defined as intimate, personal, social, or public, and that each distance would have implications that could influence social behaviors. Such behaviors, in turn, may have ramifications for health outcomes worth considering during school design and redesign efforts.

The environmental psychology literature has long recognized the transactional relationship between social life and the built environment (18). Within the school environment literature, this transactional nature between social and physical environments became clear during the 1970s when new school designs featured open-space planning that diverged from traditional teaching methods (19–21). The spatial definition of learning spaces, especially reading nooks, has been shown, for example, to improve children's reading behavior (22).

The impact of class layouts on both children's and teachers' behaviors is attributable to more than simply wall placement (23). Spatiality and proxemics acknowledge that occupants of space take an active role in constructing the meanings of that space, which, in turn, may influence behaviors (19). The influence of a given school space on behavior may be markedly different throughout a typical school day. In a classroom, for instance, although physical characteristics of the classroom remain constant, its influence on behaviors may vary throughout the day based on factors such as the subject being taught, the teacher, student age, or group dynamics, among other factors (21).

It is important to note that these concepts extend beyond the classroom as well. The entire school grounds deserve consideration in the design or redesign of school space, as they also pose constantly reinterpreted barriers and facilitations.

tors to health-related behaviors. In the example of physical education (PE)¹ classes, static spaces are sometimes transformed daily to accomplish various goals with different student populations. Should a single large space be used to conduct group sports emphasizing teamwork, or should a variety of smaller spaces be used to offer a greater diversity of activities? The answer to this and other questions requires consideration of the intersection between the PE environment and the changing needs of the different student groups using it.

Theories of Environmental Intervention

Many current theories may be adapted to describe the relationship between environmental factors and health behaviors. As noted by Gordon-Larsen and Reynolds (5), such adaptations have included elements drawn from the precede-proceed model, system theory, social ecology, and social cognitive theory. Similarly, other fields of study, including motivation theory, environmental psychology, and efforts to influence health norms may bear implications for environment-based health behavior interventions. The common theme underlying these theories is their ability to be applied across diverse facets composing the school environment. For example, examining social ecological theory, the most frequently adopted underlying framework for environmental interventions, reveals how its flexibility suits a number of environmental studies (5). First, social ecological models of health typically approach several contributors to health behavior decisions, including factors unique to the individual, factors external to the individual, and an interaction between the two (24). Gordon-Larsen and Reynolds (5) note that the proposed external environmental factors vary across studies, but this flexibility has allowed researchers to test hypotheses on a wide range of environmental facets encompassing the interpersonal, social, cultural, and physical domains (25–27).

One example of such a theory in application may be seen in a recent school-based fitness intervention targeting eighth grade girls in an effort to increase PE participation (28). Social cognitive theory was used to derive a social ecological model for intervention. Not only were students offered a variety of gender-specific PE options, but their choices were further broadened to include competitive and non-competitive activities. In addition, the intervention addressed several environmental facets by promoting improved faculty role-modeling, involving school nurses, and extending activities off campus to promote community and parental involvement.

That a single, integrative theory for interventions grounded in environmental design and redesign has yet to emerge underscores the importance of continuing collabo-

ration. Successful school-based environmental interventions for obesity are likely to require the participation of architects, psychologists, health behavior researchers, students, and other stakeholders, each of whom will bring a unique perspective and explicit or implicit theoretical model to the table.

Environment, Health, and Obesity

A growing body of literature documents the effects of the environment on health behaviors and outcomes (14). As obesity is frequently marked by comorbidity with other physical and mental health problems, consideration of several environmental factors will be vital in school design and redesign efforts. In this section, we discuss the wide range of pertinent environmental factors. We then illustrate how previous environmental research can impact or be translated to obesity prevention by exploring the case of air pollution in further depth.

