Food and Physical Activity Environments

An Energy Balance Approach for Research and Practice

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Increases in the prevalence of overweight and obesity are a function of chronic, population-level energy imbalance, whereby energy intakes exceed energy expenditures. Although sometimes viewed in isolation, energy intakes and expenditures in fact exist in a dynamic interplay: energy intakes may influence energy expenditures and vice versa. Obesogenic environments that promote positive energy balance play a central role in the obesity epidemic, and reducing obesity prevalence will require re-engineering environments to promote both healthy eating and physical activity. There may be untapped synergies in addressing both sides of the energy balance equation in environmentally focused obesity interventions, yet food/beverage and physical activity environments are often addressed separately. The field needs design, evaluation, and analytic methods that support this approach. This paper provides a rationale for an energy balance approach and reviews and describes research and practitioner work that has taken this approach to obesity prevention at the environmental and policy levels. Future directions in research, practice, and policy include moving obesity prevention toward a systems approach that brings both nutrition and physical activity into interdisciplinary training, funding mechanisms, and clinical and policy recommendations/guidelines.

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Overview

Recent increases in the prevalence of obesity in the U.S. (>33% of adults and 17% of youth)[1] and worldwide[2] are the result of widespread, chronic energy imbalance—that is, higher energy intakes (EI) relative to energy expenditures (EE). Such widespread energy imbalance is linked to environmental factors that influence EIs and EEs at the population level.[3] Some evidence suggests that there are advantages to taking an integrated approach to understanding and intervening in food/beverage and physical activity environments. A small number of studies, including two large community-based trials in the U.S. and Australia,[4,5] have taken such an integrated approach, altering the environment at multiple levels (including schools, homes, and communities) and successfully reducing excess weight gain in children. School-based approaches that target both diet and physical activity hold promise for childhood obesity prevention compared to the alternative of treating adult obesity through lifestyle changes. However, in environmentally focused research and practice efforts, diet ("energy in") and physical activity ("energy out") are often addressed separately. The objectives of this paper are to link the concept of energy balance to environmental correlates of obesity and discuss opportunities when taking an energy balance approach to environmentally oriented obesity prevention work.

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Introduction to Energy Balance

The first law of thermodynamics, that energy can neither be created nor destroyed, dictates that, in humans, EIs must either be expended or else stored. EIs are a function of both volume and energy density of consumed foods and beverages, whereas total EEs are mostly attributable to basal metabolic rate (BMR) and physical activity. BMR includes the energy required for normal metabolic processes while a body is at rest; it increases proportionately to body mass, particularly lean mass.[6] Physical activity expenditures, energy required for movement produced by skeletal muscles, is the most modifiable component of EEs; its value depends on volume of activity and energy cost of that activity.[7]

Changes in body weight depend on the difference between EE and EI: weight gain occurs when EI exceeds EE and the difference is stored (about 60%–80% as fat), and weight loss occurs when EE exceeds EI and stored mass (likewise approximately 60%–80% fat) is used to make up the gap.[8] There are several important sources of variability in energy balance dynamics over the life course. For example, during childhood and adolescence, energy needs increase because of the energy cost of growth and development, as well as increases in BMR and physical activity expenditures associated with increased body mass. Later in life, aging adults typically experience gradual losses in lean mass, thus reducing energy needs.

It is commonly assumed that a fixed reduction in EI will be linearly associated with changes in weight over time—for example, that reducing EI by 100 kcals/day over 35 days will lead to a net negative 3,500-kcal contribution to energy balance and, in turn, 1 fewer pound of body weight gain compared with no changes in EI.[7] However, energy costs of BMR and physical activity decrease as weight decreases, so associations between changes in EI and changes in energy balance are in fact non-linear[7] and EI may need to be increasingly reduced over time to sustain a consistent rate of weight loss.[9]

For overweight/obese individuals who are losing weight, increasing physical activity lessens the extent to which EI must be reduced and may therefore increase the likelihood that weight loss will be maintained.[10] However, the rate at which weight loss occurs may decrease as individuals approach normal body weight. One way to characterize how EI, EE, and current weight status could achieve energy balance in the same individual is depicted in Figure 1 as a "sweet spot." As long as EI and EE remain within the box, energy balance is achieved and obesity is conceivably averted. The flexibility of operating within the box, instead of reducing daily EI or increasing EE by a fixed amount, recognizes that energy balance can be achieved in diverse ways, which may vary depending on the environmental contexts in which behaviors are enacted.

