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Executive function and probabilities of engaging in long-term sedentary and high calorie/low nutrition eating behaviors in early adolescence

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Introduction

Consumption of high calorie/low nutrition (HCLN) foods, as well as increased levels of sedentary behavior (SB), have been associated with unhealthy levels of childhood weight gain and increased risk for obesity (Davison et al., 2001; Mitchell, J. A. et al., 2013; Prentice-Dunn et al., 2012). Over 18.4% of school-aged youth six to eleven are considered obese in the United States (Kumar et al., 2017), and are more likely than their normal weight peers to develop high cholesterol and blood pressure, prediabetes, bone and joint problems, asthma, and cancer later in life (Freedman et al., 2007; Must et al., 2006; Tanofsky-Kraff et al., 2011). Compared to their normal weight peers, overweight or obese children show significantly faster weight gain into adolescence and are more likely to be overweight or obese once reaching adulthood (Buscot et al., 2018; Field et al., 2005; Herman et al., 2009; McGinty et al., 2018; Singh et al., 2008).

Executive Function (EF) typically refers to a collection of inter-related processes that requires effortful, top-down control of action, attention, regulation of behavior and emotions, associated with neural systems involving the prefrontal cortex (Anderson, 2002; Müller et al., 2015; Zelazo et al., 2002). However, neural regions implicated in EF do not fully mature until late adolescence and into early adulthood (Ames et al., 2014; Casey et al., 1997; Gogtay et al., 2004), leaving children and adolescents vulnerable to engaging in behaviors

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Declaration of Interest
None

that require effortful initiation or inhibition, including high calorie low/nutrition food intake and high levels of SB (Bechara et al., 2006; Francis et al., 2009; Guerrieri et al., 2008; Nederkoorn et al., 2006; Stacy, Ames, & Knowlton, 2004). Problems or deficits in inhibition have been found to increase the risk for unhealthy eating and increased SB in children in a number of investigations (Guerrieri et al., 2008; Nederkoorn et al., 2006). For example, a study by Francis and Sussman found that children with a compromised ability to inhibit behavior had higher weight and faster weight gain compared to children with higher levels of inhibition (Francis et al., 2009). Further, components of EF may play a role in the initiation of HCLN eating and sedentary behavior. Working memory capacity enables individuals to maintain attention and focus, and may work in concert with other executive processes such as inhibitory and emotional control (Riggs, N. et al., 2010). Put another way, working memory can guide attention toward or away from food-related cues in the environment, thus inhibiting or facilitating their behavior (Davidson et al., 2019; Higgs et al., 2018). Strong emotional impulses may also play a role in HCLN and SB, as negative mood states have shown to increase food intake among children and adolescents (Tice et al., 2001), as well as sedentary behavior (Aparicio et al., 2016; Isasi et al., 2013).

While past research has shown a relationship between EF, HCLN eating, and SB, to our knowledge, no study has examined if early patterns of EF can potentially predict long term patterns of obesity risk among children. Little is known about whether latent subgroups of EF exist in this population, and if these subgroups predict longitudinal patterns of unhealthy eating and sedentary behavior that may, in turn, represent greater or lesser risk for obesity. The current study applied a mixture model based on a latent transition analysis framework (Nylund-Gibson et al., 2014) to ascertain whether latent profiles (Gibson, 1959) of EF in early childhood predicted longitudinal profiles of HCLN eating and SB. It was hypothesized that low EF at baseline would predict an increased likelihood of engaging in long term HCLN eating and SB. Further model testing explored the influence of covariates on the relationship between EF and longitudinal patterns of HCLN eating and SB.

Method

The data included in this analysis were collected as part of a large, randomized controlled trial designed for the prevention of multiple health risk behaviors. Twenty-eight Southern California elementary schools in two large districts were matched on school-level demographic characteristics (e.g., ethnicity, socioeconomic status), and randomly assigned by pair within each district to an EF training program or a delayed intervention control group for obesity risk prevention (Sakuma et al., 2012). Participants were assessed at four measurement periods across three years, all receiving the same assessments. At baseline, 1,005 fourth grade students and their parents signed assent and active consent forms for participation in this study according to procedures approved by the university institutional review board. Of the 1,005, 296 were removed from the sample due to either moving out of the study area (n=249, 85%), declining assent at a follow-up assessment (n=18, 6%), or being absent on an assessment day (n=29, 10%). Thus, the final sample used in this analysis consisted of 709 fourth through sixth grade students, half of whom were female (50.1%), with a mean age 9.27 years (range eight to eleven years) (see Table 1). Participants that were removed from analysis did not differ greatly from the remaining population, with the exception that they were more likely to be Hispanic (33% vs. 26%; $p<.05$) and low SES (35% vs. 21%; $p<.001$).