Range of Environmental Factors. An increasing number of environmental factors, such as air quality, acoustics, climate control, crowding, ergonomics, and lighting, may be implicated in activity patterns, stress, and/or appetite and food choices, all relevant facets of overweight and obesity. The relationship between exposure to these factors and the subsequent development of unhealthful behaviors is, in many cases, multifactorial and complex. For instance, exposure to high levels of noise not only affects scholastic measures, such as attention, but has also been linked to heightened blood pressure and stress, which may, in turn, influence health behaviors and outcomes (14).

These facets of the environment, while not appearing directly relevant to obesity prevention at first thought, could, indeed, interfere with school-based obesity interventions. For example, the effect of an intervention focused on improving PE spaces may be moderated by factors such as air quality. If school or PE attendance were to decrease due to respiratory complications, then the success of any physical activity program could be limited.

Case of Air Quality. School air quality may indirectly influence health behaviors relevant to overweight and obesity. Respiratory infection, allergy, and absenteeism rates have been shown to rise with increasing exposure to airborne allergens, such as those introduced through heating and ventilation systems, cleaning chemicals, caulks and sealants used to insulate buildings, and other building materials at school sites (14,29). Outdoor air pollution levels have also been linked to absenteeism, exacerbation of pre-existing asthmatic conditions, and a rising incidence of new asthma cases (30,31).

The exacerbation of asthma is of special concern because in the absence of carefully tailored asthma management programs, asthmatic students may be less likely to participate in physical activity (32). In addition to their impact on asthma rates, indoor and outdoor air quality levels can also

¹ Nonstandard abbreviation: PE, physical education.