For obesity prevention, reducing total positive energy balance by about 100 kcals/day in adults[11] and by about 150 calories/day in children[12]—the so-called "energy gap"—may avert most excess weight gain at the population level. Closing the energy gap may in principle be achieved through reduced EI, increased EE, or a combination of both. However, it is important to note that dietary and physical activity behaviors strongly influence each other and therefore cannot be viewed in isolation.[7] For example, increases in physical activity tend to be accompanied by increased hunger and, in turn, increased caloric intakes.[13] Therefore, efforts to reduce positive energy balance through physical activity alone may be ineffective if environments promote overconsumption in response to hunger cues. Conversely, some evidence suggests that people engaging in high levels of physical activity may be most capable of regulating EI to match energy needs,[7] whereas those engaging in very low levels of physical activity demonstrate impaired regulation of caloric intakes.[14] Thus, efforts to promote appropriate caloric intakes may be most successful if complemented by efforts to increase EE by increasing activity.

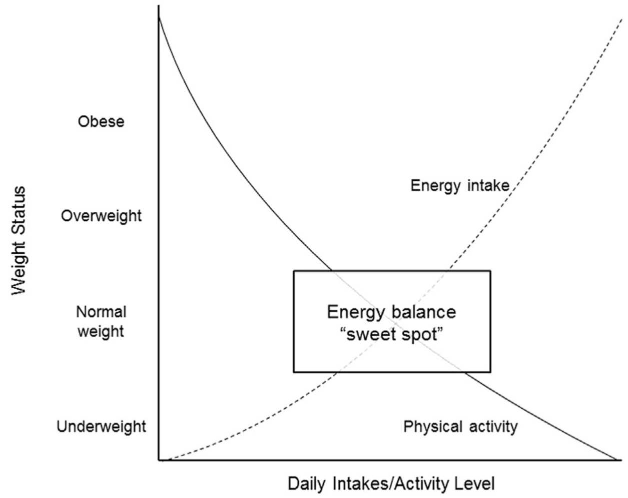

Figure 1. The energy balance "sweet spot."

Obesogenic Environments

Globally, increases in the prevalence of obesity tend to follow inter-related economic, social, and environmental shifts that affect both sides of the energy balance equation. Economic development generally increases total food availability, particularly of energy-dense products, such as added sugars, refined grains, and animal-based foods.[15] Concomitant reductions in EE are typically attributable to declines in levels of household work, occupational physical activity, and active transportation, trends related in part to increased access to labor-saving technologies.[16] In the U.S., rises in obesity prevalence since the 1970s coincided with pronounced increases in EI and decreases in EE, attributable in large part to changes in the food/beverage and physical activity environments. One study[17] using nationally representative data sets found that U.S. adults consumed an average of 1,803 kcals/day in 1977–1978, 1,949 kcals/day in 1989–1991, 2,145 kcals/day in 1994–1998, and 2,374 kcals/day in 2003–2006. These increases were driven by a combination of Americans' consumption of more energy-dense foods, increased portion sizes, and a greater number of eating occasions,[17] factors linked with changes in the U.S. food/beverage environment, such as increased availability of low-cost, hyper-palatable foods and "super-sized" portions.[18] Another study[16] estimated that physical activity EE among U.S. adults decreased from 235 MET hours/week in 1965 to 160 MET hours/week in 2009, mainly as a result of downward trends in household, occupational, and transportation activity. These downward trends are themselves associated with changes in the home, workplace, and community environments.[19]

Obesogenic environments are characterized by clustered factors that promote excess caloric intakes and inhibit physical activity. These factors include high concentrations of quick-service restaurants and other food and non-food outlets selling energy-dense foods, as well as built environment characteristics such as single-use urban landscapes, poorly maintained sidewalks, limited green spaces, or lack of connectivity to potential pedestrian destinations.[20,21] Conversely, people living in areas where healthy foods, like fruits and vegetables, are readily accessible tend to have higher-quality diets than people living in areas with less access to such foods.[22] Similarly, communities that follow principles of smart growth—including increased density, centralized amenities like schools and recreational facilities, and walkable spaces—are associated with increases in physical activity, particularly among children.[23,24]