Measures

High calorie/low nutrition.—Eating behavior was assessed using five items from the State and Local Youth Risk Behavior Survey (YRBSS, $\alpha = 0.80$) which asked questions related to HCLN intake (Brener et al., 2013). Specifically, each item asked 'How often to do you eat…' and then listed a specific food or drink such as french-fries, potato chips, doughnuts, pastries, candy, or non-diet soda. Response option were 1= Less than once a week, 2= Once a week, 3= 2-3 times a week, 4= 4-6 times a week, 5= Once a day, and 6= 2 or more of these a day.

Sedentary behavior.—Population SB was assessed utilizing a previously validated three-item measure ($\alpha = 0.68$), which assessed the number of hours spent playing video games, watching television, or using a computer outside of school (Hoelscher et al., 2003). Questions asked "On a regular school day, how many hours per day do you usually…" and listed "watch TV or video movies at home or away from school", "spend on the computer at home or away from school", and "spend playing video games that you sit down and play like PlayStation, Xbox, GameBoy, or arcade games". The seven response options were 1= I don't, 2= 1 hour, 3= 2 hours, 4= 3 hours, 5= 4 hours, 6= 5 hours, 7= 6 more hours.

Executive function.—Items from the Behavioral Rating Inventory of Executive Function, Self-Report (BRIEF-SR) were used to assess EF in participants (Guy et al., 2004). The BRIEF was designed to measure EF in every-day situations among school-age children as young as fourth grade (Harris et al., 2016; Riggs et al., 2012). Specifically, BRIEF measures two broad areas of EF: behavioral regulation, the ability to shift, and modulate emotions and behavior via appropriate inhibitory control; and metacognition, the ability to cognitively self-manage tasks and monitor performance (Gioia et al., 2002). Due to time-constraints imposed by participating schools for in-class survey administration, 23 items from four clinical subscales of EF representing working memory, behavioral inhibition, emotional regulation, and organization of materials were selected as part of survey measures, which have been used in previous studies investigating the association between executive function and various health outcomes (Harris et al., 2016; Pentz et al., 2013; Pentz et al., 2015; Riggs et al., 2012; Warren et al., 2017). For each item, participants were asked "In the past month, how often has each of the following behaviors been a problem?", with item response choices 1 = Never, 2 = Sometimes, 3 = Often. An example item for the working memory subscale is "I forget what I am doing in the middle of things", inhibitory control is "I get out of control more than my friends", emotional control is "I yell, scream, or cry for no reason" and organization of materials is "my desk/workspace is a mess". Previous work using this same population found the abbreviated BRIEF-SR scale to demonstrate predictive validity when compared to the full scale (Riggs et al., 2010). Sub-scales and items were selected using the highest loading index items from a pilot study that demonstrated acceptable internal consistency (αs=0.63 to 0.74) when compared to full BRIEF scales (Riggs et al., 2010; Riggs et al., 2010).

Covariates.—Gender, ethnicity, and socioeconomic status were included as potential covariates based on prior research that has shown some differences in obesity risk among these variables (Singh et al. 2010). Dichotomous variables were created for gender (male vs. female), ethnicity (Hispanic vs. non-Hispanic), and socioeconomic status (received a free lunch at school vs. did not receive a free lunch at school). Intervention condition assignment was also included as a potential covariate as it may have influenced HLCN eating and SB.

Analysis Plan

Intra-class correlational analyses revealed that up to 3.7% of the variation in HCLN consumption and 7.5% of the variation in SB could be attributed to random effects at the school level. To adjust for similarities between students attending the same school, a clustering variable indicating the school each student attended was included in all statistical models. Standard errors robust to non-independence were estimated for each model. Full-information maximum likelihood was employed to account for missing data (Graham, 2009; Little et al., 2014), although no variable in the sample of 709 students had more than 2% of the data missing.

