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Self-Control Constructs Related to Measures of Dietary Intake and Physical Activity in Adolescents

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Abstract

Purpose—To test self-regulation concepts in relation to dietary intake and physical activity patterns in adolescence, which we predicted to be influenced by components of a self-control model.

Methods—A survey was conducted with a multiethnic sample of 9th grade public school students in a metropolitan area (N = 539). Confirmatory analysis tested the measurement structure of self-control. Structural equation modeling tested the association of self-control constructs with measures of fruit and vegetable intake, saturated-fat intake, physical activity, and sedentary behavior.

Results—Confirmatory analysis of 14 indicators of self-control showed best fit for a two-factor structure, with latent constructs of good self-control (planfulness) and poor self-control (impulsiveness). Good self-control was related to more fruit and vegetable intake, more participation in sports, and less sedentary behavior. Poor self-control was related to more saturated-fat intake and less vigorous exercise. These effects were independent of gender, ethnicity, and parental education, which themselves had relations to diet and exercise measures. Multiple-group modeling indicated that effects of self-control were comparable across gender and ethnicity subgroups.

Conclusions—Self-control concepts are relevant for patterns of dietary intake and physical activity among adolescents. Attention to self-control processes may be warranted for prevention programs to improve health behaviors in childhood and adolescence.

Keywords

self-control; diet; exercise; adolescents; gender; ethnicity

Epidemiologic data have drawn increasing attention to diet and exercise patterns among young persons. Between 1980 and 2002, the prevalence of obesity in the US has doubled among adults and tripled among children and adolescents [1]; similar patterns have been observed in other countries [2]. Obtaining a better understanding of patterns of dietary intake and physical activity has public health significance because excess weight and inadequate exercise have been linked to increased morbidity from several diseases. The magnitude of increases in weight in the population of young persons has indicated a need for new approaches to weight-related behavior [3,4], and research conducted in adolescence provides an opportunity to study the origins of these behavioral patterns.

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The present research was based on a self-control model as a theoretical approach to understanding health behavior patterns. For substance use, theoretical papers have outlined how behavioral and emotional regulation are important factors in the etiology and prevention of substance use [5,6]. Recent research has shown self-control measures are related to substance use in adolescence [7,8] and self-control concepts have been incorporated in theoretical models of adaptation to illness among adults [9]. However, at present there have been few applications of self-control concepts for research on adolescents' diet and exercise behaviors.

Self-control is broadly defined as a set of processes involved in guiding and monitoring behavior [10]. Theory and research suggest that various aspects of self-control are interrelated and are not identical to intelligence [11]. Prior research with adolescents has shown that there are two domains of self-control measures, which are termed good self-control or planfulness, and poor self-control or impulsiveness; these two domains are statistically distinct and have different antecedents and consequences [12]. There are several facets for each type of self-control construct and these may have relevance for diet and physical activity. In the domain of good self-control are indicators such as planning and problem solving, which could be relevant for the planning and implementation of proper dietary choices and exercise patterns. An orientation toward the future may also have relevance for sustaining healthful patterns of behavior. Under the domain of poor self-control are aspects such as distractibility and impatience, which could interfere with making informed decisions, and impulsiveness, which could interfere with attempts at establishing patterns of more healthful behavior.

There has been previous research on the relation of psychosocial factors to adolescents' dietary and physical activity behaviors; however, these studies have mostly been based in the health belief model and theory of reasoned action, which do not explicitly include the concept of self-regulation. Social-cognitive theory [13] includes discussion of self-regulation but studies conducted within this framework have tended to focus on self-efficacy and outcome expectancies [14,15]. A recent study with church-going adults in a rural Southern area [16] did include a measure of self-control for physical activity, based on items such as setting aside time for activity and choosing to walk instead of driving. This study found that self-regulation was modestly related to self-efficacy, and the self-regulation measure was inversely related to negative outcome expectancies and positively related to physical activity. To our knowledge the Anderson et al. study [16] with adults has been the only one to specifically examine this construct, and there is a need for research with adolescents to study how different aspects of self-control are related to diet and exercise in this age group. While adolescents' diet and exercise may be determined to some extent by family eating patterns and environmental factors, the dynamic of development during adolescence is one of decreasing time with parents and increased time spent with friends and in leisure and recreation activities [17]. From middle school onward, young persons have control over food choices in school cafeterias and in social activities with friends after school, and they have discretion about engaging in physical activity versus maintaining a sedentary lifestyle, both in the school context and at home. Thus there is reason to examine self-control concepts in relation to adolescents' dietary intake and frequency of physical activity.

