Structure of Health-enhancing Behavior in Adolescence: A Latent-Variable Approach*

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The structure of the interrelations among a variety of health-enhancing behaviors was examined using structural equation modeling analyses of questionnaire data from 1,280 middle school students and 2,219 high school students. The health-enhancing behaviors included seat belt use, adequate hours of sleep, attention to healthy diet, adequate exercise, low sedentary behavior, and regular toothbrushing. In the middle school sample, all of the health-enhancing behaviors correlated significantly but modestly with each other, except for sleep with toothbrushing. In the high school sample, all but three of the 15 correlations among the behaviors were significant. The results further show that a single underlying factor can account for the modest correlations among these health-enhancing behaviors in both samples. The generality of the single-factor model was also established for male, female, White, Hispanic, and Black students at each school level. These findings provide some support for the existence of health-related lifestyles in adolescence.

INTRODUCTION

The structure or organization of health-related behaviors in adolescence has received only limited empirical attention. The possibility that adolescent engagement in health-

related behaviors may reflect a coherent lifestyle is important to examine since health-related lifestyles in adolescence may have major implications for later morbidity and mortality. In the present usage, the notion of lifestyle refers to behaviors rather than attitudes or value orientations, and implies intra-individual patterning among the behaviors (Jessor 1985; Sobel 1981). The concept of lifestyle also has implications for how health behaviors are learned and may be changed.

Establishing health-related lifestyles in adolescence requires demonstration that health-related behaviors do in fact correlate with each other. To the extent that involvement in these health-related behaviors is an expression of a single health-related lifestyle, the correlations among them should be explained by a

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single underlying factor. Such evidence is relevant not only to establishing the usefulness of the concept of lifestyle, but also to determining the extent to which adolescent involvement in diverse health-related behaviors reflects a coherent orientation toward the maintenance of health.

In this paper, the structure of relations among six different areas of health-enhancing behavior was explored in the following manner. First, we examined whether safety practices, sleep, diet, exercise, sedentary behavior, and dental care were correlated in samples of middle school and high school students. Second, we tested whether a single underlying factor could account for the correlations among these health-enhancing behaviors. Third, we determined the generality of that single-factor structure of relations across subsamples of urban adolescents who differ in developmental level (middle school vs. high school students), gender (males vs. females), and ethnic status (White vs. Hispanic vs. Black adolescents).

The expectation that the domain of adolescent health-related behavior may be highly structured derives from prior research that shows a significant degree of organization within the domains of adolescent drug use and adolescent problem behavior. For example, in analyses of drug use in two separate samples of adolescents, Bentler and Newcomb (1986; also, Newcomb and Bentler 1986) found a single factor reflecting "general drug use" that accounted for the correlations among latent-variable measures of alcohol use, marijuana use, and hard drug use (see also Hansen et al. 1987).

A similar level of structure or organization has been found within the domain of adolescent problem behavior, which includes behaviors "socially defined as a problem, a source of concern, or as undesirable by the norms of conventional society" and whose "occurrence usually elicits some kind of social control response" (Jessor and Jessor 1977:33). Problem drinking, marijuana use, delinquent behavior, and precocious sexual intercourse have been reported to comprise a "syndrome" of problem behavior. These four different problem behaviors correlate positively with each other and negatively with measures of conforming behavior (e.g., church attendance). Their intercorrelations are accounted for by a single underlying common factor (Donovan and Jessor 1985;

Donovan, Jessor, and Costa 1988). Confirmation that a single common factor underlies different forms of problem behavior also has been provided by two other independent studies (Osgood et al. 1988; Vingilis and Adlaf 1990).

As recently as 1987, Chassin, Presson, and Sherman (1987) noted that the degree of covariation among positive health behaviors was unknown and that no "empirical literature has addressed the issue of whether a larger health lifestyle does or does not exist for adolescents" (p. 365). Although most studies in this field have been limited to single areas of health-related behavior, such as exercise, diet, or safety, a few studies have examined multiple health-related behaviors in adolescence. Several of these studies have examined support for the existence of health-related lifestyles in adolescence.

Although not univocal, the evidence suggests that different health-enhancing behaviors do tend to correlate with each other. For example, regular seat belt use was related to higher levels of physical activity and to preferences for heart-healthy food (Maron et al. 1986), as well as to positive dental behavior (King, Robertson, and Warren 1985). Regular toothbrushing correlated positively with physical activity levels (Rajala et al. 1980) and with positive dietary behavior (King et al. 1985). The correlations among these health-enhancing behaviors, while significant, are generally very modest in size, with r's usually ranging between about .15 and .25, substantially lower than those found among drug-use behaviors or among problem behaviors.

Four studies have used factor-analytic methods to investigate explicitly the structure of relations among adolescent health-related behaviors (Hays, Stacy, and DiMatteo 1984; Kulbok, Earls, and Montgomery 1988; Nutbeam, Aaro, and Catford 1989; Nutbeam, Aaro, and Wold 1991). These studies consistently found one factor that reflected involvement in problem behaviors such as alcohol use and drug use, as well as one or two additional factors that reflected involvement in other health-related behaviors. In the Hays et al. (1984) study, the second factor consisted of meal regularity and hours of sleep (exercise failed to load on either factor). In the Nutbeam et al. (1989, 1991) World Health Organization (WHO) studies, the first factor reflected problem behavior, "unhealthy food," and coffee

drinking, and the second factor, labelled "health-enhancing lifestyle," included healthy food, oral hygiene, vitamin intake, and physical activity. In the Kulbok et al. (1988) study, there were two additional factors, each of which included both health-related behaviors and social adjustment behaviors (such as hobbies, religious activity, grades in school, and delinquent behaviors). The general conclusion from these earlier studies was that adolescent health-related behavior reflects several different underlying factors.

