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Measuring the Health Environment for Physical Activity and Nutrition among Youth: A Review of the Literature and Applications for Community Initiatives[1]

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Children's diet and exercise patterns are affected by numerous environmental factors, including the availability of healthful foods and exercise opportunities in the community, media messages about foods, and family practices regarding physical activity and food choices. Efforts to measure these environmental factors are relatively new. The present paper describes an ecobehavioral perspective on factors influencing health behavior. The authors review the reliability and validity of 16 environmental measures relevant to physical activity and nutrition among youth. To illustrate the use of environmental measures, a case study is provided of how one was used to evaluate two partnerships whose missions were to decrease risk of cardiovascular disease and some cancers among children. The paper closes with recommendations for research and practice.

Key Words: **adolescent; physical activity; nutrition; environment; measurement; community-based.**

INTRODUCTION

A wealth of evidence indicates that interventions to promote physical activity and a healthful diet are needed for children and adolescents as well as adults. By the age of 12 years, for example, more than 40% of children have at least one modifiable risk factor for coronary heart disease [*1*]. Numerous effective interventions have been identified for enhancing diet or physical activity among children [*1–5*], but most have targeted individual behavior, focused on a single setting (such as schools), and addressed only a single risk factor for chronic disease, e.g., diet or physical activity. Because diet and exercise patterns are possibly influenced by numerous environmental factors, interventions that address environmental influences may be of great value. Examples of potential environmental influences include the availability of healthful foods and exercise opportunities, social norms, peer preferences, media messages, and family practices [*6,7*].

National and international health agencies have developed recommendations for environmental change despite a lack of research examining the influence of environment on health behaviors [*8*]. Environmental interventions (e.g., increasing the quality or number of children's play spaces or reducing the fat in school lunches) change the conditions in which individual behavior occurs [*9*]. It is important to develop and test such ecologically based interventions for enhancing physical activity and nutrition among youth [*8*] To do so, methods for measuring environmental factors must be developed.

The present paper briefly describes an ecobehavioral perspective on factors influencing health behavior and reviews environmental measures in the literature. Next, a case study is provided of how an environmental measure was used in evaluating two community partnerships that sought to decrease the risk of cardiovascular disease and cancer among children. The paper explores how individual-level and environmental-level measures may be integrated to evaluate community initiatives targeting physical activity and nutrition among children and closes with recommendations for research and practice.

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An Ecobehavioral Paradigm for Environmental Influences on Physical Activity and Nutrition among Youth

Assessment strategies are derived from models that specify causal relationships. The present review relies on an ecobehavioral paradigm, an emergent method which is concerned with environmental influences and their effects on the health behaviors of large population segments [*10*]. The units of analysis are the social, physical, and cultural circumstances that affect the aggregate behavior of groups or classes of individuals. The ecobehavioral paradigm is a combination of the principles of applied behavior analysis [*11*] and the perspective of environmental models of child development [*12*]. These models posit that external influences are heirarchical in nature, that they can directly influence child behaviors or indirectly influence child behaviors through caregiver behaviors, and that they shape development of behaviors across time [*13*].

Examples of ecological applications of behavior analytic principles include work on environmental influences on child development [*14*], Winett's examination of the effects of flexible work schedules on urban families with young children [*15*], and Russos and colleague's work on community health coalitions [*16*]. As described by Hovell, "This model presumes that an individual's behavior is selected as a function of consequences (response/consequence contingencies). The model presumes that contingencies of reinforcement and punishment may be viewed on a continuum from simple to complex schedules . . . [ranging from] . . . contingencies applicable to an individual to those affecting whole communities" [*17*]. Thus, the ecobehavioral paradigm seeks to identify systemic variables to which groups of individuals are exposed that deliver contingencies, provide or prevent opportunities, exert stimulus control, set up behavior chains, foster imitation through modeling, or bring about behavioral extinction relevant to health behaviors of groups. These factors are drawn from the model of operant behavior first proposed by Skinner [*18*]. Ecobehavioral analyses often look to models used to describe the diffusion of innovations [*19*], media advocacy [*20*], and behavioral modeling [*21*] for clues to other potentially influential social variables.

The ecobehavioral approach is similar to other ecological approaches in its (a) emphasis on empirical data closely linked to theory; (b) careful measurement of observable behavior and documentation of its temporal, physical, and social environment, (c) openness to pursuing and discovering explanations that are unconventional; and (d) a working hypothesis that behavior is largely controlled by its environmental setting and that changing the environment will change behavior [22]. The implications of this model for measuring the health environment for physical activity and nutrition among children follow. It is important to examine environment–behavior interactions at multiple levels, such as the home, the community, and the national media, because any or all of these levels may influence behaviors through mechanisms such as delivering contingencies or providing opportunities for physical activity or healthful food consumption. Environmental assessment should be accompanied by careful measurement of the relevant health behaviors, since it is only in a comparison of the two that behavior–environment relationships will be identified. Last, because site specificity is assumed (the same individual behaves differently according to setting), environmental assessment should only occur in natural settings—where children live, work, and play—where food consumption and physical activity actually occur. To examine relationships between external influences and children's health behaviors, researchers must have on hand reliable measures of the environment.