The present research investigated how a multivariate conceptualization of self-control is related to diet exercise measures in a community sample of adolescents. We obtained standardized measures of low-fat and high-fat food intake and measures of vigorous physical exercise and sedentary behavior. The self-control constructs were related to diet and exercise measures in a structural equation modeling analysis, including covariates so as to control for any correlation of self-control with gender, ethnicity, and parental education. Multiple-group modeling procedures were then performed to determine whether effects for self-control constructs are comparable across gender and ethnic groups.

Methods

Participants

The basic sample of 705 participants was 9th grade students in three public high schools from a community that has census statistics similar to those of the state population. The schools are in a district containing a more urbanized area with surrounding suburban areas. Mean age of the participants was 14.6 years (SD 0.7) and 48% were female. The sample was 20% African American, 4% Asian American, 20% Caucasian, 40% Hispanic, 9% other ethnicity, and 7% mixed ethnicity. Data on family structure indicated that 31% of the participants were living in a single-parent family, 13% were with one biological parent and one stepparent, and 56% were living with two biological parents. Data on parental education indicated that 54% of fathers had an educational level through high school graduate and 46% had education of some college or more; proportions for mothers were 48% and 52%, respectively.

Procedure

A questionnaire was administered to students in classrooms by trained research staff, who read standardized instructions to the class and then privately answered any individual questions according to a defined protocol. Participants were instructed not to write their name on the questionnaire and were informed that the privacy of their responses was protected by a Certificate of Confidentiality from the US Department of Health and Human Services. The study was approved by the Institutional Review Board at Albert Einstein College of Medicine.

The survey was administered under a procedure in which parents were sent, through direct mail, a bilingual (English/Spanish) notice that informed them about the purpose and nature of the research. Parents were instructed that they could have their child excluded from the research, if they wished, by returning a stamped postcard to the research office or notifying a designated school official by telephone. Students not excluded by parents received similar information about the research prior to questionnaire administration and were instructed that they could refuse or discontinue participation. The completion rate was 83%, with 1% of the case loss from parental refusal, 2% from student refusal, and 14% from student absenteeism.

Measures

Indicators of self-control were derived from previous research with adolescents [12,18] and dietary/physical activity behaviors were indexed with standardized measures. For all measures, scale structure was verified with factor analysis and internal consistency analysis.

Demographics—The participant was asked about his/her age, gender, and ethnicity (5 options, multiple responding allowed). An item on family structure asked the participant what adult(s) he/she was currently living with (8 options, multiple responding allowed); this was recoded for analysis to three levels (single parent, blended family, or intact family). Items on education for father and mother, respectively, had a 6-point scale with anchor points grade school and post-college education (masters or doctoral degree, or other professional education).

Self-control measures—Multiple measures of self-control were derived from prior research [12,19-22]. Items were administered with 5-point scales (Not at all true, a little true, somewhat true, pretty true, very true). Indicators for good self-control were a 5-item scale on soothability (e.g., “I can deliberately calm down when I am excited or wound up,” alpha = .70), a 6-item scale on planfulness (“I like to plan things ahead of time,” alpha = .73), a 6-item scale on problem solving (“When I have a problem, I think of different ways to take care of it,” alpha = .85), a 6-item scale on cognitive effort (“When I have a problem, I try to see the problem in a different way,” alpha = .85), a 7-item scale on future time perspective (“Thinking about the future is pleasant to me,” alpha = .77), and a 7-item scale on positive self-

reinforcement ("I encourage myself to improve by giving myself something special whenever I make some progress," alpha = .84). Indicators for poor self-control were a 6-item scale on distractibility (e.g., "I have to be reminded several times to do things," alpha = .76), a 6-item scale on impulsiveness ("I often do things without stopping to think," alpha = .86), a 6-item scale on angerability ("When I have a problem, I blame and criticize other people," alpha = .84), a 5-item scale on tension maintenance ("When I have a problem, I have difficulty getting the problem out of my mind," alpha = .89), a 4-item scale on impatience ("I have to have everything right away," alpha = .56), a 7-item scale on present time orientation ("I feel it's more important to enjoy what you are doing than to get things done on time," alpha = .57), and a 7-item scale on negative self-management ("I seem to blame myself when things go wrong," alpha = .74).