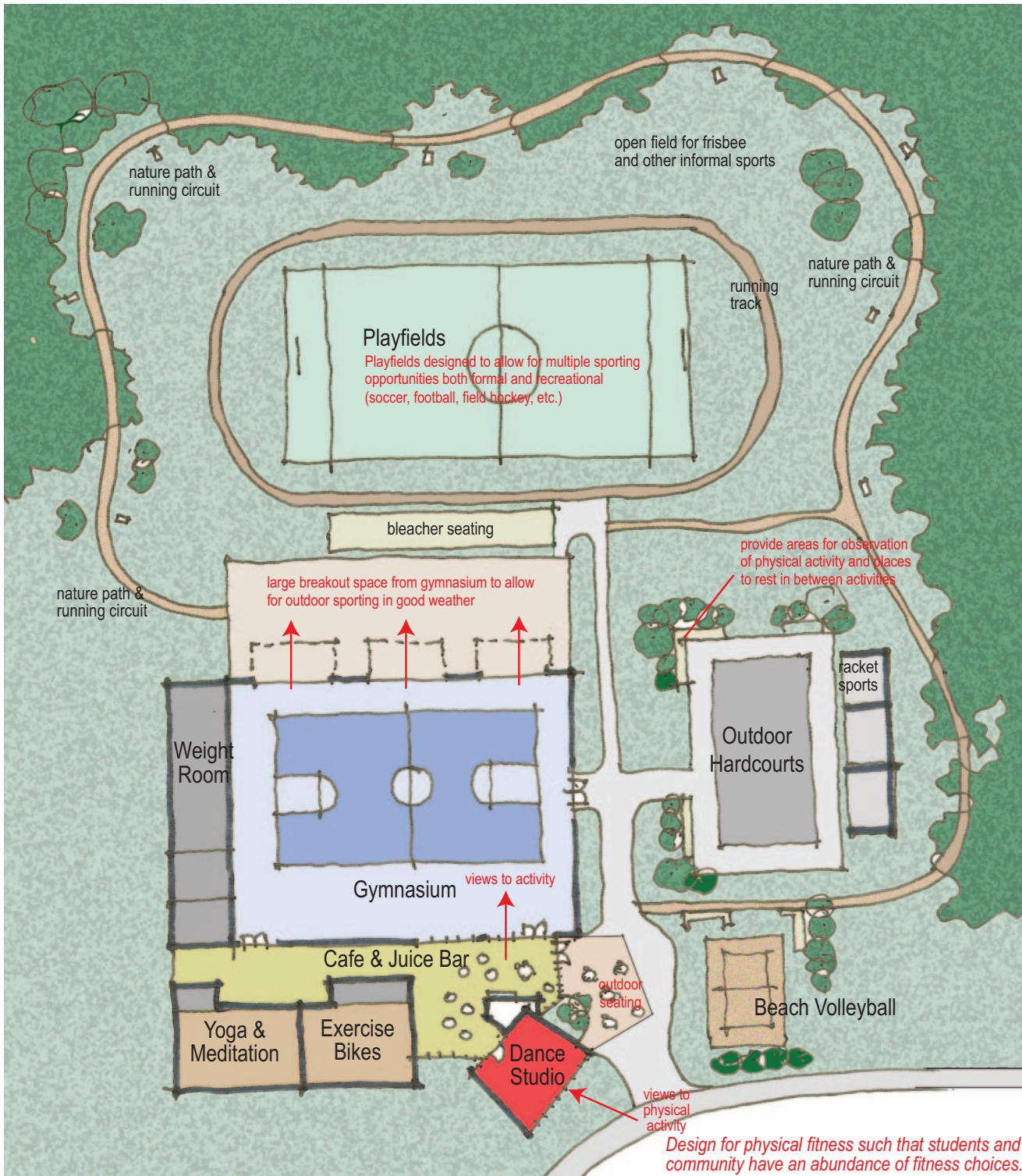


Figure 1: An example of redesigned physical fitness grounds. The inclusion of facilities that support both competitive/group sports (e.g., gymnasium, courts, and play field) and non-competitive/individual physical activities (e.g., weight room, dance studio, and nature paths) accommodates multiple forms of physical activity. In addition, flexible studio spaces (e.g., yoga and dance) and specialized facilities (e.g., tennis courts) may supplement community resources and foster facility-sharing efforts between schools and their community. Paths that run beyond traditional school grounds also enhance physical activity opportunities and connectivity with the larger community.

impact school policies regarding PE. For instance, a California statewide policy bans certain forms of athletic training during very unhealthy air conditions (33), and Sacramento regional schools have been urged to reduce or eliminate outdoor PE classes when ground-level ozone levels reach the Unhealthy for Sensitive Groups category of the U.S. Environmental Protection Agency's Air Quality Index (34,35). The result is that poor indoor and outdoor air quality may limit the motivation or opportunities for physical activity.

Indoor air quality may be improved by increasing fresh air ventilation in some areas, implementing air cleaning technologies, and ensuring that air conditioning and heating systems are serviced regularly (14,29). Similarly, indoor facilities may be used to promote activity when the outdoor air quality reaches unhealthy levels.

Innovative Elements of School Design and Redesign

Physical Activity. Efforts to increase physical activity at schools may begin with designs that augment traditional recreational spaces (Figure 1). One opportunity to encourage unstructured physical activity during recess is the creation of transitional spaces. Providing weather-protected spaces, such as porches, overhangs, or covered courts on the borders of indoor and outdoor spaces, can provide unique areas for physical activity that may be utilized by students who normally avoid activity on fields, basketball courts, and similar outdoor playgrounds. In addition, such spaces enable physical activity during unfavorable weather conditions (29).

Existing outdoor spaces may be designed to facilitate both group and individual activities. While large, unstructured spaces such as fields facilitate cooperative team play, they may provide little support for individual and small group activities. One way to address this concern is to define small, resource-rich activity pockets within larger spaces. Playground redesigns of this nature are not unprecedented; indeed, the Environmental Yard, a playground that was redesigned in Berkeley, CA in the early 1970s, followed this approach and has subsequently become an award-winning facility and grounds for subsequent research into children's activity patterns (36). The introduction of a broad spectrum of spaces, including spaces for personal or small group play, may serve to promote physical activity among students who would have otherwise underutilized large, unstructured spaces.