Measures of Environmental Factors Relevant to Physical Activity and Nutrition among Youth

Measures of environmental factors have been used for a variety of purposes, including setting social policy from data obtained through federal or state sources [*23*], improving services for disabled persons through direct observation of the physical and social climate of group homes [*24*], and designing interventions for substance abuse prevention from determining the number and density of liquor outlets or the cost of street drugs [*25–27*].

In Table 1, 16 selected community-based studies that included environmental measures relevant to physical activity or nutrition among youth are grouped by data collection method (written survey, written report or log, interview, direct observation, archival data) and are briefly summarized. Criteria for selection included having a measure that (a) related to physical activity or nutrition among youth, (b) concerned an aspect of the environment (not personal behavior alone), and (c) was directly observable (this could include social interactions). Studies that described data collection systems but did not present data were excluded, as were school-based studies (McGraw et al. [*28*] review the literature on similar measures in schools). In some instances, multiple papers were published using the same or very similar environmental measures. In these cases, the review focuses on the paper that links the environmental measure most closely to behavioral or health status outcomes; however, other applications of the measures are cited.

Most of the studies were identified by soliciting recommendations from researchers or by reviewing the reference lists of published articles. Although there are

TABLE 1

Summaries of Studies That Developed or Validated Environmental Measures Relevant to Physical Activity and Nutrition among Youth

Data collection method/authors	Scope of assessment	Source of data	Environmental measure(s)	Reliability	Comparison with health behaviors
Written surveys					
McDonald and Cordell [33]	National	Nonrandom sample of 1254 city and country park and recreation directors	Frequency and type of exercise facilities, programs, and personnel	None reported	None reported
Written reports or logs					
Flora et al. [29]	Seven cities	Nonrandom sample of project staff from three community studies	Frequency and type of intervention activities conducted by project	None reported	None reported
Francisco et al [30]	One city, one state	Nonrandom sample of project staff from two community-based projects	Frequency and type of new or modified programs, policies, or practices related to the project's health goals	Interobserver reliability (observed reliability 81.6%, $K = 0.76$)	None reported
Interviews					
Cohen et al. [31]	Two counties	Nonrandom sample of 301 representatives of organizations in both counties	Frequency and type of risk reduction activity conducted over the past year	None reported	None reported
Elder et al. [32]	One city	Random sample of 200 labor unions, supermarkets, churches, and restaurants	Frequency, type, and extent of health promotion activities	None reported	None reported
Sallis et al [40]	One city	Nonrandom sample of 347 parent–child dyads from 63 preschools serving low- to middle-income families	Eating Out and Play Opportunities Questionnaire (EOPOQ)	EOPOQ $R = 0.67$; $\alpha = 0.63$	Nearby play spaces ($P = 0.002$) and frequency and time in play spaces ($P = 0.001$) were significantly associated with child levels of physical activity
Hearn et al. [41]	One city, county	Random sample of 12 families from each of 16 intervention schools	Whether 10 fruits and 10 vegetables were present in home in past week (availability); whether f/v were in the open, in the front of the fridge as snacks, were stored in the fridge for meal preparation in past week (accessibility)	Combined fruit and vegetable availability accessibility scale $\alpha = 0.69$	Weekend ($P = 0.04$) and total weekly ($P = 0.02$) fruit and vegetable consumption was significantly related to home availability and access, weekday consumption was not
Patterson et al. [42]	Statewide	Random-digit-dial sample of 1002 households	Presence or absence of 15 high-fat foods in pantry, presence or absence of 6 reduced-fat foods in pantry	None reported	Significant correlations between individuals' energy from fat and the number of high-fat foods present ($P < 0.001$) Correlations were slightly lower but as significant in households with children

TABLE 1—*Continued*

Data collection method/authors	Scope of assessment	Source of data	Environmental measure(s)	Reliability	Comparison with health behaviors
Direct observation					
Cheadle et al [35]	One city	37 grocery stores	Proportion of poultry and fish on display, proportion of low-fat milk on display, proportion of whole wheat bread on display, presence or absence of health promotion materials near food displays	Interrater correlation coefficients ranged from 0.73 to 0.78 for foods and 0.30 to 0.67 for health promotion materials; test–retest ranged from $K = 0.44$ to $K = 1.0$	None reported
Cheadle et al. [34]	12 cities, counties, and census tracts	141 grocery stores	Proportion of red meat in meat display; proportion of low-fat milk in milk display; proportion of nonwhite breads in bread display; multiitem healthfulness scale	See Cheadle et al. above [24]	Correlations between residents' diets and grocery environment were significant in 5 of 8 cases
Mayer et al [36]	19 rural towns	131 grocery/convenience stores, 31 pharmacies, 43 gas stations, 147 restaurants	Promotional signs per fruit and vegetable type; shelf space or menu offerings devoted to whole-wheat bread, lean meat cuts, low-fat dairy products, low-fat entrees	Generally high levels of interobserver reliability (range 60–99%)	None reported
Sallis et al. [37]	One city	77 supermarkets, convenience stores, health food stores, and groceries in 24 neighborhoods housing elementary schools	Number and type of sites for physical activity; number of sporting goods stores; presence of low-fat dairy, meats; presence of low-sodium products; presence of dry or vegetarian canned beans, presence of unsaturated oils	Interobserver reliability was 99% for supermarkets, 78% for neighborhood markets, and 53% for physical activity resources	None reported
Wechsler et al [38]	One community	257 bodegas and 25 supermarkets	Presence and volume of low-fat milk for sale	Interobserver ($R >$ 0.99), test–retest ($R = 0.92$)	None reported
McKenzie et al [39]	One county	Nonrandom sample of 42 children, aged 4–8, and their families	Food available; physical location of child, parental prompts for eating or physical activity; modeling of eating or physical activity; positive and negative consequences for physical activity and eating	Very high levels of interobserver reliability (range 85–90%)	Verbal prompts resulted in increased rates of eating at home ($P < 0.001$) and physical activity behaviors at home ($P < 0.01$) and during school recess ($P < 0.01$)
Kotz and Story [43]	National (Saturday morning coverage)	Major network advertising on 3 nonrandomly selected Saturday mornings	Types of foods advertised, types of explicit messages used in ads	Interobserver reliability ranged from 67 to 100% on food message measure	None reported
Archival data					
Sallis et al [44]	One city	Random sample of 2053 residents	Use of pay or free facilities; density of exercise facilities (mapped by researchers)	Respondents answered consistently across items (see Sallis et al., 1989)	Density of (a) all facilities within 1 km ($P <$ 0.05) and (b) pay facilities within 1–5 km were significantly ($P < 0.05$ to $P < 0.01$) associated with self-reported physical activity

