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BEACHES: AN OBSERVATIONAL SYSTEM FOR ASSESSING CHILDREN'S EATING AND PHYSICAL ACTIVITY BEHAVIORS AND ASSOCIATED EVENTS

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An integrated system for coding direct observations of children's dietary and physical activity behaviors was developed. Associated environmental events were also coded, including physical location, antecedents, and consequences. To assess the instrument's reliability and validity, 42 children, aged 4 to 8 years, were observed for 8 consecutive weeks at home and at school. Results indicated that four 60-min observations at home produced relatively stable estimates for most of the 10 dimensions. Interobserver reliabilities during live and videotaped observations were high, with the exception of "consequences" categories that occurred in less than 1% of observed intervals. Evidence of validity was provided by findings that antecedents were associated with respective dietary and physical activity behaviors. The five physical activity categories were validated by heart-rate monitoring in a second study. The Behaviors of Eating and Activity for Children's Health Evaluation System is appropriate for studying influences on diet and physical activity in children in a variety of settings.

DESCRIPTORS: behavioral pediatrics, behavioral medicine, assessment, observation, activity level

The atherosclerotic disease process can begin in childhood (McGill, 1980); recent autopsy studies indicate that blood cholesterol and blood pressure levels of children are associated with the extent of fatty deposits in the arteries (Newman et al., 1986). Dietary and physical activity behaviors may partially determine serum cholesterol, blood pressure, and obesity levels in children. Dietary fats are associated with serum cholesterol in children (Frank, Berenson, & Webber, 1978; Glueck et al., 1982). The relation between eating behaviors and obesity is complex. There is no association between caloric intake and obesity in most studies of adults (Kromhout, 1985) or children (Dietz, 1983). However, several studies of children indicate that behaviors such as eating rate are associated with obesity (Drabman & Cruz, 1981). Physical activity in children is consistently associated with high-density lipoprotein cholesterol and blood pressure (Sallis, Patterson, Buono, & Nader, 1988; Simons-Morton, Parcel, & O'Hara, 1988). Although several studies have reported that obese children are less active than nonobese children (Griffiths & Payne, 1976; Klesges et al., 1984; Klesges, Malott, Boschee, & Weber, 1986), this association is not always found (Waxman & Stunkard, 1980). Identifying antecedent and consequent stimuli to dietary and physical activity behaviors will facilitate understanding of the development of health behaviors in young children. These data may assist behavior analysts in developing health promotion interventions that are appropriate for young children. Observation systems that permit the separate assessment of eating and exercise behaviors have been

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reported by Klesges and colleagues (Klesges et al., 1983, 1984). Parental prompts and modeling for eating and exercise have also been assessed (Klesges et al., 1986).

The primary purpose of the present study was to build upon the initial work of Klesges et al. (1983, 1984, 1986) by developing an observational system that (a) allows integrated assessment of eating and physical activity, (b) can be used in a variety of situations and settings, and (c) assesses a wide range of environmental and social influences that could be manipulated by health promotion programs.

Study 1 reports data on (a) reliability and validity of behavioral observations collected with children aged 4 to 8 years, (b) associations between social interactions and health behaviors at both home and school, and (c) associations between observed behaviors and body mass index in children 4 to 8 years of age. Study 2 is a validation of the physical activity codes.

STUDY 1

Method

Subjects and settings. Volunteer families were recruited from elementary schools and preschools in San Diego County to take part in a study of child health. Children with medical conditions that interfered with normal eating and physical activity were excluded. Thus, these were normal children from families with a wide range of socioeconomic status. Forty-two (17 male, 25 female) children (50% Anglo; 50% Hispanic), aged 4 to 8 years, and their families participated in this study. Body-mass index (BMI; kg/m^2) was used as a measure of obesity. The mean BMI of children was 17.1 (SD = 3.1). This is slightly above the population median (U.S. Department of Health and Human Services, 1980), but this is expected because of the large percentage of Mexican American children in the study sample. Observations were conducted in both the child's home and in school (or preschool) once each week for 8 consecutive weeks. Written parental consent for observations was obtained.

Home visits were conducted on a prearranged weekday evening when most family members were at home and under conditions described as being typical by the parent. A trained observer arrived at the home at least a half hour before dinner, and, after an adaptation period of approximately 15 min, initiated observations using the BEACHES (Behaviors of Eating and Activity for Children's Health Evaluation System). Unless reactivity was noticeable or the child went to the bathroom or to bed, observations continued for 90 consecutive min. "Reactivity" was defined as the child talking to, touching, or closely watching the observer. Observers reported that reactivity was rarely a problem. If interruptions were necessary, the "pause" button on the computer was depressed with observations resuming immediately after conditions returned to normal.