Several approaches may be taken to redesign existing spaces. For example, walking or nature trails may be used to divide or encircle undifferentiated outdoor spaces. Such paths can also serve as a means to connect smaller play environments designed to accommodate various levels of development. Examples of resource-rich, small activity cen-

ters could include small outdoor auditoriums, ponds, or exploratoriums. The underlying theme is that each provides a clear context for small group games and fills an activity niche that may not be supported by larger spaces. The addition of signage and instructions at each activity center may further supplement the space by removing knowledge barriers to using unfamiliar equipment and by providing guidelines to help influence health norms. Borrowing from the transitional space concept, such environments should make use of a combination of natural and built shelters to ensure that resources are accessible regardless of the season and weather (29).

One specific small, resource-rich activity center merits further discussion. The creation of school gardening programs offers unique learning opportunities. For instance, programs such as the Pennsylvania-based Urban Nutrition Initiative illustrate the potential of such garden programs not only as a means of encouraging physical activity and healthful eating, but also as a means of encouraging community partnerships with groups such as local farmers markets (37). By integrating fruit and vegetable gardens into existing academic or PE programs, students are given the chance to explore a physical activity outlet that does not emphasize physical competition and evaluation. Furthermore, collaborations with off-campus organizations may serve to defray costs if the partner is able to provide manpower, planning, equipment, or direct financial support.

Within schools, integrating gardening activities with education on produce and food preparation may encourage students to eat healthier and may remove barriers to preparing fruits and vegetables. In a California-based study of fourth graders' nutritional knowledge and dietary preferences, researchers found that students who received nutrition education and participated in school garden programs not only showed demonstrably higher levels of nutrition education than did controls but also expressed new food preferences attributable to their garden exposure (6).

Current research being conducted by the Mayo Clinic's Active Life research team seeks to illustrate the potential of innovative designs within classrooms as well. By incorporating features such as personal electronics, "standing" desks that encourage students to stand while working, and other innovations into their school of the future, researchers hope to increase the amount of physical activity children engage in during the course of typical daily activities (38). Previous research on this form of activity, coined "non-exercise activity thermogenesis," suggests that these behaviors may serve as a protective factor against the development of overweight or obesity (39).

Another relatively simple design involves improvements to stairwells. In one worksite study, stairwells were systematically improved through the sequential addition of carpeting, artwork, signage, and, finally, music. The placement of signs encouraging stair use resulted in significantly greater

foot traffic over a 3-month period after the sign posting. Similarly, playing music in stairwells was also found to increase foot travel during the subsequent 3 months (40). Within the school setting, stairwell improvements may be most relevant to multi-storied buildings used in urban schools. Stairwell improvements may serve not only to increase foot traffic, but also to provide a venue for posting motivational or educational advertising. Moreover, although widescale stairwell foot traffic may be restricted to break periods, emerging research suggests that even relatively modest increases in physical activity incorporated into everyday life could show promise for obesity prevention (41).

Recreational space designs may be used to benefit structured PE courses as well. Even small changes to PE curriculum have been shown to result in measurable changes in cardiovascular fitness and body composition (8). The creation of diverse outdoor spaces capable of accommodating both large and small group activities may allow schools to offer a greater variety of PE activities and allow students to choose activities that suit them best. Providing opportunities for a variety of team-based competitive sports and small group, non-competitive activities should remove barriers to physical activity for those who are disinterested in or fear the evaluation and competition of organized sports. Providing multiple activity options also allows for creating targeted programs. For instance, one study found that providing gender-tailored physical fitness options to high school girls resulted in higher levels of daily physical activity (28).