A latent profile analysis (LPA) was conducted to identify subgroups of similar students based on the means of the four subscales of EF that were measured at the baseline assessment (Lubke et al., 2005). To select the most plausible number of subgroups, a series of models were tested with between one and four profiles. Each model employed 5,000 random sets of starting values, 20 iterations at the initial stage, and 100 final stage optimizations. The best fitting model was selected (Collins et al., 2010; Nylund et al., 2007) by monitoring changes in Akaike's Information Criterion (AIC; Akaike, 1987) and sample size adjusted Bayesian Information Criterion (SSA-BIC; (Sclove, 1987) with the goal of identifying the point at which the indices reached a minimum value or an "elbow" representing the last relatively large decrease (Collins et al., 2010; Nylund et al., 2007). The Lo-Mendell-Rubin test (LMR) and the bootstrap likelihood ratio test (BLRT) were also utilized to assess model fit (Lo et al., 2001; McCutcheon, 1987; McLachlan et al., 2000). With these tests, a statistically significant *p* value suggests that adding a latent profile improves model fit; a *p* value that is not statistically significant indicates that a more parsimonious model with fewer latent profiles will provide a better fit to the data. Once the number of subgroups in the LPA model was determined, the procedure was then replicated to perform a repeated measures latent profile analysis (RMLPA) using the means of the five-item measure of HCLN consumption and the mean of the three-item measure of SB. Responses from the initial assessment, as well as the 6-month, 18-month, and 30-month follow-up assessments, were used in the RMLPA model to identify longitudinal latent profiles.

After the final LPA and RMLPA models were selected, the three-step method (Asparouhov et al., 2014; Vermunt, 2017) was employed to regress the longitudinal latent profiles of HCLN consumption and SB on the initial latent profiles of EF (Nylund-Gibson et al., 2014). The first regression model was unconditional and determined the probability that students from a specific latent profile of EF would transition to a longitudinal latent profile of HCLN eating and SB. The second regression model integrated covariates (see Figure 1) to assess whether gender, ethnicity, socioeconomic status, and intervention condition changed the probability that a student from an EF latent profile would transition to a longitudinal HCLN/SB latent profile. All analysis was conducted using Mplus 8.2 software (Muthén et al., 2018).

Results

In the LPA of EF, AIC and SSA-BIC declined sharply in the first three models and tapered off in fourth model (see Table 2). The LMR and BLRT were statistically significant in the third model but not the fourth model, suggesting the model with three latent profiles (see Figure 2) provided the best fit the data. The first profile was labeled *High EF* and consisted of 35.2% of the sample. The EF subscale means within this latent subgroup ranged from 1.3 to 1.4, with lower scores representing higher levels of executive function. The second profile was labeled *Medium EF*, comprised 47.7% of the sample, and had subscale means that varied from 1.6 to 1.7. The third profile was labeled *Low EF*, made up of 17.1% of the sample, and had subscale means between 2.1 and 2.2.

In the RMLPA of HCLN consumption and SB, there was a sizable decrease in the AIC and SSA-BIC in the model with two longitudinal latent profiles and a modest decrease in the models with three and four longitudinal latent profiles. The LMR and BLRT were statistically significant in the model with two profiles but not three or four profiles. The model with two longitudinal latent profiles was therefore selected as the final model (see Figure 3). The first longitudinal profile consisted of 17.2% of the sample, and was labeled *High HCLN/SB* to reflect the higher levels of HCLN consumption and SB reported at each assessment period. The second longitudinal profile, which exhibited lower levels of HCLN consumption and SB at each assessment, was labeled *Low HCLN/SB* and constituted 82.8% of the sample.

The three-step method was used to estimate the probability that students from each latent profile of EF would transition to the *High HCLN/SB* longitudinal profile. The unconditional regression model revealed that students in the *Low EF* latent profile had a 32% chance of transitioning to the *High HCLN/SB* longitudinal profile. Students in the *Medium EF* and *High EF* latent profiles had a 14% and 15% chance, respectively.