School visits were conducted on a prearranged day described as typical by the classroom teacher. Observations were made during lunch (20 min maximum) and during the recess period (30 min maximum) 1 day per week for 8 consecutive weeks.

The instrument. BEACHES is a comprehensive direct observation system designed to simultaneously code children's physical activity and eating behaviors and related environmental events. It can be used at home, at schools, and in most other settings in which a targeted child might be found. The system was developed within the framework of behavior analysis and included coding for 10 separate dimensions. Table 1 lists the dimensions of BEACHES and provides a brief description of the coding categories. (Complete definitions and coding conventions useful for observer training are available from the authors.)

Observation procedure. Using BEACHES, the child health behaviors of eating and physical activity, along with other variables that might influence these behaviors, were coded. Antecedents, or prompts, to increase or decrease eating or physical activity were coded. Child requests and imitative modeling are also considered antecedent events. The target child's response to antecedents was coded if it occurred within the observed 25-s interval. Physical and verbal consequences and statements of contingencies related directly to eating and physical activity were coded. The person delivering antecedent and consequent stimuli was identified. Social and ecological/environmental variables that are relevant to describing the stimulus environment were coded. The environment categories include codes for persons present, whether food is available, and whether the subject views television. Categories of physical location that are particularly relevant to children are identified. This set of 10 dimensions permits the simultaneous assessment of several variables that may influence children's eating and physical activity behaviors or that might be targeted for change in health promotion programs.

Observers focus on the target child for a 25-s observation interval and then have 35 s to record data codes into an inexpensive lap-held computer (Tandy Model 102). Thus, each observe-record cycle requires 1 min. The computer paces the alternating observation and recording periods through audible beeps, and prompts on the screen assist observers to enter appropriate codes. (Copies of the BASIC software program are available from the authors.)

Child activity, location, and environment were scored using momentary time-sampling methods; that is, codes were entered to describe events related to these three categories as they occurred at the end of the "observe" interval. The other seven dimensions were scored using partial-interval time sampling; that is, the events of interest were coded if they occur at any time during the "observe" interval.

Child physical activity was coded into five mutually exclusive categories (lying down, sitting, standing, walking, and very active) that provide a continuum of all types of activity.

Observer training and calibration. Eight observers, all women with at least 2 years of university education, were trained to use BEACHES. Six of the eight observers were bilingual; these observed the Mexican American children. They memorized operational definitions of the behavior dimensions and their subcategories first and then learned the general procedures for recording data. Videotaped examples and role playing were used to demonstrate each category. This was followed by live observations in nonstudy homes in the evening and in schools during lunch and recess. Training for each observer continued until she exceeded an interobserver agreement score of 85% on two different criterion videotapes and 90% on two consecutive live observations (using interval-by-interval correspondence with agreements divided by agreements plus disagreements multiplied by 100). Observers were also trained how to interact in order to reduce reactivity in both home and school environments. The average training program took 42 hr.

Throughout the data collection period, additional review and training sessions from 1 to 2 hr in length were conducted at least every other week. To ensure maintenance of data quality and to guard against observer drift, observers were frequently reassessed through the independent coding of several different videotapes that had previously been coded by the designers of BEACHES. Any observer scoring below criterion level (85% agreement) was retrained until mastery was achieved.

Number and length of observations. When using direct observation it is important to determine the optimal number and length of observation periods needed to obtain an adequate sample of behavior. Adequacy of sampling must be weighed against cost of data collection and subject burden. In this study, children were observed for 90 min during evening home visits. For each BEACHES subcategory, the 90-min frequency was correlated with the frequency from the first 30 min and the first 60 min of each observation. The median correlations for each dimension are presented in Table 2. The data clearly indicate that over 90% of the variance in 90-min observations was accounted for by 60-min observations for most variables. Thirty-minute observations accounted for much less of the variance. For the remainder of the analyses, only the first 60 min of home observations were studied, so the results reported here can be compared to subsequent studies that use this optimal observation time.