These four studies, however, have uncertain generalizability for American adolescents. The Nutbeam et al. (1989) WHO data were collected from 15-year-old Welsh and Norwegian school students; the larger Nutbeam et al. (1991) study included Finnish, Swedish, Scots, Austrian, Hungarian, Belgian, and Israeli adolescents as well as the Welsh and Norwegian students from the earlier study; Kulbok and her associates (1988) studied an at-risk sample consisting largely of African-American females using inner-city health services programs; and the results reported by Hays et al. (1984) were based on a small volunteer sample of students from English classes in a single New England high school. Thus, these samples are limited in their representativeness of the age range of adolescence and of the ethic/racial backgrounds of American youth. It also remains important to determine whether the structure of health-enhancing behavior has generality across developmental, gender, and ethnic background differences among American adolescents, or whether it varies in relation to those characteristics.

In this research, we explored the underlying structure of health-related behavior within a large sample of adolescents attending public schools in a large city in a Rocky Mountain state. We restricted the present focus to *health-enhancing behaviors in adolescence.* Six areas of health-enhancing behavior were examined: seat belt use, sleep, diet, exercise, low sedentary behavior, and dental care. We used structural equation modeling techniques (Jöreskog and Sörbom 1989) to estimate correlations among multiple-indicator, latent-variable measures of involvement in these classes of health-enhancing behavior. We then tested whether a single underlying factor could account for the correlations among these latent-variable measures of health-enhancing behavior. To the extent that a single factor underlies these behaviors, there is support for these six behaviors as constituents of a health-enhancing lifestyle. The generality of the single-factor model was examined in subsamples of adolescents that differ in developmental level, gender, and ethnic background.

METHOD

The structural equation modeling reported here is based on data collected as part of the first wave of an ongoing longitudinal study of the development of health-related behavior in adolescence (Jessor, Donovan, and Costa 1990).

Procedures

Data were collected in the spring of 1989 in six middle schools (grades 7–8) and four high schools (grades 9–12) in a large metropolitan school district in a Rocky Mountain state. Schools were selected for the study by the school district administration to maximize representation of Hispanic and Black students from inner city areas.

Active parental and personal consent was sought for every student enrolled in the selected schools. Letters describing the study were written to the parents and the students, and signed consent forms were returned to school. All letters and consent forms were in both English and Spanish.

Students with signed consent forms were released from class to take part in large-group questionnaire administration sessions. Questionnaires were handed out and collected by research project personnel. Average completion times were 48 minutes for middle school students and 42 minutes for high school students. Each participating student received $5.00.

Participants

A total of 4,280 students took part in the study. Participation rates varied from school to school; overall, 67 percent of the middle school students and 57 percent of the high school students completed questionnaires. This level of response, although lower than

desirable, is similar to that obtained in several other studies in which active consent was sought from parents (see Jessor and Jessor 1977; Lueptow et al. 1977; Severson and Ary 1983). Although participants represented the full range of scores on record grade-point average, achievement test scores, disciplinary actions, and school absences, they tended to be better students and to have gotten into less trouble at school.

The grade distribution of the obtained sample was as follows: 7th grade, 19 percent; 8th grade, 19 percent; 9th grade, 20 percent; 10th grade, 17 percent; 11th grade, 14 percent; and 12th grade, 11 percent. Fifty-six percent of the sample was female. The following ethnic distribution was obtained: White (Anglo), 32 percent (versus 35% in school population); Hispanic, 40 percent (versus 36%); Black, 21 percent (versus 24%); Asian, 5 percent (versus 4%); and Native American, 2 percent (versus 1%). With respect to family background, 53 percent were from intact families.

Measurement of Health-enhancing Behaviors

The Health Behavior Questionnaire that was administered was 37 pages long and was a revised and elaborated version of questionnaires used in our previous studies (see Costa, Jessor, and Donovan 1989; Donovan et al. 1991).

The six areas of health-enhancing behavior examined were safety, sleep, diet, exercise, low sedentary behavior, and dental care. *Safety* was assessed by a single question regarding the amount of time a seat belt was used when riding in a car (Regular Seatbelt Use). Additional areas of safety practices were unfortunately not included in the questionnaire. *Sleep* was represented by two indicators: Estimated Hours of Sleep (reported as six or less hours to ten or more hours per night); and Calculated Hours of Sleep, based on reports of usual bedtime and usual waketime. *Diet* was represented by three multiple-item scales: Attention to Healthy Diet, a 3-item scale assessing the amount of attention paid to "seeing that your diet is healthy," "eating in a healthy way even when you're with friends," and "eating healthy snacks like fruit instead of candy" (Cronbach's *alpha* = .75); Attention to Limiting Unhealthy Intake, a 3-item scale assessing

the amount of attention paid to limiting intake of salt, fat, and excess calories (Cronbach's *alpha* = .75); and Attention to Food Groups, a 2-item scale assessing attention to drinking enough milk and eating fresh vegetables every day (Cronbach's *alpha* = .65). *Exercise* was represented by four items that asked how many hours each week (from none to eight or more) are usually spent: "taking part in an organized sport or recreation program" (Organized Sport Participation); "working out as part of a *personal* exercise program (like running or biking)" (Personal Exercise Program); "playing pickup games like basketball, touch football, etc." (Pickup Games); and "practicing different physical activities (like shooting baskets, or working on dance routines or cheerleading routines)" (Physical Activity Practice). *Low Sedentary Behavior* was represented by three items that asked about the number of hours per day spent watching television "on an average school day" (TV Hours/Schooldays) and "on an average day on the weekend" (TV Hours/Weekends), and the number of hours usually spent each week "just sitting around doing nothing" (Hours/Sitting Around). These items were reverse-scored so that high scores reflected health-enhancing rather than health-compromising behavior. Additional items on hours spent reading or doing homework were not included due to their greater relevance for conventionality than for health. *Dental Care* was represented by a single question asking how often teeth were brushed, from "every couple of days" to "after every meal" (Regular Toothbrushing).

Data Analysis Procedures

A series of confirmatory factor analyses was carried out using LISREL 7 (Jöreskog 1990; Jöreskog and Sörbom 1989), in which two explicit models were tested against the data for plausibility. The first model tested was the measurement model, in which the 14 indicator measures were hypothesized to reflect six latent constructs of health-enhancing behavior (safety, sleep, diet, exercise, low sedentary behavior, and dental care). Each indicator measure was hypothesized to load on only one latent construct, and four of the six latent constructs were represented by several indicator measures. Because of this latter fact, it was possible to

determine a "true score" or error-free portion for the latent constructs, and to estimate correlations among the error-free portions of the latent-variable measures; these latent-measure correlations are analogous to disattenuated correlations (correlations corrected for unreliability). The second model examined was the structural model, which tested whether the latent-variable measures (first-order factors) of safety, sleep, diet, exercise, low sedentary behavior, and dental care reflect a single underlying (second-order) factor or latent variable of health-enhancing behavior.