many empirical studies of physical activity and nutrition that have measured individual behavior change, few studies were found that measured environmental factors. In fact, a search of CD ROM databases using terms such as "environment," "ecology," "physical activity," or "nutrition" yielded no studies suitable for inclusion in this review. Because of difficulties in identifying studies, it would be most unlikely that all studies using measures of the environment relevant to children's physical activity and nutrition were captured. Most of the 16 studies identified were reported as process or intermediate outcome evaluation measures for larger initiatives. Three of the studies [*29–31*] examine the effects of interventions on changes in the environment. The remaining 11 studies are static measures of the environment. They examine how certain environmental factors correlate with health behaviors and do not include an intervention.

Of the 16 studies selected, 5 examined the frequency or type of facilities, programs, or policies related to physical activity and nutrition among youth [*29–33*]. Five other studies, all using direct observation, were primarily concerned with the presence of healthful foods in supermarkets and groceries [*34–38*]. One study examined the effects of social variables (prompts to action and statements about behavior) on physical activity and eating [*39*], and 1 looked at features of the family environment (frequency of eating out, number of play spaces near home) [*40*]. Two studies examined the relationships between foods present in the home and dietary behaviors [*41,42*], and 1 study examined the type and frequency of food advertisements during children's Saturday morning television programming [*43*]. Finally, 1 study used readily available, archival information from phone books and street maps to chart the density of exercise facilities [*44*].

Eleven of the 16 studies reported on the reliability of the measures (interrater, test–retest, or internal consistency), and 6 of the 16 "validated" environmental measures against individual-level behavior data. The usefulness and validity of these environmental measures are in part determined by how well they correlate with accepted measures of behavior. For instance, a community "walkability" scale may be reliable and accurately measure how easy it is to walk in a community (operationalized as number of sidewalks, controlled street walkings, etc.). The next level of validity could be based on how well the scale correlates with actual levels of walking. In this review, unless otherwise specified, the absence of validity assessments means that no validity studies at all were identified by the authors.

Written surveys. McDonald and Cordell [*33*] reported on the National Municipal and County Park and Recreation Study. Researchers surveyed local park and recreation departments throughout the United States to gather information on staff, facilities, and space, such as miles of walking trails, and programs offered. Unfortunately, a low response rate (18%) and the lack of reported assessments of the reliability and validity of the survey limit its utility.

Written reports or logs. Flora and co-workers [*29*] described a community education and monitoring system used by the Stanford Five-City Project, the Minnesota Heart Health Program, and the Pawtucket Heart Health Program to collect data on the number and type of intervention activities created by the community-based interventions. Data were used for program administration, feedback on progress to staff, and assessment of intervention dosage.

Another measure that dealt with community programs was reported by Francisco et al. [*30*]. In this measure, coalition staff and community members recorded community changes (new or modified programs, policies, and practices) created by their community coalitions. Records were entered into a database and coded by two independent observers according to a set of definitions developed by program evaluators. Rates of interobserver agreement were calculated, and reports were provided regularly to coalitions and funders. The authors reported moderate (81.6%) levels of interobserver reliability.

Limitations of these measures include the system's use of self-report data, the lack of comparable data from sites where the interventions did not exist, and lack of validation of these measures with behavior, i.e., participation rates and subsequent behavioral outcomes.

Interviews. Cohen et al. [*31*] used pretest and posttest measures in experimental and comparison communities to examine the effects of a health promotion campaign. Evaluation staff used a structured phone interview to collect various data on risk reduction activities, including their number, type (e.g., newsletters, seminars, screenings), settings (e.g., worksite, religious organization, or civic club), and participation level. Change in the level of risk reduction activities was used as an outcome measure for a county-wide cardiovascular risk reduction intervention. No reliability or validity data for this measure were presented

Elder et al [*32*] used interviews to conduct a survey among a random sample of labor unions, supermarkets, churches, and restaurants to identify the frequency, type, and extent of health promotion activities they conducted. Two-thirds of churches and labor unions and one-third of restaurants and supermarkets reported conducting such activities. The reliability and validity of these measures were not reported

Another study used a questionnaire called the Eating Out and Play Opportunities Questionnaire to assess the effects of certain environmental variables on children's physical activity at home [*40*]. Both the availability of

nearby play spaces and the frequency of time in play spaces were found to be significantly associated with children's levels of physical activity. The first questionnaire collected information from parents on opportunities for eating out and playing in various locations; reported test–retest reliability was moderate (R = 0.67), and the α coefficient was good (α = 0.63).