Physical activity measures—To assess physical activity and sedentary behavior we used questions from the Youth Risk Behavior Survey [23]. An item for vigorous exercise (given with examples) asked: "During the last 14 days, how many days have you done at least 20 minutes of exercise hard enough to make you breathe heavily and make your heart beat fast." Responses were on a 5-point scale (None, 1-2 days, 3-5 days, 6-8 days, 9 or more days). An item on sedentary behavior asked: "During a normal week, how many hours a day do you watch television and videos, or play computer or video games before and after school?" Responses for this item were None, 1 hour or less, 2-3 hours, 4-5 hours, 6 or more hours. An item on sports participation asked "During the past 12 months, how many team or individual sports or activities did you participate in on a competitive level, such as varsity or junior varsity sports, intramurals, YMCA or other out-of-school programs?" Responses were None, 1 activity, 2 activities, 3 activities, or 4 or more activities.

Dietary measures—Block's screening scales were developed to provide measures of saturated-fat intake and fruit-vegetable-fiber intake in general populations and were validated against a longer assessment [24]. The inventory on saturated-fat intake had the lead-in statement, "Over the past year, about how often did you eat each of the following foods?" Responses were on 5-point scales (Never or rarely, 2-3 times a month, 1-2 times a week, 3-4 times a week, 5 or more times a week). Sample items (given with examples) are beef, salad dressings, mayonnaise, margarine or butter, eggs, cheese or cheese spread, and whole milk. This inventory was scored for a 14-item scale on saturated-fat consumption (alpha = .88). The inventory on fruit, vegetable, and fiber intake had the instruction: "Over the past year, how often did you eat each of the following foods?" Sample items are fruit, green salad, beans, dark bread, and orange or grapefruit juice. Responses were Never or less than once a week, 1 time a week, 2-3 times a week, 4-6 times a week, and once a day or more. This was scored for a 9-item scale on fruit-vegetable consumption (alpha = .77).

Results

Descriptive Analyses

Descriptive statistics are reported for the participants who were included in the subsequent structural modeling analysis; this subsample (N = 539) consisted of persons who were of African-American, Hispanic, or Caucasian ethnicity and had data on at least 66% of the variables included in the analysis. The measures of physical activity had reasonable frequency distributions. For vigorous exercise, 10% of participants indicated none in the past two weeks, 19% indicated having vigorous exercise 1-2 days in the last two weeks, 24% indicated 3-5 days, 18% indicated 6-8 days, and 29% indicated vigorous exercise on 9 or more days in the past two weeks. Regarding sedentary behavior, 2% of participants indicated no sedentary behavior on a typical day, 11% indicated up to 1 hour of sedentary activity, 36% indicated 2-3 hours, 23% indicated 4-5 hours, and 28% indicated 6 or more hours of sedentary activity on a

typical day. For sports participation in the past year, 47% of participants indicated none, 18% indicated one activity, 17% indicated 2 activities, 9% indicated 3 activities, and 9% indicated participating on 4 or more sports activities over the past year.

Descriptive statistics for continuous variables (Table 1) showed the indicators of good self-control had normal distributions; means were close to the scale midpoints and skewness values were low. The indicators of poor self-control had distributions shifted somewhat toward lower values but in absolute terms the skewness values were moderate. The measures of dietary intake indicated moderate levels of consumption for both fruits-vegetables and saturated fat. These variables had normal distributions, with skewness values close to zero.