The regression model with covariates (see Table 3) indicated that students with low SES were less likely to be in the *Medium EF* latent profile compared to the *Low EF* latent profile (OR = 0.37, 95% CI = 0.19 to 0.71, p = .003). Socioeconomic status also increased the probability that a student in the *High EF* latent profile would transition to the *High HCLN/SB* longitudinal profile (OR = 4.55, 95% CI = 1.59 to 13.01, p = .005). The model also showed that males in the *High EF* latent profile had higher odds of transitioning to the *High HCLN/SB* longitudinal profile (OR = 2.74, 95% CI = 1.11 to 6.78, p = . 029), with even greater odds for males in the *Low EF* latent profile (OR = 11.88, 95% CI = 2.63 to 53.74, p = .001). Further, males were less likely to be in the *High EF* latent profile compared to the *Low EF* latent profile (OR = 0.60, 95% CI = 0.37 to 0.99, p = .045).

Discussion

To our knowledge, this investigation is the first to identify latent profiles of EF in children and to use a latent transition analysis framework to determine the effect of these profiles on longitudinal HCLN consumption and SB. Executive control functions are a set of neuro-cognitive skills that allow an individual to problem solve, as well as engage in self-regulation and impulse control (Fishbein et al., 2009). Results showed support for the initial hypothesis, indicating that participants who had low EF at baseline assessment had a significantly higher probability of transitioning to a latent subgroup that regularly engaged in high HCLN consumption and frequent sedentary behavior. These results are in line with findings from prior investigations into the relationship between EF, eating, and physical activity (Ames et al., 2014; Ames et al., 2016; Francis et al., 2009; Goldschmidt et al., 2018; Nederkoorn et al., 2006; Riggs, N. et al., 2010; Riggs et al., 2003; Riggs et al., 2012; van Praag, 2009; Willoughby et al., 2018).

Several potential explanations tying into EF exist that may, in part, help explain these findings. First, it is possible that coming into contact with highly salient environmental or internal stimuli may trigger a pre-potent response to engage in a particular behavior. In other words, cues associated with an appetitive behavior can come to trigger a relatively automatic pattern of activation in memory, which may overwhelm regulatory control processes, thus allowing a behavioral response to occur without much thought or introspection (Stacy, Ames, & Leigh, 2004; Stacy et al., 2010; Wiers et al., 2007). Thus, executive control processes such as working memory capacity and behavioral inhibition become essential when facing relevant cues, potentially dampening or diminishing their influence (Friese et al., 2008; Hofmann et al., 2008; Hofmann et al., 2007; Houben, 2011; Houben et al., 2010; Nederkoorn et al., 2010). Second, it is possible that poor higher order organizational and intentional planning skills may lead to a diminished ability to organize healthy goals or appropriately weigh outcomes when executing decisions (Riggs et al., 2010; Riggs et al., 2012). Third, poor emotional regulation (i.e., the ability to cognitively control strong emotional impulses) may increase HCLN eating, as the relationship between negative mood states and increased food intake is well researched (Evers et al., 2010; Harrist et al., 2013; Tice et al., 2001). Unfortunately, executive control functions require greater cognitive resources that children may not be developmentally able to muster, and thus become easier to overwhelm (Grenard et al., 2008; Stacy et al., 2010). Investigations into neurodevelopment timelines have shown neural regions associated with executive control (i.e., frontal cortical regions) do not begin to fully mature until early adolescence (Gogtay et al., 2004). Taken together, these results may provide evidence that enhancing cognitive control directly or indirectly (Müller et al., 2015), or modifying environmental conditions to reduce EF demand (Allan et al., 2015), beginning early in childhood could be helpful in strengthening long term health behaviors. Several direct interventions already have attempted training various components of specific EF components among child and adolescent populations with promising results (Ames et al., 2016; Grenard et al., 2007; Houben, 2011; Houben et al., 2012; Houben et al., 2015; Pentz et al., 2016; Riggs et al., 2006; Verbeken et al., 2013). Further, several indirect interventions, which focus on more global self-regulatory enhancement compared to training specific EF components, have been shown to be effective in enhancing EF over time (Diamond, 2012; Diamond et al., 2011). For example, the Promoting Alternative Thinking Strategies (PATHS) emphasizes the integration of affect, behavior, and cognition, and has been shown to promote inhibitory control among seven-through nine-year olds (Greenberg et al., 1995; Riggs et al., 2006). Additionally, mindfulness training has shown support in enhancing the more controlled regulatory processes in children (Pentz et al., 2016; Zelazo et al., 2012). Nonetheless, future research could help clarify the long-term effect of EF training (both direct and indirect) on negative health behaviors.