Hearn and colleagues [*41*] conducted a study among 13 families in each of 16 elementary schools to examine relationships between the presence of fruits and vegetables in the home and children's fruit and vegetable consumption. A phone survey was used to collect data from the family's primary food preparers on the availability of fruits and vegetables in the home. Availability data were collected on the 10 fruits and 10 vegetables most commonly consumed by children. Access to these foods was assessed by asking whether fruits and vegetables were left in the open, whether fruits, vegetables, or fruit juices were placed on the front shelf of the refrigerator as a snack, or whether vegetables were prepared and stored in the refrigerator for ready use in a meal the child might prepare. Fruit and vegetable consumption among the children was assessed using 7-day food recalls. Children's "weekend" and "total weekly" fruit and vegetable consumptions were significantly related to the presence of fruits and vegetables in the home. "Weekday" consumption of fruits and vegetables (when children might consume a larger proportion of foods outside of the home) was not significantly correlated with fruit and vegetable availability/access in the home.

Finally, Patterson and colleagues [*42*] conducted a random-digit telephone survey of 1002 households in Washington state to ascertain correlations between the presence of high-fat foods in household pantries and the households' levels of dietary fat intake. Reliability of this brief measure was not reported. Strong correlations were found between the number of high-fat foods and the level of energy consumed from fat, and these associations held for households with children.

Direct observation. Five of the seven studies using direct observation documented the presence of "healthy" foods and promotional materials in supermarkets or grocery stores [*34–38*]. In general, interobserver agreement for such measures was high, ranging from 78 to 99% for neighborhood market and grocery store observations. In the only study that compared shelf-stocks and consumption patterns, Cheadle and colleagues [*34*] found significant associations between residents' self-reported dietary intake and grocery store measures (e.g., the proportion of low-fat milk in milk displays). Interrater reliability was high for measures of the availability of healthy foods on store shelves, but the reliability of measures of health promotion materials, reported in another study, was low (R = 0.30 to 0.67 [*35*]). Two years after the initial study, investigators repeated measures of the grocery environment and residents' food consumption to examine whether the relationships persisted over time. Correlations in changes were weaker and not statistically significant [*45*]. In addition, the investigators compared grocery store environmental measures with individual-level telephone surveys to examine the utility and costs of using each as an outcome measure for a health promotion intervention conducted in three communities [*46*]. The two measures were collected at three separate times in each of the three communities. In two of the communities, relative change in the two measures correlated well. In one community, the telephone survey suggested no or worsening change in dietary consumption but the environmental measure suggested that the availability of healthful food items improved. Although mixed, these findings justify further research on environmental measures as outcome measures, given the much lower cost of the grocery survey [*46*].

McKenzie and colleagues [*39*] examined the effects of the home environment on children's physical activity and diet behaviors. The BEACHES (Behaviors of Eating and Activity for Children's Health Evaluation System) palm-top computer system allowed observers to enter aspects of the home environment and children's behavior. Information was entered on the identity (i.e., mother, brother) of other family members present, whether prompts or behavioral modeling for physical activity or eating occurred, and what consequences were delivered following children's physical activity or eating behaviors. Two social environmental variables, parental prompts to eat and parental prompts to engage in physical activity, resulted in increased eating and physical activity behaviors. Researchers found high levels of interrater reliability (85–90% interval-by-interval correspondence) across all categories of behavior and environment during in-home observations. The palm-top computers prompted observers to focus on the target child for 25-s intervals and then gave observers 35 s to record their observations according to a set of behavior categories. Reliability was assessed by having two observers record data using synchronized palm-top computers while observing the same videotaped or "live" interactions. Reliability calculations compared interval-by-interval correspondence in observations; the formula used to calculate reliability was agreements divided by agreements plus disagreements multiplied by 100. The authors noted several limitations of the methodology; BEACHES requires extensive training sessions and quality control; and the coding system does not capture all of the behaviors of interest.

Kotz and Story [*43*] examined the types of food products advertised during children's Saturday morning television programs. Advertised foods were categorized by food group according to the food guide pyramid; types

of explicit and implicit messages used in advertisements were coded as well. Interrater reliability was reported for only one measure (the types of explicit messages used in ads) and was variable (ranging from 67 to 100% agreement). Foods advertised were predominantly high in fat, sugar, or both, had low nutritional value, and did not include fruits or vegetables.

Archival and other recorded data. In a study reported by Sallis et al. [*44*], investigators mapped exercise facilities and conducted a mailed behavioral survey to examine whether distance between homes and exercise facilities was related to frequency of vigorous exercise. Distances and facility density were calculated using phone books (to locate facilities) and street maps with superimposed grids. The researchers provided incentives to encourage residents to complete the behavioral survey. They achieved a 43% return rate. Densities of all facilities ≤1 km of home and pay facilities within all distances studied (up to 5 km from home), were significantly associated with self-reported rates of vigorous activity. Analyses controlled for age, education, and income. Limitations include the absence of some facilities from the density map, the exclusion of low- to moderate-intensity physical activity from analyses, and the exclusion of children as respondents. Although this study focused on adults, similar methods might be used to examine how distance to exercise facilities or recreational areas might influence children's activity levels.