Several measures are provided by LISREL 7 to evaluate the fit between a structural equation model and the data. The Goodness of Fit Index (GFI), which varies between 0 and 1, expresses the relative amount of the variance and covariance accounted for by the model. This index should be .90 or larger in an adequate model (see Cole 1987; Kline 1991). A GFI adjusted for the degrees of freedom (AGFI) of greater than .80 usually indicates a good fit. The Root Mean Square Residual (RMR) expresses the average deviation between the observed and the predicted correlations among the indicators, and should be smaller than .10 for well-fitting models. The likelihood-ratio chi-square measure of fit should be *nonsignificant* for a well-fitting model, indicating no significant discrepancy between the observed and the predicted covariance matrices. With large samples, however, very small discrepancies can result in significant chi-square values even when all of the other indexes indicate excellent fit (Breckler 1990).

Because nearly all of the 14 indicator measures are ordinal, the asymptotically distribution free weighted least squares (WLS) estimation procedure was employed (Browne 1984). PRELIS was used to generate a matrix of polychoric, polyserial, and Pearson correlations among the indicators, as well as to generate the asymptotic variance-covariance matrix of the correlations needed for the WLS estimation procedure (see Jöreskog 1990). Correlation matrices were analyzed because ordinal measures do not have an origin or unit of measurement.

Only White, Hispanic, and Black respondents with complete data on the 14 behavioral indicator variables were included in these analyses. The analyses were performed on two main samples: middle school students

(N = 1,280) and high school students (N = 2,219). The LISREL analyses were then replicated on ten subsamples: middle school males (N = 579), females (N = 701), Whites (N = 498), Hispanics (N = 513), and Blacks (N = 269);[1] and high school males (N = 914), females (N = 1,305), Whites (N = 790), Hispanics (N = 978), and Blacks (N = 451). Between 89 and 96 percent of each subsample had scores on all 14 behavioral indicator measures.

RESULTS

The results are presented in three sections. In the first section, tests of the measurement model are described and the correlations among the latent-variable measures of involvement in the six areas of health-enhancing behavior are examined. The plausibility of the second-order latent variable model is discussed in the second section. In this model a single underlying factor accounts for the correlations among the behaviors. The third section contains a description of tests performed on the generality of the single, second-order latent variable model across ten subsamples.

Test of the Measurement Model

The measurement model relating the 14 indicator measures to the six latent constructs of health-enhancing behavior was supported in both the middle school and high school samples. For each of the four latent constructs with multiple indicator measures, all the within-construct indicators were significantly correlated ($p < .001$; see matrices for middle and high school students in Appendix). Every one of the indicator measures of health-enhancing behavior also loaded significantly (by critical-ratio test) on the appropriate latent variable in both data sets (see Figure 1 for middle school results, Figure 2 for high school results). The major differences in factor loadings between the middle school and high school samples were the following: Organized Sports Participation and Pickup Games were more important components of Exercise, and TV Hours/Schooldays and TV Hours/Weekends were more important components of Sedentary Behavior in the high school sample than in the middle school sample.

FIGURE 1. Measurement Model of Health-enhancing Behaviors, Middle School Sample. (Large circles represent latent constructs, rectangles are indicator measures, small circles with numbers are residual variances, and arcs are correlations among residual variances. Factor loadings are standardized and significance levels were determined by critical ratios on unstandardized coefficients [***$p<.001$].)