Using a different observation system, Klesges et al. (1984) indicated that four observation sessions were needed to estimate adequately a child's phys-

Table 1
BEACHES Dimensions and Description of Coding Categories

Categories	Description
1.0 Environment 1 alone 2 mother 3 father 4 sibling(s) 5 peer(s) 6 teacher 7 other adult(s) 8 food available 9 views TV	Describes pertinent environment conditions present during the interval. In addition to indicating who is present, codes are entered if food is accessible to the child (i.e., visible, attainable, and within 3 ft of the child) and whether or not the child watches television.
2.0 Physical location 1 inside home 2 outside home 3 outside general 4 playground/play space 5 inside school 6 cafeteria 7 outside school 8 school play space	Describes the location of the child at the end of the interval.
3.0 Activity level 1 lying down 2 sitting 3 standing 4 walking 5 very active	Provides an estimate of the intensity of the child's physical activity. Codes 1 to 4 (lying down, sitting, standing, walking) describe the body position of the child and Code 5 (very active) describes when the child is expending more energy than he or she would during ordinary walking. For example, Code 5 (very active) would be used to indicate the child is wrestling with a peer (even though he is lying on his back) or pedaling a moving tricycle or stationary bike (even though sitting).
4.0 Eating behavior 1 ingests no food 2 ingests food	Describes whether or not the child ingests food during the interval.
5.0 Interactor 1 alone 2 mother 3 father 4 sibling(s) 5 peer(s) 6 teacher 7 other adult(s)	Describes persons that participate with the child in a physical or verbal exchange that is related to physical activity or eating.
6.0 Antecedents 1 none during interval 2 prompts to increase 3 prompts to decrease 4 provides imitative model 5 child request	Describes antecedent stimuli that are related to increasing or decreasing the child's eating or physical activity. Included are (a) physical (e.g., offerings) and verbal (e.g., "Eat your spinach.") prompts, (b) imitative prompts (i.e., the interactor behaves in a manner to influence the child to engage in similar physical activity or eating behavior), and (c) child requests.
7.0 Prompted event 1 not applicable 2 high-intensity activity 3 low-intensity activity 4 food	Describes the eating or physical activity behavior that was prompted. Low-intensity activities include those within physical activity Levels 1, 2, and 3, and high-intensity activities include those within Levels 4 and 5. However, prompts related to locomotor activities (e.g., walking, running, hopping, skipping, galloping, chasing, fleeing, dodging, and crawling), as well as manipulative (e.g., throwing, catching, kicking, punting, dribbling, volleying, and striking) and nonmanipulative activities (e.g., balancing, rolling, twisting, hanging, jumping) that involve gross motor movement are coded as high-intensity activities.

Table 1
(*Continued*)

Categories	Description
8.0 Child response 1 none during interval 2 complies 3 refuses	Describes the child's response to the prompt. The child may comply, refuse, or not respond during the interval.
9.0 Consequences 1 none during interval 2 reinforce/positive feedback 3 punish/negative feedback	Describes the physical and verbal consequential stimuli that are associated with increased or decreased eating and physical activity. Identified reinforcers or punishers may be contingent on the behavior during the interval or are stated that they will be contingent upon compliance or refusal (e.g., "Finish your lunch or you won't get your popsicle for dinner.").
10.0 Events receiving consequences 1 not applicable 2 high-intensity activity 3 low-intensity activity 4 food 5 child request	Describes the type of eating or physical activity behavior that received consequences.

ical activity. Therefore, we examined the number of observation periods required using the BEACHES system. (Details of these analyses are available upon request from the authors.)

For simplicity, the mean reliability of the 10 dimensions based on the intraclass correlation are reported here. For these data, the reliability of the mean of eight observation sessions was 80%, and the reliability of the mean of the first four observation sessions was 67%. In this case, the increase in precision of the sample mean achieved by increasing the number of observations from four to eight also could be achieved by increasing the number of subjects studied by only 20%. For most of the subsequent correlational analyses, data from the first four observation sessions are reported to facilitate comparisons with subsequent studies that will use this optimal number of observations.

Interobserver reliability. Interobserver reliability was assessed both during home observations in the field and during videotaped tests. Results are presented in Table 3 as both mean percentage agreements (interval by interval) and kappa coefficients (Fleiss, Cohen, & Everitt, 1969), a procedure that adjusts for chance agreements. Nineteen randomly scheduled reliability observations of home visits were available for analysis. During home observations, mean percentage agreement ranged from 94% to 99% and median kappas ranged from 0.71 to 1.0; however, the median kappas for consequences and events resulting in consequences were 0.00. These latter two categories were observed in less than 1% of the intervals. Even though the median kappas were almost uniformly high, some individual pairs had low kappas, primarily because of low variability in some categories during particular observation sessions.