Summary. The 16 studies reviewed illustrate how diverse in scope environmental measures can be. They can relate to activities of government, community-based initiatives, or the behavior of parents. They might involve international food companies or local grocers. They can examine social, physical, or combinations of social and physical factors. For example, McKenzie and colleagues [*39*] examined the social environment; they collected data on a large number of antecedent events (e.g., verbal and imitative prompts) as well as postbehavior consequences (e.g., physical and verbal events such as punishment or verbal praise) relevant to eating and physical activity behaviors among children. Alternately, two studies [*34,44*] compared the physical availability of healthful foods or exercise venues to individual health behaviors. Kotz and Story's [*43*] study on food advertising calls into question the distinction between social and physical factors, similar to social interactions, media messages are verbal, visual, and involve role models. Like physical features of the environment, they are unavoidable and have the potential to influence masses of children—whomever passes through the TV environment

Linking environmental measures to individual health in order to evaluate health interventions is a daunting but important task. Community initiatives, whether they are regional or local efforts, provide opportunities for developing and evaluating environmental measures. The following case study illustrates the use of an environmental measure in evaluating a community health initiative.

APPLICATION: A CASE STUDY OF THE KANSAS LEAN SCHOOL HEALTH PROJECT

The Kansas LEAN School Health Project created two partnerships between two schools and their communities, one in a remote rural community and one in a mid-sized city [*47,48*]. The school–community partnerships sought to reduce children's risks for coronary heart and chronic diseases. The evaluation of these partnerships is used here to illustrate how measures of process, environmental change, and individual level outcomes can be combined to assess project effectiveness.

Objectives and Structure

The school–community partnerships included three school-based components: modify the fat content in school lunches, enhance opportunities for school and community-based fitness activities, and enhance nutrition education. A fourth component was to involve businesses, schools, parents, and others to create broader changes in the community. Thus, the school–community partnerships had two purposes, (a) to help implement the school-based components and (b) to create "systems changes" in the school and broader community to enhance children's community-wide opportunities for physical activity and healthy food choices.

Intervention Strategies

The school–community partnerships focused on creating individual-level and environmental-level changes. Activities such as fitness assessments and lessons in preparing low-fat snacks were designed to increase children's health knowledge and health-promoting practices. Other efforts sought to modify the environment to make fitness and healthy nutrition choices easier (e.g., developing combined parent and child aerobic classes in conjunction with the local YWCA). The school–community partnerships served as catalysts for community change by convening citizens to plan and implement changes, facilitating the exchange of information and resources, and institutionalizing successful projects.

Evaluation Methods

In Table 2 the evaluation questions and measures used to address those questions are presented. Process measures addressed community members' satisfaction with the school–community partnership, their feelings

TABLE 2

Summary of Evaluation Questions and Measures for the Kansas LEAN School Intervention Initiative

Evaluation questions	Measures
Process	
Were the goals of both projects important to the community?	Community surveys of goals
Were the projects implemented as planned?	Teacher logs, monitoring system (codes service provision, planning products)
Were the community changes achieved by the project considered important to reducing risks for cardiovascular disease?	Community survey of the importance of changes
Environmental-level outcome	
Did the projects create changes in both community's health environment?	Monitoring system (code: community change)
Did the projects lower the fat in school lunches?	Nutrient analysis of school lunches
Individual-level outcome	
Did children's nutrition knowledge, attitudes, skills improve?	Student surveys
Did children's fitness levels improve?	Fitness assessments

about the importance of partnership goals and achievements, and whether components directed toward individual-level change (for example, the nutrition education modules) were implemented as planned. Environmental-level outcome measures assessed whether the partnership changed the children's health environment, both in school and in the broader community. Individual-level outcome measures included assessment of students' (a) nutrition knowledge, attitudes, and skills and (b) physical fitness.

Results

Process measures suggested that partnerships were well implemented Teacher logs and member surveys indicated that the components were implemented as planned and that the partnership goals were important to community members. Community members rated the importance of most community changes actually achieved by the project as "important' or "very important" in reducing children's risk for cardiovascular disease.

Environment-level outcome. Evaluators collected the number of community changes created by the school–community partnerships over $2^1/_2$ years as a measure of effectiveness. Community change was defined as new or modified programs, policies, and practices adopted to reduce risk factors for cardiovascular disease. School–community partnership staff reported candidate community changes on log forms and evaluators coded the reported events using a behavioral definition of community change adapted from Francisco et al [*30*]. This information was graphed and reported back to the partnerships periodically to give them feedback on the rates of changes they had facilitated; such changes included revisions in school lunch menus, adopting a new nutrition curriculum, and developing new parent–child aerobic classes. The cumulative numbers of community changes reported by the two partnerships are presented in Fig. 1. The partnerships reported facilitating 179 and 72 community changes, respectively, with the number of community changes rising relatively evenly over the 30 months.

In addition, children's access to healthful school meals improved: the proportion of calories from fat in school lunch menus decreased from baseline levels of 38 to 40% to the target level of 30% in both communities. Appropriate caloric levels were maintained. Cost and participation in school meals remained unchanged.