One final consideration for designs to promote physical activity is the possibility of opening school resources to the surrounding community. Sharing facilities, such as pools, gymnasiums, and other physical activity grounds, with the surrounding community may accomplish several goals in the right setting. First, by sharing facilities, schools may be able to share the cost of both the creation and maintenance of their physical activity centers. With increasing pressure placed on limited school funding, seeking out external financial support for physical activity programs and facilities will likely be vital for the implementation of many health-promoting designs and redesigns. In addition, partnering with community organizations increases the connectivity of schools with their neighborhoods. The benefits of close connections between the school and the community in which it lies are manifold and could include partnerships or reciprocity granting students access to off-campus physical activity opportunities that could not otherwise be supported on campus.

Diet. School design and redesign may be a promising approach to encourage healthful eating at school. In many schools, the cafeteria may serve as the primary source for promoting healthy diets because of the high participation rate of schools in the National School Lunch Program, which should ensure the availability of nutritious meals. Given the importance of school cafeterias, they may be

designed to compete more effectively with vending machines, student stores, and off-campus fast food restaurants. In addition, traditional cafeteria spaces may be redesigned to take advantage of nutrition education opportunities through the introduction of commercial teaching kitchens and demonstration areas (Figure 2).

In practice, many cafeterias also offer competing foods that are not held to federal nutrition guidelines (6). Similarly, not all competing food sources need to be considered categorically bad; some schools have begun offering healthful snacks through vending machines in place of, or in competition with, traditional junk foods (6,42). The following design ideas may be tested in future research and should be considered in concert with individual school dietary environments. Such design efforts are also likely to be most effective when paired with school policies that promote healthful eating, such as providing nutrition education, offering healthful and appealing alternatives to junk foods, restricting on-campus junk food sales, implementing pricing incentives, encouraging faculty and food service staff to serve as positive role models and provide social support, and conducting obesity screening efforts through school health services (6,42,43).

One of the first factors to consider in promoting healthful eating through school design should be not only the availability of healthful foods at cafeterias, but also the quality of such options. The preparation and presentation of healthful food options are a vital consideration for any environmental intervention, as motivational and educational messages will be effective only if viable, esthetically and gastronomically pleasing healthful options are available to students. Increasing the proportion of low-fat foods available in school cafeterias has been shown to improve students' meal choices, even in the absence of supplemental classroom or home-based interventions (43). Similarly, providing attractive produce and opportunities to try new foods used as part of a larger dietary promotion campaign has been shown to increase students' fruit consumption (44).

The lunchtime school environment is one typically teeming with competing food vendors. One of the simplest ways to promote the use of cafeteria facilities may be to control the location and density of competing food resources. For instance, vending machines are often placed in close proximity to school cafeterias, encouraging their use as an alternative to school meals (6). One approach to reducing lunchtime use of vending machines is to locate such machines away from cafeteria sites, lunch seating, or routes to the cafeteria. If a school sells sports drinks through a vending machine, they could locate their vending machine near their athletics program rather than near the cafeteria or lunch grounds. While environmental designs alone do not reduce the quantity of energy dense, low nutritional value foods available to students, relocating competing foods away from lunch areas may shift the use of such foods from