Videotaped tests were developed to assess the training program, to ensure that observers used the

Table 2
Correlations among BEACHES Data from 30-, 60-, and 90-min Observations

Dimension	Median correlations for each dimension: 30 vs. 90 min	60 vs. 90 min
1. Environment	.90	.96
2. Physical location	.93	.98
3. Activity level	.73	.94
4. Eating behavior	.49	.85
5. Interactor	.89	.98
6. Antecedents	.78	.94
7. Prompted event	.83	.96
8. Child response to prompt	.81	.96
9. Consequences	.84	.94
10. Events receiving consequences	.73	.96

Table 3
BEACHES Interobserver Reliability Data

	Home observations (19)			Video observations (24)		
	Mean % agree-ment	Kappa		Mean % agree-ment	Kappa	
		Median	Range		Median	Range
1. Environment						
a. alone	98	.93	.00–1.0			
b. mother	99	.97	.88–1.0			
c. father	99	1.0	.65–1.0			
d. sibling	97	.90	.63–1.0			
e. peer	99	1.0	.00–1.0			
f. teacher	N/A					
g. other adult	99	1.0	.00–1.0			
h. food available	98	.93	.79–1.0	88	.88	.17–.92
i. views TV	96	.71	.61–1.0			
2. Physical location	99	1.0	.00–1.0	90	.85	.48–1.0
3. Activity level	94	.91	.69–1.0	93	.86	.47–1.0
4. Eating behavior	98	.93	.00–1.0	92	.92	.66–1.0
5. Interactor	98	.88	.65–1.0	88	.80	.67–.94
6. Antecedents	97	.87	.65–1.0	90	.88	.64–.94
7. Prompted event	97	.84	.66–1.0	91	.90	.58–.93
8. Child response	97	.84	.00–1.0	88	.72	.49–.91
9. Consequences	98	.00	.00–1.0	87	.75	.54–.92
10. Events receiving consequences	97	.00	.00–1.0	100	1.00	1.00–1.00

Note: Most environment variables were not coded during video observations.

same definitions, and to assess observer drift. Both natural and staged situations were edited together to construct a videotape that presented the most difficult behaviors and interactions to code. Thus, the videotape test was a stringent assessment of observer skills. Each observer's scores were compared to a criterion correct scoring determined by the investigators. Because of the nature of the videotaped test, no environment or physical location variables were coded. Table 3 presents the results of the eight observers coding the same videotape on three different occasions, at least 6 weeks apart. Specific feedback on errors was not provided. Mean interval-by-interval agreements ranged from 88% to 100%. Median kappas ranged from 0.72 to 0.92, and the kappas for individual pairs were generally acceptable. There was no indication of observer drift. The higher kappas in the videotaped test were due in part to the greater variety of responses and higher rates of occurrences; this effect was particularly apparent for the two consequences dimensions.

Results

Two types of analyses are reported. First, data for selected subjects are presented graphically to illustrate how BEACHES can be used in single-subject research. Eating behavior, physical activity, and prompts are presented to allow inspection of covariation between prompts and behavior. Second, associations among variables were examined to study the validity of BEACHES and to explore issues related to children's health behavior. Specifically, correlations were studied between prompts and behavior, between prompts and BMI, and between behavior and BMI.

Graphic presentation of data. The data collected with BEACHES can be used to assess health behaviors and influences on these behaviors for either individual children or groups. Figure 1 displays sample data from 4 children. Figure 1 ("high activity") shows the percentage of intervals "walking" or "very active" for each of the eight observations as well as the percentage of intervals with