Environmental factors that influence dietary and physical activity behaviors are not mutually exclusive, and likely there are synergies in environmental change efforts commonly viewed as either diet- or physical activity–related. For example, one study[25] found that the introduction of a neighborhood grocery store into a previously deprived neighborhood (typically viewed as a diet-related intervention) was associated not only with adoption of more healthful dietary patterns but also with a threefold increase in walking for food purchases. Conversely, environments may influence energy balance favorably and deleteriously at the same time. A systematic review[26] of studies on obesity and youth sports programs, for example, found that, although such programs can increase children's physical activity, foods and beverages commonly brought to or purchased at youth sporting events, such as sugary beverages, candy, and ice cream, may offset EE. Likewise, the unhealthy array of foods and beverages available at sporting events (e.g., at concession stands) may adversely impact the EI of sedentary spectators.[27]

Given the links between increases in obesity prevalence and broad-scale environmental changes, it is not surprising that obesity-prevention campaigns focusing mostly on individual-level factors (e.g., educational campaigns to increase knowledge) typically have had little to no effect on weight, particularly if not accompanied by supportive environmental changes.[28] Conversely, multilevel social and physical environmental changes, including changes to the food/beverage and physical activity environments in the home, school, workplace, and community, offer promise for reducing positive energy balance, and in turn obesity prevalence, at the population level.[29]

In sum, there is a reciprocal relationship between individuals' EI and EE as well as overlap between food/beverage and physical activity environments. Therefore, observational research, intervention efforts, and policies that exclusively focus on either food or physical activity environments may not account for the full impact of those environments on energy balance and, in turn, obesity. The following sections discuss challenges in integrating food/beverage and physical activity environmental obesity-prevention efforts, as well examples where such integration has been done successfully, in research, community practice, and policy domains. Opportunities for further coordination and recommendations for future work are also discussed. Table 1 summarizes these findings.

Research Community

Research with individuals has shown that programs targeting both food/beverage and physical activity behaviors may more effectively impact obesity compared with those that focus on one or the other exclusively[30,31]; however, research regarding food/beverage and physical activity environments has often only focused on one side of the energy balance equation. Silos within academic and policy communities may perpetuate this approach. For example, academic departments and degree programs in exercise and nutrition sciences are typically housed separately. Similarly, large-scale research organizations also often focus principally on either food/beverage or physical activity environments, but not both. For example, Active Living Research (www.activelivingresearch.org) and Healthy Eating Research (www.healthyeatingresearch.org), two major programs of the Robert Wood Johnson Foundation's childhood obesity prevention efforts, maintain separate program staff and initiatives aimed at physical activity and nutrition research and advocacy, respectively. These divisions are in part a function of the specialized training required to master the science of each discipline and the practical difficulty of building and maintaining expertise in both.

Related to such silos, observational studies on environmental correlates of obesity have historically tended to focus on either food/beverage- or physical activity–related factors, but not both.[32,33] For example, a recent

Table 1. Application of Energy-Balance Frameworks to Environmentally Focused Obesity-prevention Efforts: Examples, Gaps, and Future Directions

Domain	Example	Gaps	Future Directions
Academics and researchers	The Healthy Communities study (2010–2015) includes assessment of physical activity and food/beverage environments and their relationships to BMI	An integrated research framework with valid methodology that demonstrates how research could identify environmental approaches to address both diet and physical activity for an energy balance approach Studying potential behavioral synergies in those settings in which both eating and physical activity behaviors often occur in proximity (e.g., parks)	Rigorously evaluate how interactions between physical activity and nutrition environments influence energy balance and obesity Similarly, evaluate interactions between sedentary behavior and eating environments as a complement to physical activity–nutrition environment research
Community practitioners	Shape Up Somerville incorporated changes to both food (e.g., school meals) and activity (e.g., recess equipment) environments to reduce positive energy balance and incidence of obesity in young children[4,39]	Coalition formation harnessing expertise in food and physical activity environments Participatory model building Use of surveillance data and geospatial methods to target programs	Conduct and model interventions incorporating nutrition-only, physical activity–only, and combined nutrition/physical activity environmental intervention conditions Evaluate whether integration of efforts yields time/cost efficiencies or synergistic benefits for obesity prevention
Policy community	The National AfterSchool Association adopted voluntary quality standards for both healthy eating and physical activity, which are being disseminated to out-of-school programs nationwide	A systems science perspective involving interactions, synergies, and connections in the whole system Examination of synergistic relationships of policy with environmental change	Establish comprehensive, integrated PA and nutrition standards/guidelines in diverse environments that influence energy balance, including worksites, healthcare institutions, schools, recreational facilities, and other settings