FIGURE 2. Measurement Model of Health-enhancing Behaviors, High School Sample. (Large circles represent latent constructs, rectangles are indicator measures, small circles with numbers are residual variances, and arcs are correlations among residual variances. Factor loadings are standardized and significance levels were determined by critical ratios on unstandardized coefficients [***$p < .001$].)
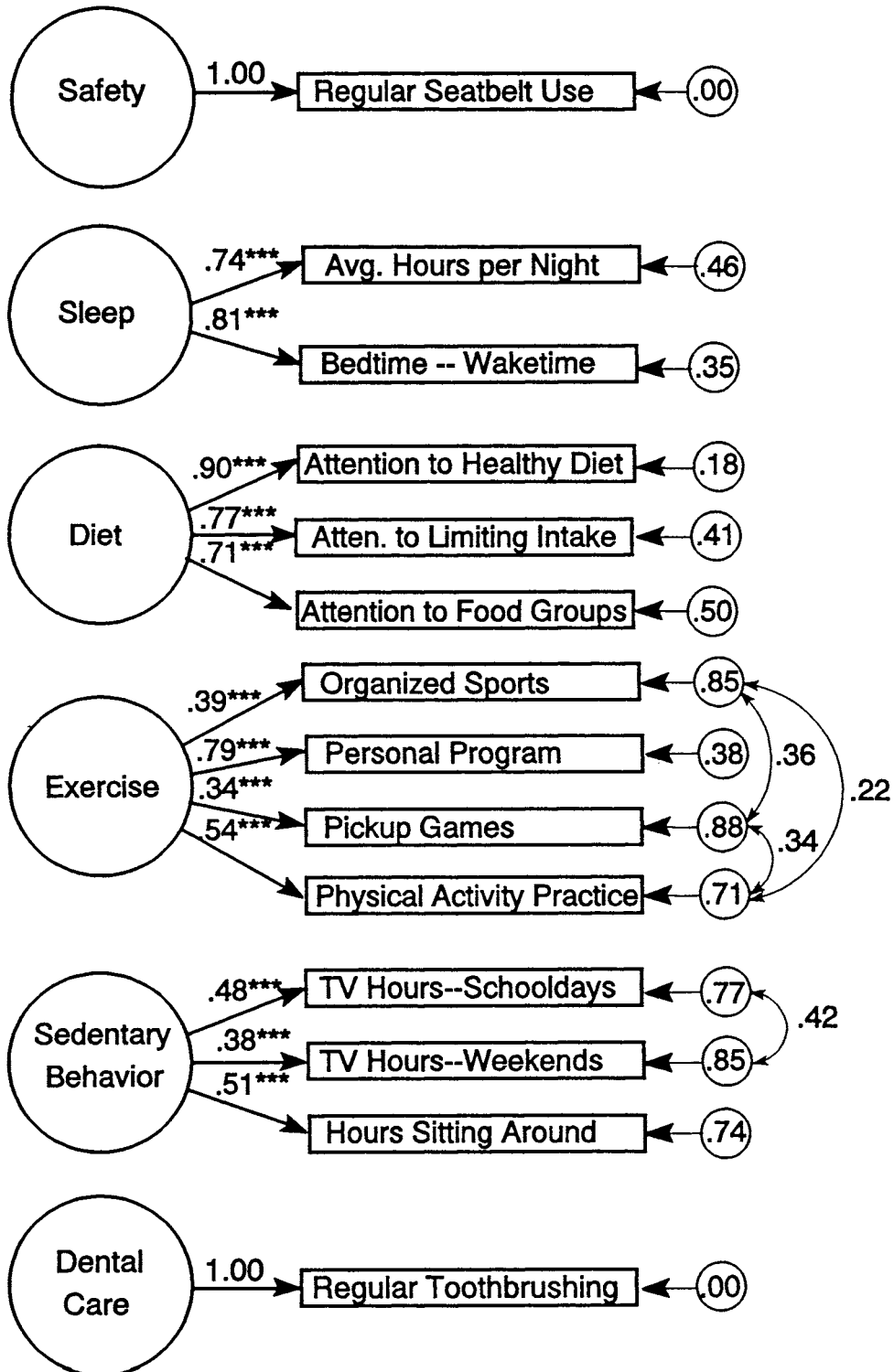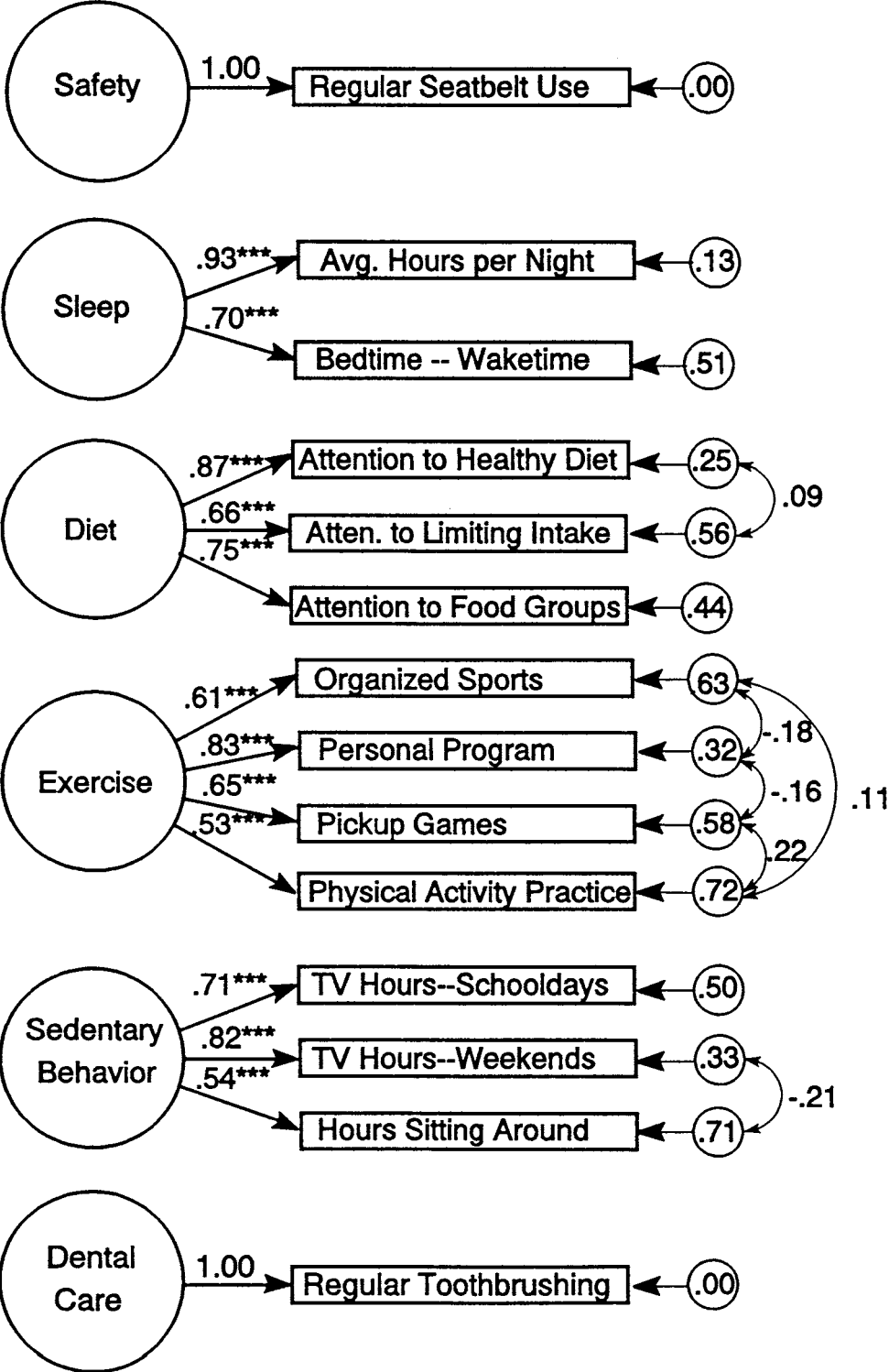
The results suggest that the different indicator measures do indeed reflect their respective latent constructs, and that the latent variables of the health-enhancing behaviors are reliably assessed. Overall, the measurement model provided an excellent degree of fit to the data for both samples of adolescents. Table 1 presents the multiple measures of the goodness of fit of the initial and final confirmatory factor analyses for these samples. In both samples, the initial fit of the measurement model was excellent. With the addition to the model of four selected significant correlations (out of 91 possible) among the residual variances of the indicator measures in the middle school sample and of six in the high school sample (see Figures 1 and 2), the fit of the model was significantly improved in both samples (by difference chi-square tests; $p<.0005$). The GFI for the final measurement model was .99 for both samples.[2]

The correlations among the six latent-variable measures of health-enhancing behavior are presented in Table 2 for the middle school and high school samples. (It should be noted that correlations involving Safety or Dental Care are not corrected for unreliability because these variables have only single indicators.)