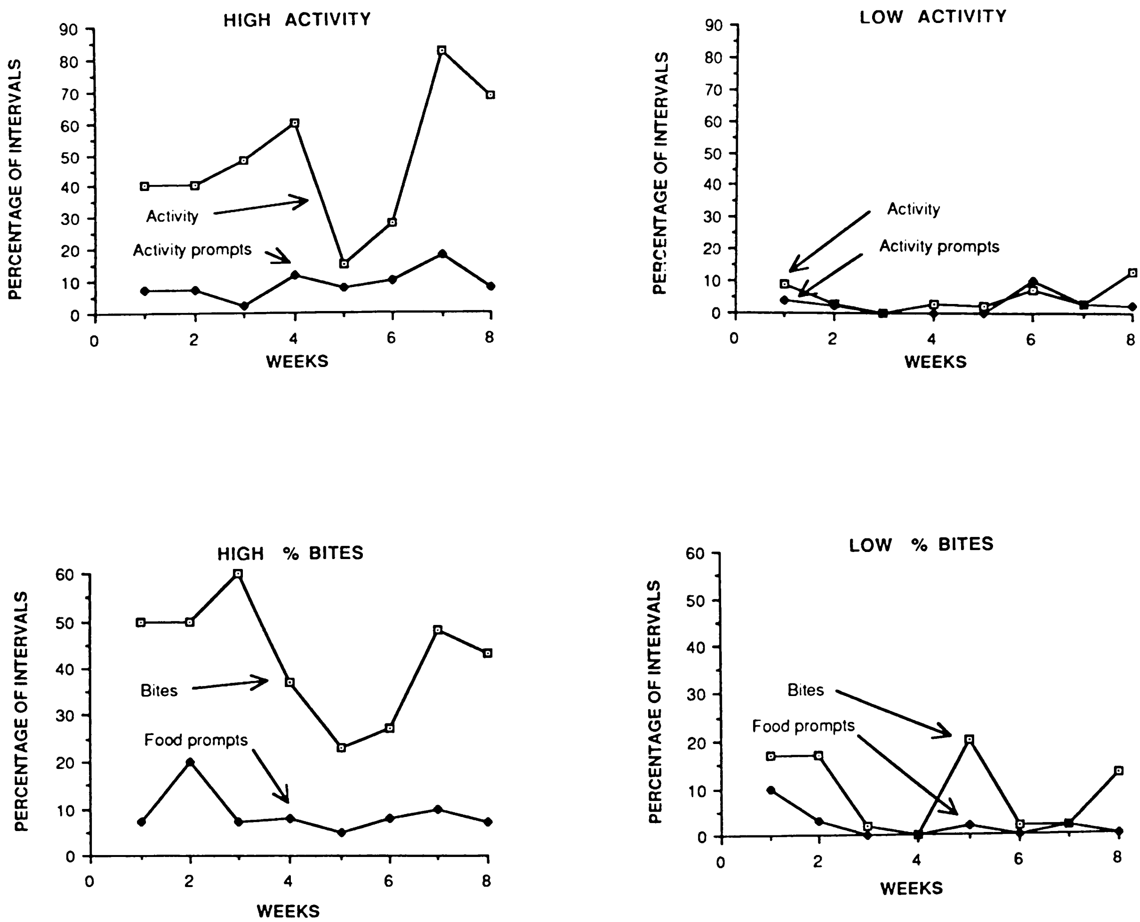

Figure 1. "High activity" and "low activity" show percentage of active intervals and prompts to be active during home observation sessions for selected children with relatively high and low activity levels, respectively. "High % bites" and "low % bites" show percentage of intervals with bites of food and food prompts during home observation sessions for selected children with relatively high and low eating rates, respectively.

prompts to be active for a child with a high level of activity. Figure 1 ("low activity") presents the same data for a child with a relatively low level of physical activity. Both activity and prompts are variable over the eight sessions for each subject, and the simultaneous display permits an examination of covariation in individual children. The percentage of intervals with prompts is higher in the high-activity child than in the low-activity child.

Figure 1 ("high % bites") shows the percentage of intervals with food ingestion (i.e., "bites") and prompts to eat for a child who ate during a large percentage of intervals. Figure 1 ("low % bites") presents the same data for a child who was observed eating during a small percentage of intervals. Both variables demonstrated variability, and, within these individuals, there was no clear association between prompts and percentage of intervals with bites. However, a comparison across all subjects indicates that children who ate during a large percentage of intervals received more prompts to eat than children who ate during a small percentage of intervals.