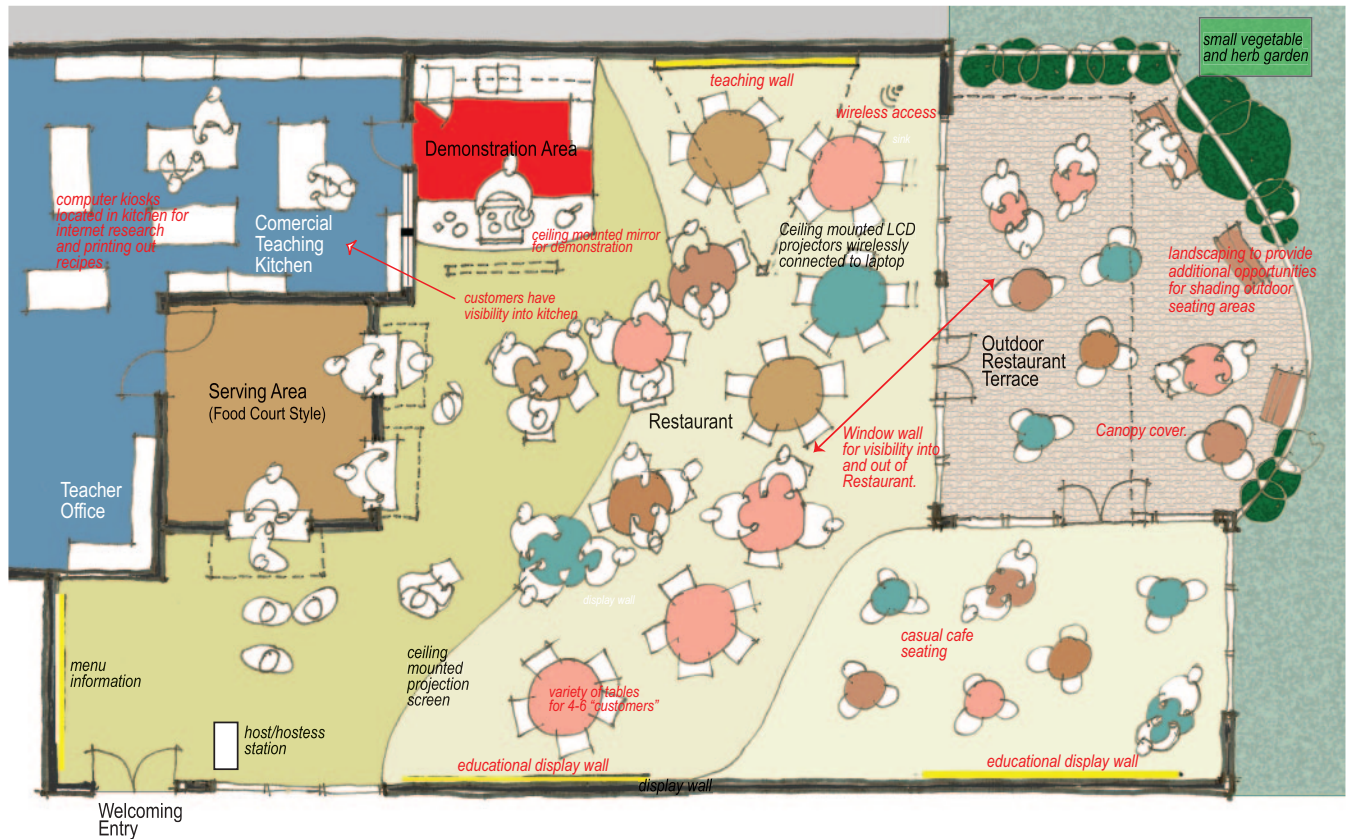


Figure 2: This figure presents an example of a redesigned cafeteria integrating nutrition education opportunities and café elements. The inclusion of a teaching kitchen, demonstration area, and projector/teaching wall enables both nutrition education as well as contact with food service staff who may provide positive role modeling and social support. Café elements such as a food-court styled serving area, natural lighting, and varied seating arrangements and locations result in an esthetically inviting dining space, which supports varied food preferences and provides distinct spaces for various social groups. The inclusion of a vegetable or herb garden could segue into a school gardening program.

lunchtime meal alternatives to snacks, impact students' overall junk food consumption, and introduce healthful foods into students' diets.

Another consideration for the school dietary environment is the role of nutrition messages around campus. The labeling of foods sold on campus, for example, could be useful in allowing students to make healthful choices, especially when paired with health education on label use (2). In one study of pricing and labeling effects on low-fat snack purchases, labeling low-fat vending machine options and posting signs encouraging low-fat purchases resulted in modest increases in low-fat snack sales, independently of pricing (42).