Individual-level outcome. In both school–community partnerships, the evaluation found statistically significant increases in students' knowledge of nutrition. Students' fitness levels also increased in both partnership schools. Partnership B students had significantly better gains in fitness assessments compared to same-grade students in neighboring schools.

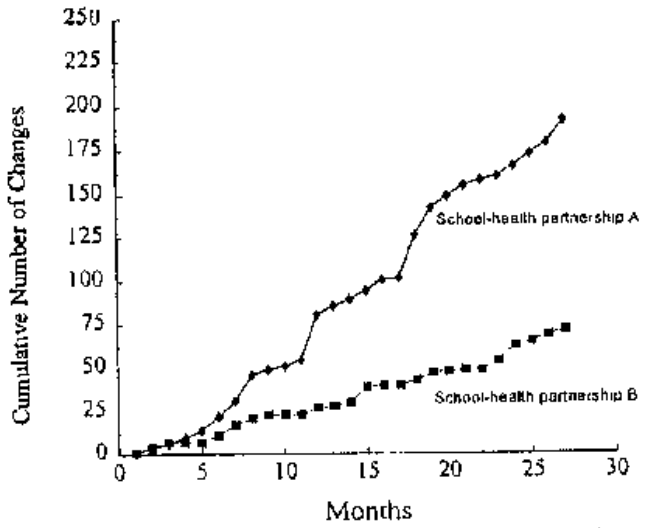

FIG. 1. Cumulative number of community changes facilitated by two partnerships

In addition to providing an outcome evaluation, community change data were used during the life of the partnerships to improve their functioning. Ongoing graphing of the data and subsequent feedback assisted staff, funders, and potential funders in understanding where partnerships were directing their energies. For example, partway through implementation, pie charts were used to show Partnership A that of its 85 community changes, 47% were directed toward nutrition and diet, 46% toward physical activity, and 6% toward other environmental changes. Such analyses helped to show whether the partnership was being implemented as planned, for example, whether the targeted risk factors were being addressed. In addition, data on community changes were combined with importance ratings by community members to focus partnerships on achievements that "mattered" to the community.

Summary of Methods

This case study describes an evaluation of community-controlled partnerships which involved a high degree of staff and community member participation in the intervention and evaluation procedures [*49*]. The key environmental measure used here, the number of community changes, was an intermediate outcome for the initiative. Behavioral surveys and fitness assessments were the main outcome measures for the initiative. The combined environmental, behavioral, and health status findings suggest that the initiative was successful, but the case study design limited the strength of the findings. Because community change data were not collected in comparison communities, the evaluation could not definitively test the causal effect of environmental change on individual nutrition or physical fitness variables. Last, the community was neither randomly selected nor randomly assigned to the intervention. The community leadership was highly motivated; the same intervention may not have worked in any community.

Partnerships or coalitions that involve citizen groups in designing and implementing planned social change may be especially necessary for creating effective and sustainable changes in the environment [*50*]. In the case at hand, school policies and budget allocations were controlled at the community and district levels. As state-based organization may not have been as influential in creating locally acceptable and culturally appropriate environmental change. In fact, because of the strong community ownership of the school partnerships, many of the changes in school curricula and practices in food service were maintained even after the completion of the formal intervention [*51*]

Such partnerships, also called coalitions, deliver multiple interventions in communities [*39,40*]. The aim of many partnerships is to change environmental influences on health by enveloping citizens in opportunities and reinforcement for positive health behaviors. In doing so, they offer numerous occasions for both creating and measuring environmental change, as many communities are somewhat closed systems [*54*]. Such partnerships provide ideal settings for developing environmental measures, assessing their sensitivity to changes in the environment, and exploring links to individual-level health behaviors.

RECOMMENDATIONS FOR RESEARCH AND PRACTICE

Scientists, practitioners, and policy-makers face a number of challenges in examining environmental influences on children's physical activity and nutrition. Challenges include: (a) identifying additional environmental factors for measurement, (b) establishing the predictive validity of environmental measures, (c) determining causal relationships between measures of environment and behavior, (d) increasing the number of levels (e.g., home, block, neighborhood, school district, etc.) in which environmental intervention and research are conducted, (e) increasing the number of settings in which environmental intervention and research are conducted, (f) increasing the variety, reliability, and "user-friendliness" of environmental measures, and (g) using environmental measures to advocate for environmental-level intervention. The studies reviewed in this paper provide clues as to how these fundamental issues are currently being addressed; here we provide recommendations for future research and practice.

Identifying Additional Environmental Factors for Measurement

The review of 16 studies (Table 1) yielded 11 different kinds of environmental factors, each of which related to one or more of the following variables: (a) practices of retailers, (b) policies and practices in the home, (c) availability and use of recreation opportunities, and (d) community-wide health interventions. To these four variables could be added school practices (e.g., percentage of fat in school lunches or the amount of moderate to vigorous exercise in physical education programs); descriptions of school-based measures are elsewhere [*28*] in this issue.