Validity of selected variables. The associations between selected BEACHES variables as well as between external criterion variables and BEACHES variables were examined to assess the validity of the coding system. The consequences dimensions were not studied because the reliabilities of these

Table 4
Means (and Standard Deviations) of Study Variables (N = 42) Based on First 4 Weeks of Observations

Variable	Type of observation		
	Home	School lunch	School recess
Percentage of intervals with food ingestion	22 (10)	58 (20)	—
Percentage of intervals with prompts to eat	3.7 (2.4)	6.8 (5.1)	—
Percentage of intervals walking or very active	17 (9.7)	—	43 (15)
Caloric expenditure per minute	0.06 (0.008)	—	.08 (.01)
Percentage of intervals with prompts to increase high-intensity activity	5.8 (4.5)	—	3.4 (1.9)

variables were low. BEACHES data were reduced by computing means of variables over the first 4 weeks of home, lunch, and recess observations. The means and standard deviations of these variables are presented in Table 4.

Associations with dietary variables were analyzed as partial correlations, adjusting for age, sex, and ethnicity. As expected, prompts to eat were significantly correlated with percentage of intervals with food ingestion at home (r = 0.56, p < .001), but correlations were not significant during school lunch (r = 0.22, ns). Observed food ingestion was not correlated with BMI (r = 0.02 at home and r = 0.12 at school). BMI was significantly and negatively associated with prompts to eat at home (r = 0.28; p < .05), but not at school (r = 0.06).

Partial correlations for physical activity-related variables were controlled for age, sex, and ethnicity. "Caloric expenditure" refers to the computed kilocalories of energy expenditure per minute from observed physical activity. As expected, there were moderate correlations between prompts to be active and caloric expenditure at home (r = 0.43; p < .01) and during school recess (r = 0.46; p < .01). Caloric expenditure was not correlated with BMI (r = 0.01 at home and r = 0.05 at school). Prompts to be active were not associated with BMI in this sample (r = 0.04 at home and r = 0.09 at school).

STUDY 2

A separate study was conducted to validate the physical activity coding system and to estimate the energy expenditure associated with each activity category.

Method

Subjects and settings. Nineteen children, aged 4 through 9, were recruited from a preschool and an afterschool day-care program. On average the children were 6.3 years of age, weighed 24.4 kg, and were 47.1 cm tall. No child participated in both Study 1 and Study 2.

Procedure. Heart rate was monitored with the UNIQ Heart Watch (Computer Instruments Corp.) while the children participated in specified activities chosen to represent the BEACHES activity codes. The Heart Watch is a small electrode band and transmitter worn on the chest with a receiver worn on the wrist. Heart rates were sampled every 30 s and stored. In some categories several activities were assessed to obtain the range of intensity levels that would be included in a given activity category.

Energy expenditure values were calculated from the heart rates using normal values for young children (Bar-Or, 1983). Energy expenditure at rest was estimated at 6 mL/kg/min. Each 10-beat-per-minute increment in heart rate was estimated to indicate a 4.4 mL/kg/min increase in expenditure.

Results

Table 5 lists the five activity categories and the activities used to represent each category. The mean heart rates and estimated energy expenditures are shown for each activity category. Because energy cost differences between younger (4 to 6 years) and

Table 5
Estimated Energy Cost Values for BEACHES Activity Codes

Activity category	Activity examples	Mean (*SD*) heart rate	Mean (*SD*) energy cost kcal/kg/min
Lying	Lying watching TV	99 (9.9)	0.029 (0.013)
Sitting	Sitting watching TV, kneeling, easy swinging	107 (9.8)	0.047 (0.018)
Standing	Standing and talking	110 (8.8)	0.051 (0.021)
Walking	Slow and easy walking, vigorous walking	130 (6.5)	0.096 (0.015)
Very active	Cycling, running, hard swinging, sliding (includes climbing and running)	153 (12.6)	0.144 (0.026)

older (7 to 8 years) children were small, all reported values are for the entire group. Heart rates increased with each activity code increment, with mean heart rates ranging from 99 beats per minute for the lying-down category to 153 beats per minute for the very active category.

GENERAL DISCUSSION

The BEACHES observational system provides for coding of children's physical activity and dietary behaviors in one integrated program. Associated environmental characteristics, antecedents, consequences, and other variables that are potential determinants of child health behaviors are simultaneously assessed. Extensive field testing has demonstrated the feasibility of the system, the reliability of the behavioral coding categories, and the utility of the hardware and software used for direct data entry. The validity of the major behavioral variables was supported by the pattern of associations among variables. The BEACHES possesses several advantages over previously available observational systems for studying child health behavior. Those advantages include the assessment of eating and physical activity behaviors and associated variables in one integrated system, the assessment of relevant ecological and social context variables, and the use of physical activity codes that are easily quantified. The simultaneous assessment of eating and physical activity may be of particular importance to researchers in the field of childhood obesity. The methodological study reported here indicates that the BEACHES instrument is ready for use in studies of determinants of dietary and physical activity behaviors of Anglo and Hispanic children, aged 4 to 8 years, in a variety of settings.