While health promotion messages show promise for encouraging healthful diets, they compete with existing advertisements for unhealthy foods, which have been disproportionately marketed to youths. In a recent study of the advertising environment around New Zealand school grounds, over one half of the surrounding outdoor adver-

tisements were for food products and over 70% of these promoted unhealthy options (45). Incorporating décor that involves health education messages into classrooms, hallways, stairwells, cafeterias, and other school grounds may help to offset exposure to such advertising by influencing student health norms. Creating school advertising environments that bar advertising unhealthy products may further contribute to students' dietary choices both on and off campus. As noted by Hayne et al. (2), the \$33 billion spent annually by U.S. food retailers to promote consumption stands in stark contrast to the combined \$2.5 million currently spent by the National Cancer Institute and National Heart, Lung, and Blood Institute to promote healthful eating. With the numbers stacked against health promotion, it seems likely that a combination of both advertising messages promoting healthful food and restrictions on existing advertising practices will be required to make an impact on prevailing student health norms and provide motivation for new behaviors.

While the impact of competing foods on campus may be controlled through design or policy interventions, access to off-campus fast foods remains a concern. From an environmental perspective, one way to encourage the use of school facilities is to ensure that they are functionally, esthetically, and developmentally competitive with off-campus dining options. Introducing design elements used in food courts and teaching kitchens may help to address these issues.

The design and redesign of cafeterias to improve efficiency will be critical in ensuring their use. One of the reasons cited for students' use of competing food vendors is that accessing the cafeteria takes too long. Between long lines at cafeterias and short lunch periods, time pressures encourage students to rely on alternative food vendors for their lunch (6). While the duration of lunch periods is a matter of school policy, efficient cafeteria designs could be used to reduce waiting time and line lengths. Design considerations affecting student circulation during lunch hours could include incorporating clear divisions of space so that school lunch employees do not have to compete with student traffic, separating dining and serving areas, promoting circulation patterns that discourage students from doubling back or meandering during high traffic periods, placing trash receptacles so as not to interfere with circulation patterns, and using self-service stations liberally. Ultimately, less than one third of students' mealtime should be spent obtaining food (46,47).

Another goal in cafeteria design should be creating dining environments that are esthetically appealing. Esthetic designs using student stakeholders may be one approach to making cafeterias more student-friendly. The use of student artwork in cafeteria spaces may serve as an inexpensive way to involve the school community in the cafeteria while ensuring that the cafeteria esthetic avoids becoming stagnant or outdated. As artwork, music, and lighting improvements have been documented to improve stairwell use, these elements could be promising and testable first steps for cafeteria design and redesign as well (40). While studies of the effects of artificial light levels and natural lighting in classroom settings remain contentious (14), the use of full-spectrum or natural lighting in cafeterias may play an important role in creating an inviting environment for students (29). Additional design efforts could include reducing conversational noise levels and crowding in cafeteria and dining spaces, introducing natural elements such as plant or water displays, or using displays to promote accomplishments that could encourage school spirit and cohesion. Further research in school cafeteria and dining area designs may benefit from existing restaurant and food court designs, which could serve as models for competitive, visually appealing dining centers.

One additional approach to improving student lunch grounds is to provide developmentally appropriate socialization areas near or in cafeterias to encourage on-campus

eating. Dividing undifferentiated school lunch spaces into smaller niches may allow students to claim spaces as their own and reduce stigmas associated with eating on campus. This goal may also be promoted by including various student groups in the design or redesign of school lunch grounds. The end result is a "home-like" environment, which is inviting to students and allows for the creation and claiming of personal spaces (29).

School-based Health Centers. The past decade has seen a renewed interest in expanding school nurse offices to comprehensive school-based health centers (48). The number of centers has increased from a scant 200 in 1990 to 1500 in 2005 (6,49). While the missions associated with and services offered through such centers vary, many emphasize prevention and education (6). Obesity prevention efforts may be facilitated through several channels with the expansion of existing nursing offices or creation of comprehensive school-based health centers. School-based health centers also have the additional benefit of targeting students at high risk for obesity, especially those who are under-insured or who may not otherwise receive healthcare (6,49).