review of the scientific literature on associations of activity-related environmental factors with adult weight status reported that urban sprawl and land use mix were consistently associated with weight status, although only in North America.[34] A review[35] on the association between food-related environmental factors and adult overweight/obesity and dietary behaviors found that greater access to supermarkets and less access to take-away outlets were associated with lower BMI and prevalence of overweight/obesity. However, of all analyzed environmental factors, only living in a socioeconomically deprived area was consistently associated with obesogenic dietary behaviors. In seeking to explain this counterintuitive finding, the authors noted that "environmental factors may influence BMI through a more complex interplay of factors, including physical activity, which has not been well explored in other studies. However, this is difficult to ascertain as no known studies have assessed features of the environment, dietary intakes, physical activity and weight status simultaneously." The lack of funding mechanisms and policy initiatives to support such integrated research has hindered practitioners' and policymakers' ability to affect real and sustained changes that support healthy lifestyles.

In the U.S., racial/ethnic minorities and those of lower SES are disproportionately likely to be exposed to physical and policy environments that limit availability, affordability, and appeal of healthy eating and active living options. This contributes, in part, to the high risk of obesity in black and low-income communities and may limit the potential effectiveness of prevention and control interventions.[36] Although the environment clearly plays an important role in the development of overweight/obesity, the dietary and physical activity mechanisms that contribute to this relationship, the interaction between those mechanisms, and the relationship between these factors and sociodemographic disparities in obesity require more research.

Recent research initiatives are taking a more integrated approach to environmental assessment and intervention. For example, the Healthy Communities Study, sponsored by the National Heart, Lung, and Blood Institute, is investigating how community-level policies and programs targeting childhood obesity influence diet, physical activity, and BMI among children aged 3–15 years (www.nhlbi.nih.gov/resources/obesity/pop-studies/hcs.htm). This research, which will continue from 2010 to 2015 and include more than 200 communities across the U.S., will provide a comprehensive understanding of the complex relationships among individual-, home/family-, organizational-, and community-level factors that influence both sides of the energy balance equation. Future observational studies should continue to evaluate food/beverage and physical activity environmental correlates of obesity and test for possible interactions among these correlates. Additional questions of interest include exploring potential social and behavioral factors that could drive changes in terms of both healthy eating and physical activity. If common pathways can be identified, more targeted intervention strategies may ensue that can benefit both health behaviors.

Energy balance–oriented environmental research interventions appear to mostly target children, consistent with widespread public health recommendations to prioritize prevention of obesity in the early years of life.[37,38] The following sections discuss examples of environmental interventions that were grounded in energy balance frameworks and successfully promoted healthy weight among children at the population level.

Shape Up Somerville (SUS) was a community-engaged, controlled intervention that aimed to reduce undesirable weight gain among children in Grades 1–3 in Somerville MA, a diverse, densely populated city north of Boston.[4,39] Guided by social-ecological models of health behavior, SUS incorporated multilevel environmental changes to promote healthy eating and increase EE by up to 125 kcals/day beyond those associated with normal growth and development. Environmental changes were designed to reach children in multiple settings and at multiple time points during a typical school day. To increase physical activity before school, SUS's walk-to-school campaign included walking school bus initiatives, traffic-calming efforts, and publication of maps outlining safe routes to school. Enhancements were also made to meals served in school breakfast and lunch programs, including increases in fruits, whole grains, and low-fat dairy. Equipment and training for foodservice staff supported implementation of these changes, which were further reinforced through promotional efforts like taste-testing events.[40] Schools were also provided with new equipment to support active recess, and after-school environments incorporated healthier snacks and physical activities. To influence the home environment, SUS developed parent newsletters and nutrition forums and provided parents with coupons for free or reduced-price healthful foods. In the community, efforts such as the "SUS-approved" healthy restaurant program and a farmers' market initiative increased access to healthful foods, whereas city bikeability/walkability ordinances and installation of bike racks and thermoplastic crosswalks supported physical activity.