In the middle school data, 14 of the 15 correlations among the health-enhancing behaviors were statistically significant ($p<.05$). Greater involvement in one health-enhancing behavior was modestly associated with a tendency to be more involved in the other health-enhancing behaviors as well. More regular use of safety belts was associated with more hours of sleep a night, greater attention to eating a healthy diet, more hours per week of physical activity, fewer hours a week of television watching and sitting around, and more regular toothbrushing. Sleep and Dental Care correlated with all the other behaviors, but not with one another.

In the high school data as well, the majority of the correlations among the behavior measures were significant (12 of 15). A number of the correlations, however, were smaller than they were for the middle school sample, particularly those between Low Sedentary Behavior and the other behaviors. In contrast to the middle school results, there was no correlation between Sleep and Safety, nor between Exercise and Low Sedentary Behavior, and the direction of relation between Sleep and Low Sedentary Behavior was reversed.

The significant correlations among the latent-variable measures of health-enhancing behavior provide the warrant for determining whether a single, higher-order latent variable or factor underlies the six health-enhancing behaviors in these adolescent samples.

The Second-Order Latent Variable Model

If a second-order latent variable of health-enhancing behavior is reflected in safety belt use, sleep, diet, exercise, low sedentary behavior, and dental care, the only correlations among these (first-order) latent variables should be those that result from their joint determination by the underlying (second-order) factor. The results of the test of this model are presented in Table 3.

Overall, the fit of this second-order model to the data was good in both samples (see Table 3). On three of the four measures (GFI, AGFI, RMR), the level of fit of the second-order model was high and well within acceptable limits (e.g., GFI was .98–.99)[3] despite significant values on the chi-square measure of fit. According to difference chi-square tests, this second-order factor model does not fit the data as well as the measurement model, but comparison of the two models on the other three fit measures shows

TABLE 1. Summary of Goodness of Fit Indices for the Measurement Model for the Middle School and High School Samples

	GFI	AGFI	RMR	Chi-square	df	p	N
Middle School Sample							
Initial Model	.986	.977	.043	212.2	64	.00	1,280
Final Model	.995	.991	.026	76.9	60	.07	
High School Sample							
Initial Model	.982	.970	.050	468.2	64	.00	2,219
Final Model	.984	.972	.046	400.4	58	.00	

Note: GFI = Goodness of Fit Index, AGFI = Adjusted Goodness of Fit Index, RMR = Root Mean Square Residual. The final measurement model fits significantly better than the initial model in both samples due to the addition of correlations among the residual variances of the indicator measures; these are shown in Figures 1 and 2.

TABLE 2. Correlations Among Latent-Variable Measures of Health-enhancing Behavior, By School Level

Middle School Students (N = 1,280)	1.	2.	3.	4.	5.	6.
1. Safety	1.00					
2. Sleep	.27	1.00				
3. Diet	.33	.26	1.00			
4. Exercise	.13	.06	.34	1.00		
5. Low Sedentary Behavior	.27	.21	.34	.27	1.00	
6. Dental Care	.09	.00[ns]	.22	.24	.14	1.00
High School Students (N = 2,219)	1.	2.	3.	4.	5.	6.
1. Safety	1.00					
2. Sleep	.03[ns]	1.00				
3. Diet	.24	.20	1.00			
4. Exercise	.13	.13	.33	1.00		
5. Low Sedentary Behavior	.12	− .06	.15	.02[ns]	1.00	
6. Dental Care	.10	.02[ns]	.27	.09	.05	1.00

Note: All correlations except those with an *ns* superscript are statistically significant (greater than twice their standard errors).

the magnitude of the difference to be relatively small (e.g., GFIs were .990 versus .995 in the middle school sample). The majority of the correlations among the health-enhancing behaviors were therefore explainable on the basis of a single underlying latent variable.

The six first-order latent constructs of Safety, Sleep, Diet, Exercise, Low Sedentary Behavior, and Dental Care all loaded significantly on the underlying latent variable for both samples (see Table 3). Exercise and Dental Care had similar loadings for the two samples, Safety and Sleep loaded somewhat more strongly in the middle school sample, and Diet loaded some-

TABLE 3. Loadings of Health-enhancing Behavior Latent Variables on a Single Second-Order Factor and Goodness of Fit of the Model by School-level Groups

Health Behavior Latent Variables	Standardized Factor Loadings	
	Middle School	High School
Safety	.45	.28
Sleep	.34	.22
Diet	.73	.90
Exercise	.44	.37
Low Sedentary Behavior	.51	.14
Dental Care	.30	.28
Measures of Fit		
Goodness of Fit Index (GFI)	.990	.982
Adjusted GFI (AGFI)	.985	.971
Root Mean Square Residual (RMR)	.036	.050
Chi-square	142.5 (*p* = .00)	469.9 (*p* = .00)

Note: All loadings are statistically significant (*p* < .05).

what more strongly for the high school sample. The only substantial difference in loadings between the middle school and high school samples was with respect to Low Sedentary Behavior, which loaded less strongly for the high school sample.

While all six behaviors loaded significantly on the underlying latent variable, the generally modest size of the loadings suggests that much of the variance in these behaviors was not determined by the underlying common factor. There is also considerable variability among the health-related behaviors in the extent to which each is determined by the underlying factor. Diet is the behavior most strongly determined by the underlying latent variable.

These results support the inference that a single second-order latent variable or factor can account for the correlations that exist among the six latent-variable measures of health-enhancing behavior in these adolescent samples, but much of the variance in these behaviors is not captured by the underlying factor.

Generality of the Second-Order Latent Variable Model

Whether a single, second-order latent variable model provides an adequate description of the structure of adolescent health-enhancing behaviors for both genders and across ethnic/racial backgrounds remains an important question. All of the preceding analyses were therefore carried out in ten different subsamples.