Although 90-min home observations were conducted, subsequent analyses indicated that 60-min observations accounted for over 90% of the variance in almost all categories. Thus, 60-min observations are recommended to reduce costs. Further analyses indicated that four observation sessions provided a reasonably stable estimate of child behavior, given a sufficient pool of subjects. Because these results were in agreement with those of Klesges et al. (1984), we recommend four observations per child in each setting to adequately characterize child eating and physical activity behaviors and associated environmental events.

There are some limitations to BEACHES. First, because it is a complex coding system, the time required to train observers is substantial. Not all of the approximately 40 hr of training is classroom time. At least 10 hr of practice observation and collection of interobserver reliability data are required. If only portions of the entire system are needed for a particular study, the training time could be reduced. The most difficult categories to train are those dealing with antecedent and consequent interactions.

Second, even the 51 coding categories do not capture all variables of interest. The eating and activity behaviors of others in the child's environment are not captured, even though they are probably important influences on the child's behavior. Because 35 s of each minute of the observation period are spent recording data, some behaviors and interactions are missed.

A third limitation of BEACHES is that it does not provide data on nutritional quality. A fourth limitation, already noted, is that consequences for eating behavior and physical activity were unreliably observed in the field. The low reliability seems to be due partially to the very low frequency of consequences (less than 1% of intervals).

Figure 1, presented in Study 1, provided examples of how individual data from BEACHES can be presented graphically to identify important antecedent behavioral influences. The covariation of several social and ecological variables with eating and physical activity can be studied using BEACHES. This instrument can be applied in treatment settings to track changes not only in child behavior but also in targeted variables such as parental prompts, availability of food, TV viewing, and time spent in various physical locations.

Several associations among BEACHES variables strongly supported the validity of the major behavioral categories. The findings providing the most support for BEACHES were the relationships between eating and prompts and between physical activity behavior and prompts. Prompts for eating were associated with the frequency of food ingestion at home but not at school. Prompts for physical activity were associated with increased caloric expenditure both at home and at school. The social interactions coded with BEACHES appear to be strongly related to child health behaviors, so further research with BEACHES may be able to improve our understanding of the development of eating and physical activity behaviors in children.

Both energy intake and energy expenditure are involved in the development of obesity, as shown by the effectiveness of behavior change in treating childhood obesity (Epstein, 1986). In cross-sectional studies, associations of measures of obesity with eating and physical activity behaviors are inconsistently found (Dietz, 1983). Studies of obesity and physical activity were discussed by Saris (1986), who suggested that the number of behavior assessment methods used and their limitations may have produced confusion in this field. Saris also recommended that long-term studies are more appropriate than cross-sectional studies in determining the contribution of eating and physical activity behaviors to the development of obesity. BEACHES methodology could be used in such longitudinal studies.

Study 2 was conducted to validate the physical activity codes. Table 5 clearly indicates that both heart rate and energy cost increased with each activity category, thereby supporting BEACHES activity coding system. Caloric cost values were computed so that observed physical activity can be studied by category or by converting codes into a single physiologically meaningful metric. To obtain energy expenditure, the number of intervals (minutes) in a given category are multiplied by the energy cost value in Table 5 and by the child's weight in kilograms. Calories are summed across all five activity categories. Caloric expenditure per minute was calculated to adjust for varying lengths of observation, especially during school recess. The activity coding system and validation study presented here are similar to those of Epstein, McGowan, and Woodall (1984), but the BEACHES categories were associated with a more progressive increase in heart rate than the Epstein et al. system.

These findings of high reliability and evidence of validity in this small sample suggest that it is appropriate to use BEACHES to investigate influences on children's eating and physical activity behaviors. The instrument was tested in two ethnic groups, with children aged 4 to 8 years, in both home and school settings. It assesses important physical environment variables as well as social antecedents and consequences. Further development work is required. The reliability of observation should be documented in schools and other settings in which BEACHES is used. Its usefulness with children younger than 4 years and older than 8 years and in more diverse ethnic groups should be confirmed. BEACHES is an integrated direct observation system developed within a behavior analysis framework that is ready for application to investigate a variety of questions related to health behavior in children.

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