By promoting energy balance through modifications to both food/beverage and physical activity environments, SUS successfully achieved targeted outcomes: after the first year of the intervention, BMI z scores decreased among first- through third-graders in the intervention community relative to two control communities.[39] These decreases persisted, compared to controls, after a second, sustainability-focused year, during which the research team transitioned into support roles and the implementation responsibility shifted to local organizations and the community.[4] These decreases in obesity prevalence may have been a function of behavioral changes on both sides of the energy equation: pre–post surveys indicated that children in Somerville, compared with those in control communities, showed significant increases in sports and physical activities and decreases in screen time and sugary beverage consumption.[41]

Be Active Eat Well (BAEW) was a 3-year (2003–2006) demonstration project that sought to reduce excess weight gain among children aged 4–12 years living in Colac, a town in the rural Barwon South West region of Victoria, Australia. BAEW involved environmental changes to support lifestyle behaviors associated with energy balance.[42] Like SUS, BAEW included a walking school bus initiative and walk-to-school days to increase use of active transportation before and after school. School nutrition policies were implemented to increase availability of water and fruit and to improve the nutritional quality of school meals. Foodservice staff members were provided training and dietitian support to enable them to implement these changes, and taste-testing events were held to drive uptake of menu changes. To promote healthier food environments outside school, BAEW also implemented a community garden. All efforts included a strong focus on community capacity building (e.g., network partnerships and infrastructure investments) to enable the community to implement and sustain program efforts.

As in SUS, the energy balance–focused environmental changes promoted by BAEW successfully reduced undesirable weight gain in the target population. Children at randomly selected schools in Colac had lower increases in waist size and BMI z scores from baseline (2003/2004) to follow-up (2006) compared with children at randomly selected schools from the rest of the Barwon South West region.[42] A subsequent analysis found that in 2009, 3 years after the intervention period, the prevalence of pediatric overweight/obesity remained 6 percentage points lower than at baseline. This change was no longer significantly different from control communities, which likewise experienced decreases in the prevalence of overweight/obesity; the authors attributed this finding to spillover effects.[5]

Future efforts to seek out evidence- and practice-based synergies within such programs would likely greatly benefit both the food/beverage and physical activity environmental and policy fields. For example, environment-focused intervention studies using 2 X 2 designs, including "energy in" conditions, "energy out" conditions, "energy in + energy out" conditions, and control conditions, may help determine whether combined energy balance interventions have synergistic advantages for obesity prevention beyond the additive impact of separate "energy in" and "energy out" environmental changes.

Facilitating further obesity-prevention research addressing both food/beverage and physical activity environments will require overcoming institutional silos. Tools such as electronic networks offer promise in terms of identifying and matching expertise across disciplines. Multidisciplinary degree programs, fellowships, and training programs that integrate both nutrition and physical activity, like the Built Environment Assessment Training (BEAT) Institute (www.med.upenn.edu/beat), may further promote comprehensive energy balance approaches to environments. New funding mechanisms that call for integrated energy balance environmental interventions are also needed.

Community-Level Practice

Building on research interventions like SUS and BEAW is the Childhood Obesity Research Demonstration (CORD) study, a multisite research and dissemination effort funded by CDC.[43] The goals of CORD are to evaluate the effects of a multilevel, multisectoral intervention on the prevention and control of childhood obesity among underserved children aged 2–12 years. The effort is also designed to inform future practice efforts and policy initiatives. Similar to the SUS and BAEW interventions, the CORD sites in Massachusetts, Texas, and California are working with families, healthcare centers, early care and education centers, schools, and community organizations to address energy balance by targeting four behaviors: diet, physical activity, water drinking, and sleep. Evaluation will include assessment of changes in energy balance behaviors and BMI among children in intervention communities compared with those in control communities. The California site, in particular, is also examining the extent to which the intervention influences parents' behaviors and weight status, given reciprocal influences between children and parents. A fundamental aspect of CORD is its focus on policy, systems, and environmental changes to ensure that evidence-based strategies have the potential to be translated into organizational and community practices and policy initiatives.[43] With this goal in mind, CORD also has an extensive sector evaluation component that examines costs to implement the various strategies from the school, early care and education, and healthcare perspectives.