The measurement model fit the data in all

ten subsamples: the GFIs were all between .98 and .99; the AGFIs ranged from .97 to .99; the RMRs ranged from .03 to .05; and the likelihood ratio chi-squares were non-significant for all five middle school subsamples as well as for one of the five high school subsamples (consistent with the results for the two main samples). All of the indicator measures loaded significantly on the appropriate latent variables of health-enhancing behavior in all ten of the subsamples. The great majority of correlations among the health-enhancing behaviors were also significant in all ten subsamples.

The fit of the second-order latent variable model of the structure of positive health behavior may be seen in Table 4: the GFIs range from .971 to .988 across the ten subsamples, not much lower than the GFIs for their respective measurement models. The magnitude of these fit indexes supports the generality of the single second-order latent-variable model across gender and across ethnic/racial backgrounds.[4]

All six latent-variable measures of health-enhancing behaviors (Safety, Sleep, Diet, Exercise, Low Sedentary Behavior, and Dental Care) loaded significantly on the underlying latent variable in nine of the ten subsamples examined here (top portion of Table 4). In the tenth subsample (High School Blacks), all of the health-enhancing behaviors loaded significantly except for Low Sedentary Behavior.

Comparison by gender of the magnitude of the loadings showed that Sleep had similar loadings for the males and females at both school levels, and that Safety tended to load more strongly on the underlying factor for the females than for the males at both school levels. In the middle school sample, Exercise had similar loadings for both genders, Diet

TABLE 4. Standardized Loadings of Health-enhancing Behavior Latent Variables on a Single Second-Order Factor, and Model Goodness of Fit, By Subsamples within School-level Samples

Health Behavior Latent Variables	Middle School Students				
	Males (N = 579)	Females (N = 701)	White (N = 498)	Hispanic (N = 513)	Black (N = 269)
Safety	.37	.52	.54	.42	.45
Sleep	.38	.30	.24	.37	.32
Diet	.60	.82	.63	.87	.62
Exercise	.41	.46	.48	.33	.27
Low Sedentary Behavior	.57	.48	.36	.47	.31
Dental Care	.42	.26	.38	.27	.35
Second-Order Model Measures of Fit					
Goodness of Fit Index (GFI)	.986	.982	.982	.981	.971
Adjusted GFI (AGFI)	.979	.973	.973	.972	.958
Root Mean Square Residual (RMR)	.044	.051	.049	.056	.064

Health Behavior Latent Variables	High School Students				
	Males (N = 914)	Females (N = 1,305)	White (N = 790)	Hispanic (N = 978)	Black (N = 451)
Safety	.19	.38	.39	.34	.20
Sleep	.20	.22	.19	.29	.12
Diet	.92	.76	.80	.79	.99
Exercise	.31	.49	.41	.40	.31
Low Sedentary Behavior	.08	.31	.26	.15	$.03^{ns}$
Dental Care	.28	.36	.29	.27	.34
Second-Order Model Measures of Fit					
Goodness of Fit Index (GFI)	.981	.988	.984	.984	.979
Adjusted GFI (AGFI)	.972	.981	.976	.968	.967
Root Mean Square Residual (RMR)	.053	.043	.050	.055	.058

Note: All loadings are significant (i.e., greater than twice their standard error), except for the one with *ns* superscript.

loaded more strongly for the females, and Sedentary Behavior and Dental Care loaded more strongly for the males. In the high school sample, the pattern of gender differences was almost reversed: Dental Care had similar loadings for both genders, Diet loaded more strongly for the males, and Sedentary Behavior and Exercise loaded more strongly for the females.

Comparison of the magnitude of the loadings among the three ethnic/racial groups showed the following consistent differences for both school levels: Safety and Exercise tended to load more strongly for White than for Black adolescents; Sleep loaded more strongly for Hispanic than for White adolescents; and Sedentary Behavior loaded more strongly for Hispanic than for Black adolescents.

Additional analyses showed that the differences among the subsamples at each school level were not due to differences in the measurement models, but were largely due to differences in the loadings of the health-enhancing behaviors on the underlying latent variable. Multiple-sample structural equation analyses were carried out among the five subsamples at each school level to test hypotheses about which parameter estimates were invariant across the subsamples: Model A set both the measurement and structural model parameters equal across the five subsamples; Model B set the measurement model parameters equal across the subsamples and allowed the structural parameters (the loadings on the second-order latent variable) to vary across groups; and Model C permitted both the measurement and structural parameters to vary across the groups at each school level (see Table 5). None of these

strong tests of invariance or variance across the subsamples were supported by non-significant chi-square measures of fit; on the other hand, none of the GFIs for the subsamples were below .97 in any of these models. The significant difference between the chi-square for Model A and the chi-square for Model B implies that allowing the loadings on the second-order latent variable to vary across groups improves the fit of the model for both middle school and high school samples. In contrast, Models B and C are not significantly different by the chi-square difference test for either sample, implying that also allowing the loadings of the indicator measures to vary makes no additional increment in fit. Taken together, these results suggest that the data for these subsamples all support the general higher-order model of the structure of health-enhancing behavior, but that there is variability among the groups in the extent to which the different behaviors are determined by the underlying latent variable.

The analyses in these subsamples confirm the generality of the single, second-order latent variable model for males and females, and for Whites, Hispanics, and Blacks at both school levels, making it clear that the earlier results for the two main samples were not artifacts of the mixture of subpopulations in the data. While variability existed among the subsamples in the loadings of the health-enhancing behaviors on the underlying variable, this was not sufficient to cast doubt on the main findings.