A confirmatory analysis of the self-control measures was performed with Mplus ver. 3.1 [25] using maximum likelihood estimation. From an initial two-factor model with six indicators for a latent construct of good self-control and seven indicators for a latent construct of poor self-control, two indicators, soothability and present orientation, were dropped because of relatively low loadings on the constructs. A nested test, comparing the fit of the revised two-factor model with the fit of a one-factor model specifying all the 11 indicators as measures of one latent construct of self-control, showed a difference chi-square (1 df) of 686.68 ($p < .0001$), indicating marked superiority for the two-factor model. Standardized factor loadings of indicators on constructs were > .50 for all the scales. There was a correlation of -.31 between the good self-control and poor self-control constructs, so the measures were inversely related but statistically distinct.

Correlations of the study variables were computed in Mplus with categorical specification for the physical activity measures, using weighted least squares estimation. Two latent constructs for good self-control and poor self-control were measured as indicated previously. Preliminary analyses indicated that indices of family structure were not significantly correlated with criterion variables so these were dropped. The final analysis included a binary index for gender, two binary indices for ethnicity (African-American vs. Hispanic or Caucasian, and Hispanic vs. African-American or Caucasian), and a 6-point variable for parental education; the analytic sample was 539 cases. Results (Table 2) indicated good self-control and poor self-control each had significant correlations with the dietary and physical activity measures. The demographic measures were not strongly correlated with self-control but had some correlations with criterion variables, hence were retained in further analyses.

Structural Equation Modeling Analysis

The structural model was specified with self-control constructs as exogenous (i.e., not predicted by any prior construct in the model) together with measures of gender, ethnicity, and parental education, so as to control for any correlations of demographic variables with self-control. The measures of dietary intake and physical activity were specified as endogenous (i.e., could be predicted by prior constructs in the model), with covariances of their residual terms. Because of the categorical specification of criterion variables the model was analyzed in Mplus using weighted least squares estimation with robust standard errors, and the EM algorithm was used to include cases with missing data. The final model dropping nonsignificant paths and including three correlated errors had chi-square (55, N = 539) of 118.75, Comparative Fit Index of .93, and Root Mean Square Error of Approximation of .047, all indices indicating reasonable fit to the data (Figure 1). Correlations of residual terms for criterion variables were in the range from -.07 to .11 except for a correlation of .31 between sports participation and vigorous exercise and a correlation of .39 between fruit-vegetable consumption and saturated-fat intake, which could be attributable to total intake. The constructs in the model accounted for 4% to 8% of the variance in the dietary measures, and 9% to 17% of the variance in the activity measures.

Results indicated that good self-control had significant paths to higher levels of fruit-vegetable intake and participation in sports, and lower level of sedentary behavior. Poor self-control had significant paths to higher level of saturated-fat intake and lower level of vigorous exercise. These effects controlled for any correlations of self-control constructs with demographic characteristics. Regarding demographic variables, male gender was related to more vigorous exercise and more sports participation. African-American ethnicity was related to higher saturated-fat intake, less vigorous exercise, and more sedentary behavior. Hispanic ethnicity was related to less vigorous exercise and less participation in sports. Parental education had a marginal path to adolescents' participation in sports.

We examined for gender and ethnic differences in effects of self-control through multiple-group modeling. For gender, separate covariance matrices were computed for boys and girls and were entered to a multiple-group analysis in which the model in Figure 1 (excluding gender) was estimated in both groups simultaneously with all parameters freely estimated. Coefficients for paths from self-control to criterion variables from this analysis are summarized in Table 3. A second model with the five paths from self-control constructs to criterion variables constrained to be equal across gender groups was specified, and the fit of this model was compared with that of the base model using a procedure outlined in Muthén and Muthén [25, chap. 15]. The chi-square difference with 5 df was 2.96 (ns), indicating that effects of self-control were comparable for boys and girls. In a comparable procedure analyzing the model in Figure 1 (excluding ethnicity), constraining paths for self-control to be equal across ethnic groups produced a chi-square difference with 9 df of 8.18 (ns), indicating that effects of self-control on diet and exercise were comparable across ethnic groups. As shown in Table 3, paths for self-control were generally significant in each of the gender and ethnic groups despite smaller cell sizes. Thus the relation between self-control and criterion variables was found across all gender and ethnicity groups.