The current study also investigated whether covariates changed the probability of transitioning to a longitudinal latent subgroup. Results indicated that being male significantly increased the probability that a student would engage in high levels of HCLN consumption and SB. While speculative, it is possible these results can be attributed to general differences in eating behavior between sexes. Specifically, investigations into childhood diet have shown a difference between the daily amount of sugar consumed by boys compared to girls (Ervin et al., 2012), and that after age nine, males preferred and consumed greater quantities of sweet foods than females of the same age (Cooke et al., 2007; Desor et al., 1975; Desor et al., 1987; Greene et al., 1975). Further investigation among children is needed to understand gender differences with respect to eating behavior and physical activity, and how these differences may be exacerbated by varying levels of neurocognitive functioning and development.

Students from a lower socioeconomic status also had a higher probability of transitioning into the high HCLN consumption and SB profile. For these students, it may be possible that high calorie snack foods are more readily available compared to healthy food alternatives such as fruit and vegetables (Powell et al., 2007). Further, children and adolescents from low income families may also live in environments where physical activity is more restricted (Hoyos Cillero et al., 2010; Jin et al., 2015). For example, an investigation into childhood SB in Southern California found that lower income children watched more hours of television per day, had less access to physical activity equipment, and were more likely to have restrictions on outdoor physical activity (Tandon et al., 2012). Based on these findings, it is plausible that various environment conditions, such as neighborhood disorganization and access to safe physical activity venues, can have an influence over child behavior.

Limitations and Strengths of the Current Study

There were several limitations to the present study. First, EF, HCLN consumption, and SB were only measured over a period of 30 months. It is possible that due to rapidly maturing neural structures (Gogtay et al., 2004), EF and HCLN/SB behaviors may change post-middle school. However, the stability of these outcomes in our sample, as well as past research showing childhood weight influences adolescent and adult weight, may provide evidence early EF can have a marked impact on future eating and physical activity behaviors. Future assessments conducted over a longer timeframe may provide additional insight into the influence that EF has on longitudinal behavioral patterns that begin in childhood. Univariate and multivariate growth curve models and growth mixture models may be particularly useful in identifying long-term trends associated with EF. Second, due to feasibility issues at study locations, laboratory-based measures of EF such as Self Ordered Pointing Task or Go-No/Go were not used. The BRIEF survey, used in their place, was designed to capture real-world behavioral manifestations of EF through measurement of day-to-day behavior (Gioia et al., 2002; Guy et al., 2004). Typically, this measure has been used when various participant or setting constraints prohibit the use of laboratory tasks. While some researchers argue that performance-based and rating measures of executive function assess different underlying mental constructs (Toplak et al., 2013), previous investigations have found the BRIEF adequately measures the components of EF under investigation in this study (Kenworthy et al., 2008; Mahone et al., 2002; Mangeot et al., 2002; Nadebaum et al., 2007). Nevertheless, future research should utilize more robust laboratory-based measures of EF to further clarify the relationship between EF and trajectories of SB/HCLN. Finally, the SB measure used in this study does not capture non-screen based sedentary behaviors (e.g., reading, doing homework). However, a strong link between high levels of screen time and obesity has been well documented (Mitchell, J.A. et al., 2013; Robinson et al., 2017), with large increases in usage first observed in children as they transition between elementary and middle school (Twenge et al., 2018). Regardless, future investigations into sedentary behavior could include non-screen behaviors to generate a more complete picture of child and adolescent health.