DISCUSSION

Structural equation modeling analyses showed that the latent-variable measures of

TABLE 5. **Summary of Multiple-Sample Structural Equation Analyses Within the Middle School and High School Samples**

	Middle School Results			High School Results		
	Chi-square	df	p	Chi-square	df	p
Model A	652.1	489	.00	1245.4	487	.00
Model B	592.1	465	.00	1152.1	463	.00
Model C	464.5	345	.00	1041.6	335	.00
Model Comparisons						
A vs. B	60.0	24	.0005	93.3	24	.0005
B vs. C	127.6	120	ns	110.5	128	ns
A vs. C	187.6	144	.05	203.8	152	.001

Note: Model A sets measurement and structural parameters equal across groups; Model B sets measurement parameters equal across groups and allows the structural parameters to vary across groups; and Model C allows all parameters to vary across groups.

safety, sleep, diet, exercise, low sedentary behavior, and dental care all correlate significantly with each other for the middle school sample (except for sleep and dental care). For the high school sample, all but three of these correlations were significant (all except sleep with dental care, sleep with safety, and exercise with sedentary behavior). The correlations were modest in all cases, consistent with the findings of earlier research.

The second-order structural equation analyses provide evidence that a single factor or latent variable can account for most of the correlation present among the six health-enhancing behaviors. This finding of structure within the domain of adolescent health-enhancing behavior is consonant with findings from earlier research within the domains of adolescent problem behavior (Donovan and Jessor 1985; Donovan et al. 1988; Jessor and Jessor 1977) and adolescent drug use (Bentler and Newcomb 1986; Newcomb and Bentler 1986). The amount of variation in the different health-enhancing behaviors that is determined by the underlying common factor, however, is considerably smaller than was the case in the domains of drug use and problem behavior.

The significant but modest correlations among the six latent-variable measures of adolescent involvement in the various health-enhancing behaviors, and the finding of a single common factor underlying these correlations, provide some support for the notion of health-related lifestyles in this stage of development. According to these results, the different behaviors are not a set of completely isolated, independent behaviors; rather, there is at least a modest degree of organization to involvement in these health behaviors.

The present finding of a single underlying factor of health-enhancing behaviors also helps to clarify the structure of relations among different classes of behaviors within the larger domain of adolescent health. In the exploratory factor analyses of the WHO data reported by Nutbeam et al. (1989, 1991), the four different dietary behaviors examined loaded on two different factors depending on the healthy versus unhealthy direction of their scoring. In contrast, in the present analyses where diet was constituted as a latent variable underlying several different behaviors, it occupied a central position in a dimension of health-enhancing behavior that encompassed areas of health-related behavior such as

exercise and dental care that were part of the WHO study as well as areas of behavior not examined in that study, including sleep, safety belt use, and sedentary behavior. The focus on latent constructs assessing areas of health behavior may well be critical for future examinations of health-related lifestyles.

The exclusion of problem behaviors such as alcohol use or illicit drug use from the present analyses was not to deny their relevance for adolescent health or their importance in adolescent health-related lifestyles. It was solely to permit examination of the interrelations among a set of health-related behaviors that did not vary so much in their potential for eliciting institutionalized social sanctions. In our previous research (Donovan et al. 1991), we found that involvement in the problem behaviors of marijuana use, problem drinking, cigarette smoking, and even delinquent-type behavior was negatively associated with involvement in health-enhancing behaviors. If health-compromising problem behaviors had been included in the present study, analyses suggest that we would have found two second-order latent variables, one reflecting problem behaviors and one reflecting health-enhancing behaviors, that correlate around −.5. Such a result could be interpreted either as evidence of the multi-dimensionality of a larger domain of health-related behavior (that encompasses health-enhancing behavior) or as evidence that these higher-order latent variables reflect two separate but related domains of adolescent behavior. Further research is needed to clarify which of these interpretations is most appropriate. That decision may well hinge on the extent to which variation in both domains is explainable by the same or differing sets of explanatory variables.

The finding that a single, second-order factor "explains" the correlations among the six health-enhancing behaviors itself requires explanation. What differences in the person or the situation could result in the structure of covariation accounted for by the second-order factor? One approach to interpreting the underlying factor is to invoke more general orientations at the individual level, such as psychosocial orientation to health or psychosocial and behavioral conventionality-unconventionality. In analyses of an earlier data set (Donovan et al. 1991), we found that variation in a variety of adolescent health-

related behaviors was associated with both of these general orientations. Orientation to health was reflected in measures of value on health, health locus of control, health self-description, and parental and friend models for health-enhancing behaviors.

The fact that the correlations among the health-enhancing behaviors are not larger does mitigate somewhat support for the notion of an underlying health lifestyle. However, it may ultimately be a consequence of the relative crudeness of the measurement of these health-enhancing behaviors, rather than a reflection of their "true" interrelations. Even with measurement variance controlled for, as here, the core underlying constructs may not have been captured adequately in the current research. Only four of the six behaviors were assessed by multiple indicators, and there were relatively few indicators of any given health-enhancing behavior. It is unfortunately true that little research has as yet been devoted to the development of reliable survey measures of these health-enhancing behaviors for use with adolescent populations. Our own work in this area should be viewed as a preliminary effort.

The low level of correlation also may be due in part to inconsistency in adolescents' recognition of the health relevance of these different behaviors. In this sample of adolescents, ratings of the effect of involvement in the various health-related behaviors on the health of people their age had only modest relations to each other. The modest level of correlation also may be due in part to variability among the various behaviors in the extent to which they are under the adolescent's own control. In some households, adolescent bedtimes, television viewing, and regularity of toothbrushing may be strictly overseen by parents, while other health behaviors may be at the adolescent's discretion. Such systematic differences could attenuate the correlation between behaviors enforced by parents and those under the adolescent's own control. In a related vein, the greater magnitude of the correlations for the middle school adolescents could be due to the generally greater level of control and monitoring of health habits by parents of younger adolescents.

In our interpretation of the results of the second-order factor analyses carried out in the gender and ethnic/racial subsamples at each school level, we have tended to concentrate on the generalized consistency of the finding that a single underlying factor accounts equally well for the correlations among the health-enhancing behaviors in all subsamples, and on the consistency of the finding that all of the behaviors load significantly on that underlying factor in these subsamples (save for sedentary behavior among the high school sample of Black adolescents). The fact remains that substantial variability still exists in the magnitude of those loadings across the ten subsamples. Future research clearly should delve more fully into the factors accounting for this variability.