For communities to develop additional environmentally oriented energy balance interventions, access to credible data and tools will be required. Many data are already available, including through public sources. The National Collaborative on Childhood Obesity Research (NCCOR) website includes a warehouse of surveillance systems that provide data on individual and environmental factors related to diet, physical activity, and obesity; many of these data are geocoded, enabling localized diagnosis of community-level characteristics (www.tools.nccor.org/css). NCCOR also provides a registry of valid, reliable measures pertaining to obesity prevention, including hundreds of tools for evaluating food/beverage and physical activity environments. Organizations such as Smart Growth America (www.smartgrowthamerica.org) and PolicyLink (www.policylink.org) provide access to research, tools, and technical support to help communities transform environmental conditions not only to promote healthy eating, physical activity, and healthy weight but also to advance other outcomes like conservation and economic development.

Initiating and sustaining comprehensive environmental changes, including changes to both food/beverage and physical activity environments, requires an active, engaged citizenry and sufficient preparedness for change. The Community Readiness Model (CRM) is one framework for evaluating communities' preparedness for change, akin to the Stages of Change model used to understand individual behavior.[44] Communities that demonstrate very low levels of readiness may not be capable of sustaining environmental changes once support is withdrawn, whereas communities with very high levels of readiness may initiate and sustain environmental changes even without outside support. Intervening with communities consistent with their level of readiness helps to optimize the impact of scarce environmental-change resources. This framework has been used to determine stage of readiness to initiate childhood obesity prevention efforts in multiple U.S. communities as well as in the United Kingdom.[45–47] Similar approaches are being used in the CORD study, and future papers will describe the extent to which readiness frameworks predict communities' engagement and propensity to sustain change.

Policy

The policy community, like the research and practitioner communities that both inform and are impacted by policy, has also traditionally addressed diet and physical activity separately. It is well established that government action at the local, state, and national levels is necessary to increase the healthfulness of food/beverage and physical activity environments and to both reduce obesity rates in the overall population and close related health disparities.

The U.S. government has issued one set of guidelines focused principally on diet (e.g., control of total calorie intakes)[48] and another focused on physical activity (e.g., minutes of daily or weekly moderate to vigorous physical activity).[48,49] However, such reports have begun to show signs of integrating diet and physical activity. For example, beginning in 2000, U.S. dietary guidelines have incorporated recommendations for physical activity.[50] The most recent guidelines, from 2010, also included more explicit emphasis on energy balance as well as a new discussion of the importance of multisectoral approaches to address social and environmental determinants of diet and physical activity.[48] Notably, the first major U.S. federal government report on physical activity and health was not published until 1996,[51] and federal physical activity guidelines were only recently published by the USDHHS, in 2008.[49] By contrast, the federal dietary guidelines for Americans were first issued in 1980 and are refreshed every 5 years. It is unclear if and when the next update of the physical activity guidelines will occur.

Organizations that influence policy on a broad scale, like the IOM in the U.S., also are beginning to take more integrated approaches to address environmental and policy determinants of obesity. For example, Figure 2 shows a framework developed by the IOM's Committee on Accelerating Progress in Obesity Prevention,[29] which illustrates ways in which multiple environments, with reinforcing policies, may overlap and impact both sides of the energy balance equation. Schools, for example, can be viewed as both food/beverage, or "energy in," environments (e.g., by way of school meals) and as physical activity, or "energy out," environments (e.g., by way of playgrounds and other facilities). The figure has been modified to include specific examples of environmental factors that may influence one or both sides of the energy balance equation and that might be integrated in energy balance–based environmental policies. In addition to such broad-scale policy initiatives, evidence-based