One mechanism by which school health centers can influence obesity prevention is the implementation of height, weight, and BMI screening to inform primary and secondary prevention efforts and increase students' self-awareness (6). While concerns exist over the privacy of such information, the stigmatization of labeling children, and the risk of promoting eating disorders, the implementation of annual health report cards has shown promising results as a means of increasing the connectivity between schools and students' families (6). Additional concerns include the fear that parents may place the children on diets without first seeking medical guidance, but these fears may be at least partially addressed by pairing such report cards with in-school nutrition education, medical referrals, and the inclusion of educational materials sent home with such report cards.

Additional benefits of building and staffing school-based health centers include promoting close ties between schools and the healthcare community. The presence of or access to nutritionists, health educators, and similar medical staff at school sites could help to ensure that the potential of school-based physical space designs and redesigns is realized. With health education offered to as few as 20% of high school juniors and seniors, educational programs supported by school-based health center staff may serve to augment other school-based obesity interventions (2). For instance, the feedback of a nutritionist would likely benefit the previously mentioned school garden programs. Similarly, mental health services may be of use in the fight against obesity, as the disease is often associated with mental health disorders and frequently results in teasing or social ostracism (6). Pro-health educational messages for corridors, common spaces, cafeterias, and classrooms may also be designed or promoted with support from health center experts. Further-

more, of great importance, such centers could represent an access point for public health researchers to evaluate existing school spaces and school-based health behavior interventions.

Future Research Directions

While promising findings are emerging from several fields of study, substantial research remains warranted before comprehensive school design and redesign can be promoted to scale as a means of encouraging physical activity and healthful diets among school age children. Stimulating new research is, thus, the goal of the current paper. With preliminary evidence emerging from fields as disparate as architecture and nursing, the pressing need for collaboration is clear. In particular, researchers in the fields of physical activity, nutrition, health communications, and obesity will need to partner with environmental psychologists and design professionals to ensure that both the predictor and outcome variables of future studies are of high relevance, quality, and comparability. In addition, partnerships with education specialists will ensure that health-promoting school designs are compatible with efforts to promote academic goals. Through collaboration, it may be possible to find common goals for both health researchers and education specialists. Similarly, feedback from school stakeholders, such as students and teachers, may help to guide research and design methods.

Another direction for future research includes creating methodologies to evaluate existing school spaces. The creation of standardized guidelines to evaluate the extent to which school grounds promote healthful behaviors and discourage unhealthful behaviors will be vital if designs and redesigns are to be implemented efficiently. A number of models and theories have been proposed to evaluate the quality of comprehensive school-based health centers (50). Similarly, evaluation tools such as the School Health Index have been found to assist schools in identifying areas in which they can further promote physical activity and good nutrition (51). Additional tools, such as the Analysis Grid for Environments Linked to Obesity, may also be adaptable to school evaluations and would expand evaluation criteria to encompass economic, political, and socio-cultural elements (1). Because the meanings of spaces are created by people who live and work in a given space, such evaluative tools may also benefit from the inclusion of qualitative data collected from the students, teachers, and staff who use the school facilities regularly (52). The inclusion of such qualitative data may help ensure that design efforts remain accessible and meaningful to constituents over time.

A final consideration for future school design and redesign is the role of ethical and equitable access to designed spaces. As school design interventions progress from theory to application, care must be taken to ensure that both high-risk and underserved demographics are represented in the

process. In many cases, these communities may be the least prepared organizationally and fiscally to engage in school renovations or construction, so a critical role for scientists, educators, and policymakers will be learning to work within such communities to create the infrastructure needed to push for and maintain designed facilities and working with funding agencies to ensure that funds are channeled to those most in need.

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