Several of the measures reviewed in this paper were conducted as part of interventions that focused primarily on adults; more measures need to be developed for interventions directed at children. In addition, directly observing children in schools, homes, childcare settings, houses of worship, and recreational settings should yield ideas for the development of new environmental measures. Also, literature on the etiology of physical activity and nutrition, which has identified the importance of peer influences at school [*6*], the presence or absence of safe play spaces and safe walking or biking

paths to schools and playgrounds [5], and the development or reclaiming of green spaces in cities [5] should be further explored for what it can contribute to the creation of new measures. Finally, researchers should learn about the efforts of the many community initiatives that are springing up to address children's health and development. Initiative members are often innovative professionals, with a wealth of experience with children, who do not take the time to publish their ideas regarding environmental influences. For example, some influences occur in practically every community (e.g., the nutritional content of meals on restaurant "kiddie menus") while others may be idiosyncratic to one community, district, or state (e.g., whether skim milk is readily available to school food services through a regional distributor). Factors of influence in one community may not exist in another. Local citizens may be aware of these influences and the best means for changing them. Collaboration with local and regional advocates may help researchers identify and explore new classes of environmental variables. In addition, "grassroots" community initiatives are in an excellent position for providing access to data for environmental measures of local factors that affect children's health behaviors. For example, one supermarket chain, because it was a member of a state-wide coalition, provided researchers access to its sales database, which allowed an investigating team to evaluate the effects of reductions in the prices of low-fat food items (Adrienne Paine-Andrews, Ph.D., unpublished data, 1991).

Establishing the Predictive Validity of Environmental Measures

Only 6 of the 16 studies reviewed compared environmental measures to self-reported or directly observed health behaviors. Among adults a strong link has been established between physical activity and health; among children, the relationship is less clear. It appears that ongoing physical activity can result in improvements in body composition, aerobic fitness, and measures of motor fitness [55]. Given this, Sallis [56] has suggested that rates of physical activity could be considered a primary endpoint for intervention efforts to improve the health of children. Likewise, there is evidence to suggest that modifications to childhood eating patterns may reduce adult incidence of chronic disease [57]. Our recommendation is that future studies validate environmental measures and choose behavioral, not health status, endpoints to do so.

Unfortunately, studies that validate environmental measures with behavioral data are difficult to design and conduct. Members of the study population may not have been exposed to the environmental factor; conversely, many other factors (in addition to ones being measured) may affect the population. The achievements of Cheadle et al. [34], who successfully compared grocery shelf-stocking practices with residents' self-reported diet, and Sallis and colleagues [44], who examined proximity to exercise facilities and rates of physical activity, stand as exceptions to the rule. Future research should identify other sampling strategies and experimental designs that will allow examination of possible relationships between environmental factors (including environmental changes through intervention) and behavior change. This is an especially pressing need for community initiatives. One initiative that did so partnered with schools to collect individual-level behavioral data against which to compare data from environmental measures [58]. A community within the initiative compared its environmental data with behavioral data they collected using the CDC's Youth Risk Behavior Survey [59], a widely available self-administered instrument which collects information on a wide variety of adolescent health behaviors, including intake of high-fat foods and physical activity. The use of preexisting surveys should be pursued with caution. Many surveys are developed for surveillance and not program evaluation purposes. Their dietary measures may not be sensitive to the effects of environmental change unless large samples are used or the dietary measures are modified.

Determining Causal Relationships between Measures of Environment and Behavior

As with behavioral phenomena in general, sorting out the causative relationships between environmental influences and personal behavior will no doubt prove to be a formidable task. Doing so will require strong experiments including randomization or interrupted time series designs and good rationales regarding causal connections between the environment and behavior.

For example, two of the three intervention studies in the review [29,30] failed to collect similar data in comparison communities (where the intervention was not being implemented). This made it impossible to infer whether the environmental changes and correlated behavioral change were due to the intervention. Some other event, different from changes in the environment created by the intervention, may have been responsible for subsequent changes in behavior. In the future, better controlled natural, quasi, or experimental study designs should be used to explore causal relationships.

Even the direction of causality may be hard to establish. For example, well-stocked shelves may encourage consumption, but the supply of many products may be driven by demand. Furthermore, do other factors such as socioeconomic status affect both shelf stocking *and* consumption? What additional factors influence these variables? It is possible that many environmental variables and individual variables are reciprocally dynamic,

that is, they constantly interact [60]. Improved environmental measures may help researchers establish these relationships and assist policy-makers in choosing the best targets for intervention.

Increasing the Number of Levels in Which Environmental Intervention and Research Are Conducted

The scope of the 16 studies reviewed reflects the onion-like layers of the child's health environment [13]. Closest to the child is the intimate home environment where behavior is prompted and consequences are delivered. The shelf-stocking practices of community grocers may reflect and influence parents' food purchasing practices. Farther afield, the nationwide availability of exercise facilities reflects citizen demand and government funding for exercise sites, and national food policies influence the cost and mix of food "choices" in the food stream. The level (e.g., home, neighborhood, city, state) at which environmental data are collected should correspond to the intended uses of the data. For example, an initiative that targets a county for intervention activities should consider collecting data across the entire county, not just one city or neighborhood.

Some environments, however, lend themselves poorly to geographical description. Kotz and Story's [43] study on the Saturday morning media environment for children was bounded not geographically but by time. Popular Internet sites or paper magazines find their ways into the homes of geographically far-flung interest groups; even the populations of public schools and church congregations are not always geographically determined. Future research and practice should explore innovative ways of intervening in such environments and assessing the effects of environmental factors on the target population's behaviors.