Discussion

The aim of this research was to test a theoretical formulation that predicts relations of self-control constructs to health-related behavior. The study was based on a community sample of adolescents and used standardized measures of dietary intake and physical activity. Consistent with previous research [12] the measured indicators of self-control were normally distributed in the adolescent population, and the latent constructs for self-control represented two distinct domains rather than opposite ends of a single continuum. Results indicated the self-control constructs were related to both dietary and exercise behaviors, controlling for demographics. Independent of effects for self-control, the analysis showed significant effects for gender and ethnicity, with females having less vigorous exercise and minority-group members having less vigorous exercise and a less healthful dietary pattern.

The results showed that planfulness and impulsiveness had different types of relationships to dietary and exercise behaviors. Persons who scored higher on good self-control had more fruit and vegetable intake and less sedentary behavior, as well as having more participation in sports. A different pattern was noted for persons scoring higher on poor self-control, who had more saturated-fat intake and a lower frequency of engaging in vigorous exercise. These results were based on a diverse sample of adolescents and analyses indicated that effects of self-control were not limited to a particular demographic subgroup, as effects of self-control on dietary and physical activity outcomes were found to be comparable across gender and ethnic groups. The finding of different patterns for the two domains of self-control is consistent with research in other areas [12,26]. The suggestion is that a higher level of good self-control relates to behaviors that require information seeking, planning, and investment of effort to accomplish, whereas persons who score high on poor self-control are more susceptible to situational pressures and less inclined to resist temptations for undesirable behaviors [11]. Theoretical papers have

outlined dual-process models of adolescent behavior positing a more reasoned/reflective pathway together with a more impulsive/reactive pathway [27], and these concepts may be useful for understanding processes in the formation of diet and exercise patterns.

The finding of significant effects for self-control in this study indicates that adolescents do have some choice in regard to their diet and exercise so individual characteristics can play a role in shaping patterns of eating and frequency of physical activity, and they may interact with environmental factors. The results suggest directions for further research on health-related behavior in the context of social-cognitive theory [28]. It is possible that self-control has direct effects on dietary intake and physical activity, not involving any other processes. Research on adolescent substance use, however, suggests that indirect effects should also be considered [11]. It is possible that developing a higher level of good self-control is associated with greater awareness of vulnerability to health risks and a more reasoned approach to making decisions about diet and exercise [29-30]. The component processes underlying a higher level of poor self-control are conducive to a present-oriented perspective in which there is less concern with the future, more inclination to affiliate with teens who are engaging in health risk behaviors [12,18], and less motivation to persevere in achieving goals for more healthful behavior [31]. These kinds of processes may be explored in further research on relations of self-control processes to dietary and physical activity outcomes.

The results of the present study are consistent with national data in showing gender and ethnicity related to diet and exercise patterns [e.g., 32,33]. It is recognized that the determinants of dietary intake and physical activity are multifactorial in nature, including variables such as home availability of fruits and vegetables and family support for and modeling of behavior patterns [15,16,34]. In addition, social factors act to promote or create barriers to healthful behavioral patterns [35,36], and environmental factors may affect access to shopping and physical activity opportunities [37,38]. These kinds of variables may be addressed in efforts to reduce health disparities in the population.

Although relatively simple measures were used to index diet and exercise, the self-control constructs accounted for 5-15% of the variance in the health behavior outcomes controlling for demographics, a contribution that is meaningful from a prevention standpoint in view of the multiple contributions to such behaviors and the fact that self-control characteristics are modifiable. Interventions in clinic and home settings that included components for goal-setting and self-monitoring have shown effects for reducing body-mass index scores [39,40], and the present research has suggested problem solving, delay of gratification, self-reinforcement and other cognitive skills as also relevant for diet and exercise patterns. Thus we think in addition to family environment, attention to self-control processes is warranted as an avenue of investigation for programs designed to improve health behaviors in childhood and adolescence.

There are some aspects of this study that could be noted as limitations. Though the sample was diverse in ethnic and socioeconomic characteristics, the study was conducted in one community and the results need to be replicated in other geographic areas. One of the self-control indicators had lower reliability, and while this is compensated by the latent construct approach, longer indicator measures should be tested where feasible. The measures of diet and exercise were relatively simple ones, and further research using more intensive assessments of diet and exercise patterns would be desirable to test effects of self-control on health behaviors. Finally, the design of the present study was cross-sectional, and longitudinal research can be conducted to delineate temporal relations of variables and study possible mediation processes for effects of self-control.