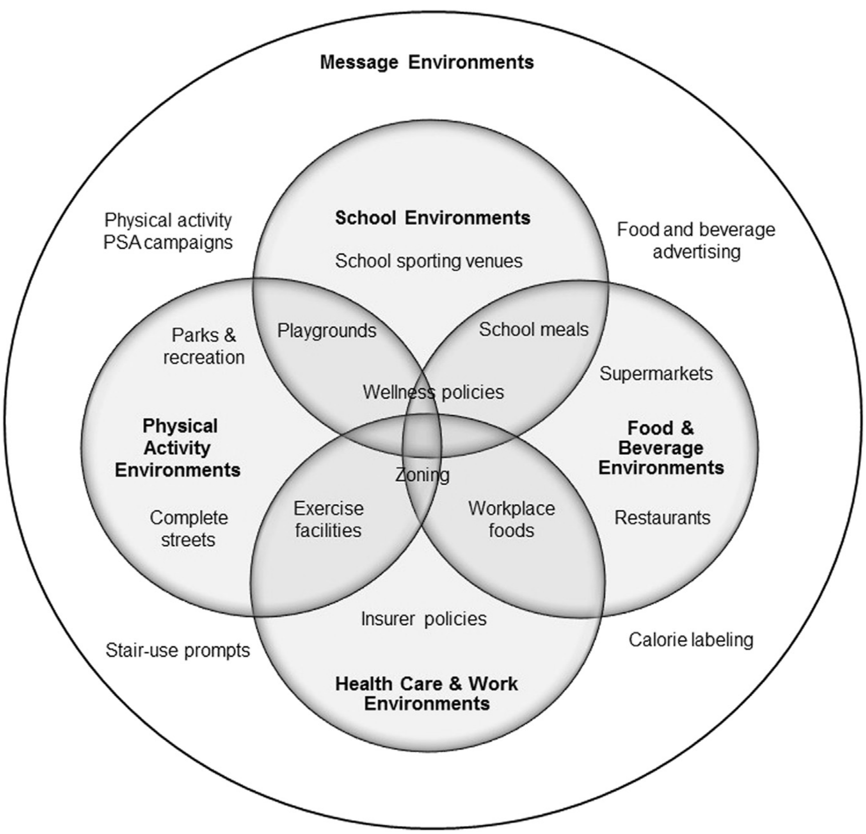

Figure 2. Examples of environmental and policy factors that influence energy balance.
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PSA, public service announcement.

standards/guidelines and evaluation tools may also support multilevel environmental changes in specific settings. For example, in 2011, the nonprofit National AfterSchool Association adopted voluntary, evidence-based nutrition and physical activity quality standards for after-school programs, including recommendations to ensure physical environments promote both healthy eating and physical activity.[52]

In order to increase accountability of both governments and the private sector for their actions, and improve the healthfulness of food environments, the International Network for Food and Obesity/Non-Communicable Diseases Research, Monitoring and Action Support (INFORMAS) has recently been founded to systematically and comprehensively monitor food environments and policies in countries of varying size and income. This will enable INFORMAS to rank both governments and private-sector companies globally according to their actions on food environments. Identification of those countries that have the healthiest food and nutrition policies, and using them as international benchmarks against which national progress toward best practices can be assessed, should support reductions in global obesity and diet-related non-communicable diseases.[53,54] To operationalize policy impact and benchmark progress on controlling EI, a monitoring framework, Government Healthy Food Environment Policy Index (Food-EPI), was developed to assess government policies and actions for creating healthy food environments. Similar tools are needed for physical activity–related policies.[55] In summary, policy efforts need to lead—or, at minimum, follow the evidence obtained from—research and practice efforts that demonstrate the importance of having a dual focus on EI and EE when conceptualizing environmental changes.

Conclusions

Although many environmentally oriented obesity prevention efforts focus on either food/beverage or physical activity environments, more comprehensive approaches accounting for both sides of the energy balance equation may represent the most efficient and effective path toward creating health-promoting environments. Further observational and intervention research is needed to understand how community environments influence both dietary and physical activity behaviors and how different combinations of environmental interventions influence energy balance and obesity prevention. Such studies might also evaluate whether there are time or cost efficiencies gained by addressing both sides of the energy balance equation together rather than through separate efforts.

To advance such research, it is critical to develop teams that incorporate expertise in both diet and physical activity, as well as in other relevant disciplines like urban planning and development, marketing, and business. Given the resources required to implement multilevel environmental changes at the community level, researchers and practitioners should carefully assess communities' readiness for change and allocate resources toward those where change is most likely to be adopted and sustained. Other areas of potential promise include studies of the diffusion of the impacts of childhood obesity-prevention programs to other members of the community, including family members, teachers, and other adults. Through exploration of intergenerational as well as transbehavioral effects of multilevel interventions aimed at built and social environments, substantive advances in the field can be made.

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