Increasing the Number of Settings in Which Environmental Intervention and Research Are Conducted

Other settings in which environmental measures could be developed and tested include after-school community sports teams and recreational clubs, churches, child-care centers, malls, restaurants, and unsupervised recreational areas; radio and television stations could also be approached. A sample strategy would be for churches to institute transportation services or a broad array of supports for low-income children to participate in sports and recreational physical activities. In this case, environmental change would be measured within church settings and its effects on the youth population tracked.

Increasing the Variety and User-Friendliness of Environmental Measures

The 16 studies reviewed used a variety of methods (e.g., written surveys, direct observation, and interviews) to assess environmental variables. The two most common data collection procedures were direct observation (8 studies) and person-to-person interviews (4 studies); these are likely the most reliable but also the most expensive forms of measurement. As community initiatives and other grassroots projects generally have limited research funds, it is important for researchers to develop inexpensive but reliable measures of environmental change [61]. For example, community groups in Hawaii and North Carolina adopted a measure from a CDC manual [49] to collect data on community or systems change. These groups report interobserver reliability ranging from 80 to 95%, which is within the same range achieved by the university group that developed the measure (Vincent Francisco, personal communication). Alternatively, it may be possible for researchers or practitioners to modify expensive measures, for example, adapting person-to-person interviews for use as pencil-and-paper surveys, which could subsequently be tested for reliability and validity.

Only 1 of the 16 studies used archival or precollected information as a data source for an environmental measure: Sallis and colleagues [44] used telephone directories and maps to assess the density of exercise facilities in a city. Archival and other precollected data sets are potentially inexpensive measures of the health environment; however, other potential archived data sources include the World Wide Web pages and Internet resourse lists; CD-ROM yellow and white page listings for the nation, regions, and states; state and district school boards; departments of recreation at the state, county, and municipal level; chambers of commerce; and state, county, and municipal health departments. These archival data sets, however, are not collected and recorded by researchers. It is likely that their reliability and validity are less than optimal. In some cases it may be possible to ascertain their quality, in others not. As most measures will probably have to be modified to fit local contexts, community initiatives and researchers could partner to develop measures that are inexpensive, are relevant to the initiative's interventions, are reasonably reliable and valid, and collect data within the target population [49].

One aspect of user-friendliness is cost. Environmental measures may prove to be less expensive than individual behavior measures. For example, Cheadle and colleagues, in their study of self-reported dietary intake and grocery store measures [34], found that a random-digit survey of individual behavior was 33 times more expensive than environmental surveys of the 16 grocery stores serving the same population. The authors noted

that if measures of shelf supply were developed to the point of high reliability and validity, and if they were indeed associated with rates of purchase and consumption, they may be a more cost-effective measure of community-level outcomes than telephone surveys of individuals.

Using Environmental Measures to Advocate for Environment-Level Intervention

Wider use of environmental measures might direct intervention efforts toward changing the environment. Kotz and Story's [*43*] study, which found that Saturday morning advertising promoted the exact opposite of the food guide pyramid recommendations, is a good example of the type of "creative epidemiology" that can catch the attention of policy-makers and consumers alike. Such information, combined with tactics from diffusion theory [*20*] and media advocacy [*20*], may help policy-makers engender backing for widespread environmental changes to support physical activity and nutrition for children.

These recommendations are made with some caveats [*62*]. Environmental influences are not the sole determinants of behavior or health status. Genetic predisposition to obesity may run in families, and a number of clinical diagnoses such as Prader–Labhart–Willi syndrome have very strong associations with childhood obesity [*63*]. Also, the conditions that cause sedentariness or poor nutrition may not be the same as those that maintain suboptimal health behaviors. For example, in one southern community, during the 1960s, the city council closed public pools for 5 years rather than desegregate [*64*]. During that time, some children may have switched to watching television or other sedentary activities. The environmental change (pool closure) likely created opportunities for new but in some cases sedentary habits. Undoing the environmental change (opening the pools) may not have been enough to entice some children, who were under the sway of new conditions, back to the pools. Others would have entered the work force or in other ways passed the developmental phase in which swimming is an attractive activity. To understand the influence of the environment on children's health behavior, it will be necessary to examine the timing and nature of multiple influences and their interactions with social, physical, and psychological development.

Too often, however, health interventions have been focused on individual-level behaviors. Even when successful, they remain "changes within a social system which itself remains unchanged" [*64*]. Until better measures of the health environment are developed, the relative effects of the environment versus biological makeup or behavioral history will remain unknown.

CONCLUSION

Most of the 16 studies reviewed assessed the reliability of environmental measures but few tried to determine whether measures were linked to physical activity and nutrition behaviors among youth. More measures need to be developed at several levels of the health environment and within a variety of settings.

Community initiatives can use environmental measures to track progress in creating environmental change. To remain accountable to grant-makers and local citizens, these initiatives need simple and relevant assessment procedures.

For the most part, aggregated individual-level data such as rates of mortality, morbidity, and health behaviors are used by media and government to define health problems. This has perhaps inadvertently focused efforts on individual-oriented solutions. Wider use of environmental measures may help shift the focus of public health efforts "upstream" to population, rather than individual, interventions and explanations. This may enable researchers, practitioners, and policy-makers to identify causal links between the environment and children's health behaviors. Identifying environmental factors that influence children's physical activity and nutrition will help us better understand the extent to which we are indeed providing a level playing field for all.

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