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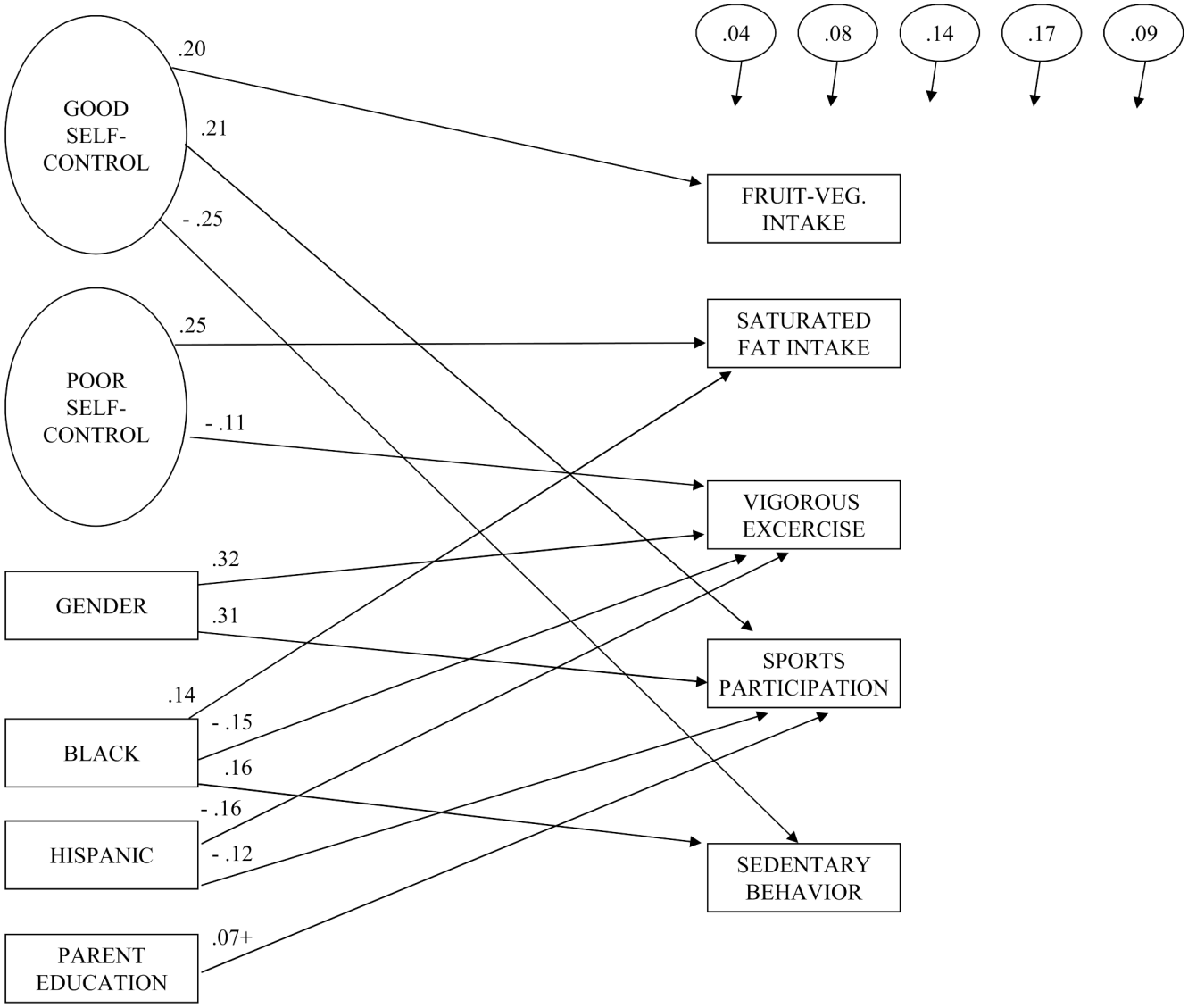

Figure 1.