The present results are at variance with the findings of previous research on the structure of *adult* health behavior (see Harris and Guten 1979; Kannas 1981; Langlie 1977, 1979; Tapp and Goldenthal 1982; Williams and Wechsler 1972). This may be due to the greater number and specificity of health behaviors examined and to the use of principal components analyses in the studies of adults. It is also possible that health-enhancing behavior becomes more fragmented and multi-dimensional with development from adolescence into adulthood due to the assumption of multiple adult role obligations.

The set of health-related behaviors examined in this study did not, of course, encompass the entire health domain, and that remains an important limitation. It is quite possible that more than a single underlying factor might be needed to account for the correlations if a more comprehensive array of adolescent health-related behaviors were to be studied. Another limitation of the research is that all of the data were collected through the use of a single, self-report instrument. Because the health-behavior measures do not come from multiple sources (e.g., self-report, collateral report, observations, medical records, etc.), it is possible that the single-factor model reflects at least partly a common method factor. In the absence of a multitrait-multimethod design, we cannot rule out such a possibility. All of the earlier studies were similarly limited, however, and yet they did find multiple underlying factors in their data. The fact that the findings are based on adolescents in a single school district in a large city in the Rocky Mountain states is another limitation. However, this is a large,

heterogeneous sample with substantial representation of ethnic minority youth and of the full array of socioeconomic backgrounds. A final limitation is that the participation rates in the selected schools were somewhat lower than desired, and participants tended to be somewhat more conventional than nonparticipants.

The single-factor structure of health-enhancing behavior is nevertheless consistent for both middle school and high school students, and it also holds for males and females and for White, Hispanic, and Black adolescents at both school levels. The data do lend at least some preliminary support for the notion of health-related lifestyles in adolescence. The lifestyle notion may have important implications for the design of health promotion programs for this population. It suggests that such programs may wish to address the larger repertoire of health-related behaviors. A concern with the patterned organization of health behaviors may be more salutary than the usual concern with separate, unrelated health-enhancing behaviors.

NOTES

1. With 14 observed variables, PRELIS normally requires at least 315 cases in a sample in order to compute asymptotic variances and covariances of the estimated correlations. This size restriction was overridden for the middle school Black subsample.

2. Alternate measures of the goodness of fit, which compare the six-factor measurement model to a null model which assumes independence among the indicator variables, further confirm the fit of the model. Bentler and Bonett's (1980) normed fit index (NFI) was .987 for the middle school sample and .961 for the high school sample, while the non-normed fit index (NNFI) was .996 and .947 for the two samples, respectively.

3. Because the second-order factor model is superimposed on the first-order measurement model, it is possible that its goodness of fit may have been biased upward by the fit of the measurement model. To examine this possibility, a further series of LISREL analyses was performed based just on the correlations in Table 2 among the latent-variable measures of health-enhancing behavior. For the middle school sample, the GFI for this single-factor model was .974, the AGFI was .940, and the RMR was .051. For the high school sample, the GFI was .991, the AGFI was .980, and the RMR was .033. These measures of fit confirm that a single factor can still account for the correlations among the six latent-variable measures of health-enhancing behavior, even when the fit of the measurement model is not allowed to influence the overall fit.

4. LISREL analyses of the correlations among the six latent-variable measures of health-enhancing behavior (as in Note 3) confirm the fit of the second-order model in all of the subsamples. The resulting GFIs ranged from .947 to .973 for the middle school subsamples, and from .976 to .988 for the high school subsamples.

APPENDIX

Correlations Among Observed-Variable Indicators of Health-enhancing Behavior, By School Level

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14
A. Middle School Sample (N=1,280)														
1. Regular Seatbelt Use	1.00													
2. Estimated Hours of Sleep	.18	1.00												
3. Calculated Hours of Sleep	.24	.59	1.00											
4. Attention to Healthy Diet	.28	.19	.15	1.00										
5. Attention to Limiting Intake	.24	.17	.15	.70	1.00									
6. Attention to Food Groups	.27	.16	.16	.64	.54	1.00								
7. Organized Sports	.06	-.02	.01	.13	.07	.10	1.00							
8. Personal Exercise	.13	.01	.04	.24	.21	.19	.30	1.00						
9. Pickup Games	-.05	.05	.03	.11	.10	.13	.50	.28	1.00					
10. Activity Practice	.08	.04	.03	.16	.13	.14	.44	.43	.52	1.00				
11. TV Hours/Schooldays	-.18	-.02	-.12	-.16	-.09	-.14	-.13	-.10	-.01	-.05	1.00			
12. TV Hours/Weekends	-.09	-.01	-.07	-.15	-.09	-.09	-.06	-.10	-.00	-.03	.60	1.00		
13. Hours Sitting Around	-.10	-.10	-.09	-.16	-.16	-.12	-.11	-.08	-.09	-.05	.23	.23	1.00	
14. Regular Toothbrushing	.09	.06	-.05	.20	.21	.13	.06	.18	.06	.17	-.06	-.09	-.05	1.00
B. High School Sample (N=2,219)														
1. Regular Seatbelt Use	1.00													
2. Estimated Hours of Sleep	.01	1.00												
3. Calculated Hours of Sleep	.03	.66	1.00											
4. Attention to Healthy Diet	.20	.14	.13	1.00										
5. Attention to Limiting Intake	.18	.13	.12	.67	1.00									
6. Attention to Food Groups	.18	.14	.13	.66	.50	1.00								
7. Organized Sports	.18	.06	.04	.15	.07	.15	1.00							
8. Personal Exercise	.12	.07	.03	.26	.21	.20	.33	1.00						
9. Pickup Games	-.03	.16	.08	.18	.11	.18	.42	.39	1.00					
10. Activity Practice	.08	.09	.03	.17	.12	.17	.44	.43	.57	1.00				
11. TV Hours/Schooldays	-.14	-.07	.02	-.09	-.03	-.09	-.06	-.05	.09	.05	1.00			
12. TV Hours/Weekends	-.05	.08	.06	-.05	-.01	-.05	.03	-.03	.11	-.07	.59	1.00		
13. Hours Sitting Around	-.09	-.06	-.02	-.21	-.17	-.19	-.14	-.10	-.08	-.07	.34	.26	1.00	
14. Regular Toothbrushing	.10	.03	.01	.22	.25	.15	-.02	.11	.06	.06	-.00	-.04	-.08	1.00

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