Structural model for self-control and diet/exercise behaviors. Rectangles indicate observed variables, ovals indicate latent constructs. All values are standardized coefficients. Coefficients are significant at $p < .05$ unless otherwise noted; + indicates $p < .10$. Included in the model but excluded from the figure for graphical simplicity are covariances of exogenous variables (see Table 2) and residual covariances for criterion variables (see text). Values in circles at top of figure are squared multiple correlations, the variance accounted for in a given construct, which the arrow points to, by variables to the left of this construct in the model.

Table 1

Descriptives for Continuous Variables

Variable	Range	M	SD	Skew
Indicators for good self-control				
Soothability	5-25	14.54	4.07	0.14
Planfulness	6-30	20.76	4.66	- 0.10
Problem solving	6-30	21.10	5.32	-0.41
Cognitive effort	6-30	18.86	5.76	-0.05
Future time perspective	7-35	20.71	5.50	0.19
Positive self-reinforcement	7-35	21.76	6.21	0.09
Indicators for poor self-control				
Impatience	4-20	7.29	2.62	0.76
Distractibility	6-30	14.82	5.02	0.44
Impulsiveness	6-30	14.74	5.56	0.50
Angerability	6-30	12.01	5.33	1.18
Tension maintenance	5-25	14.02	5.64	0.31
Present orientation	7-35	19.05	4.99	0.47
Negative self-management	7-35	15.96	5.25	0.54
Measures of dietary intake				
Saturated-fat intake	0-56	29.04	11.54	0.22
Fruit-vegetable intake	0-36	18.73	7.05	0.12

Note: N = 539 for descriptives.

Table 2

Correlations of Study Variables

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Male	.--										
2. Black	-.04	.--									
3. Hispanic	-.01	-.57	.--								
4. Parent educ.	.07	.24	-.22	.--							
5. Good SC	.04	.05	.05	.03	.--						
6. Poor SC	-.05	-.15	.08	-.09	-.31	.--					
7. Fruit-veg.	.04	.03	.00	.00	.21	-.03	.--				
8. Saturated fat	.07	.12	.03	.03	-.08	.23	.38	.--			
9. Vig. exercise	.41	-.08	.10	.04	.07	-.11	.12	-.04	.--		
10. Sport partic.	.40	.06	-.15	.10	.21	-.10	.17	.03	.44	.--	
11. Sedent. beh.	.11	.17	-.05	-.03	-.23	.12	-.02	.15	-.07	-.08	.--

Note: N for correlations is 539. SC = self-control. Approximate significance levels are r > |.11|, p < .05; r > |.13|, p < .01; r > |.15|, p < .001.

Table 3

Structural Coefficients for Self-Control Constructs, by Gender and Ethnicity

	Female		Male			
Path	b	(SE)	b	(SE)		
Good ctrl => Fruit-veg.	.055**	(.022)	.060**	(.019)		
Poor ctrl => Saturated fat	.158****	(.040)	.186****	(.045)		
Poor ctrl => Vig. exercise	-.101*	(.046)	-.062	(.042)		
Good ctrl => Sports partic.	.091****	(.024)	.045*	(.021)		
Good ctrl => Sedent. behav.	-.079****	(.020)	-.070***	(.020)		
	Black		Hispanic		Caucasian	
Path	b	(SE)	b	(SE)	b	(SE)
Good ctrl => Fruit-veg.	.074**	(.026)	.045*	(.020)	.063*	(.029)
Poor ctrl => Saturated fat	.157**	(.059)	.195****	(.044)	.078	(.063)
Poor ctrl => Vig. exercise	-.097+	(.060)	-.077+	(.047)	-.108*	(.059)
Good ctrl => Sports partic.	.068*	(.030)	.035	(.023)	.108****	(.028)
Good ctrl => Sedent. behav.	-.056*	(.030)	-.091****	(.019)	-.063*	(.027)

Note: Values are unstandardized coefficients (SE in parentheses). For gender analysis, N's are 255 for females and 284 for males. For ethnicity analysis, N's are 135 for Blacks, 268 for Hispanics, and 136 for Caucasians.

* Coefficient is significant in subgroup at $p < .05$.

** significant in subgroup at $p < .01$.

*** significant in subgroup at $p < .001$.

**** significant in subgroup at $p < .0001$.