Conclusions

The results of this study help further our understanding of the interplay between executive control processes and eating/sedentary behavior among children and early adolescents. The population under investigation is at the early stages of setting long-term behaviors that put them at greater risk of developing negative health outcomes, such as becoming overweight or obese. Given these risks, a goal of future interventions might be to train individuals with lower EF across multiple domains (i.e., inhibition, working memory, etc.) over the long term to adopt alternative means of regulating behavior or engaging in appropriate decision-making. Indeed, a few interventions have demonstrated that adequate cognitive training has been key to reducing risky behaviors (Bickel et al., 2011; Fiore et al., 2000; Kalichman et al., 2000; Sussman et al., 2004), and two meta-analysis has shown that, at least over the short term, inhibition training shows small but significant effects in reducing negative health behaviors (Allom et al., 2016; Jones et al., 2016). Simultaneously, steps could be taken to enhance environmental conditions so that high levels of EF would not be required for children to make healthy decisions (Allan et al., 2015). Collectively, these two approaches may help reduce the probability that children will engage in unhealthy behaviors that become lifelong habits. Future research remains necessary to determine what, if any, long-term effects these efforts may have over health behaviors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Research Highlights

- Diet and sedentary behavior are major factors in childhood and adult obesity.
- Neurocognitive factors may highlight risk to developing obesity in childhood.
- Executive function is linked to long-term habits of eating and sedentary behavior.

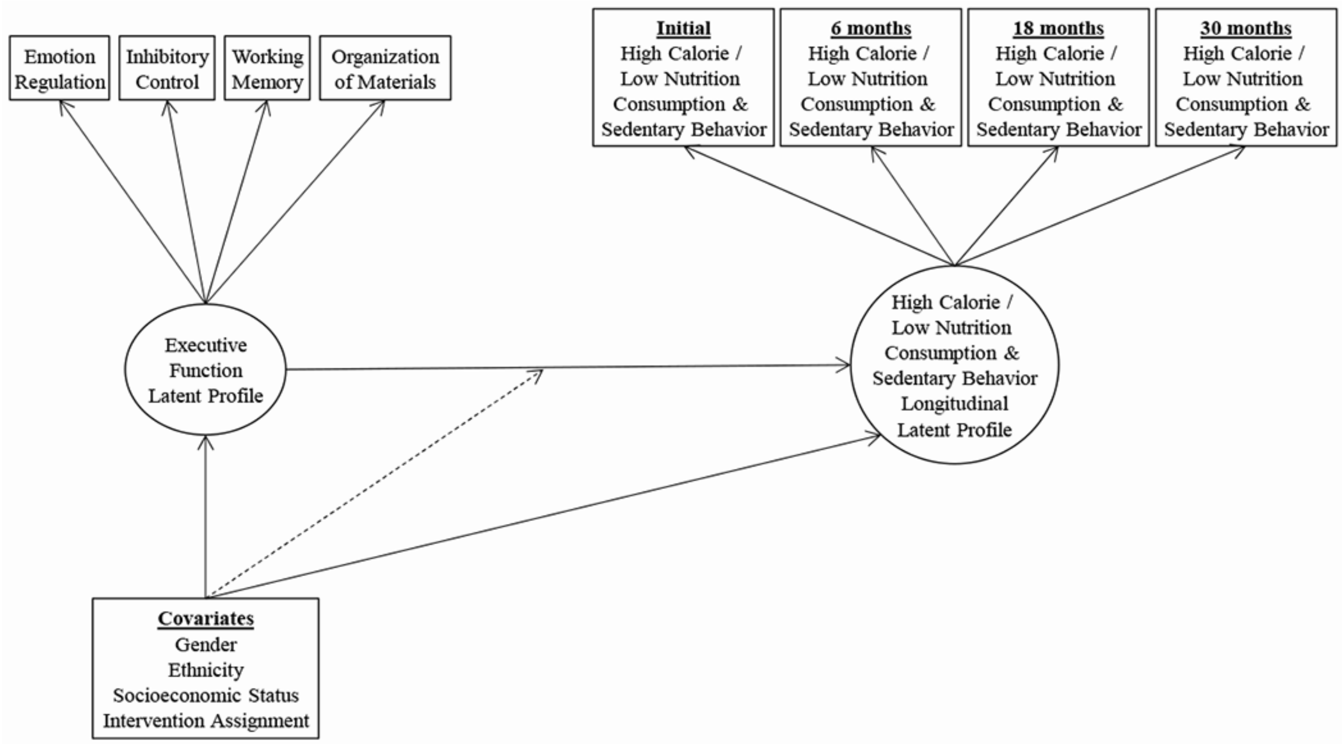

Fig. 1.
Visual depiction of model utilizing a latent transition framework.

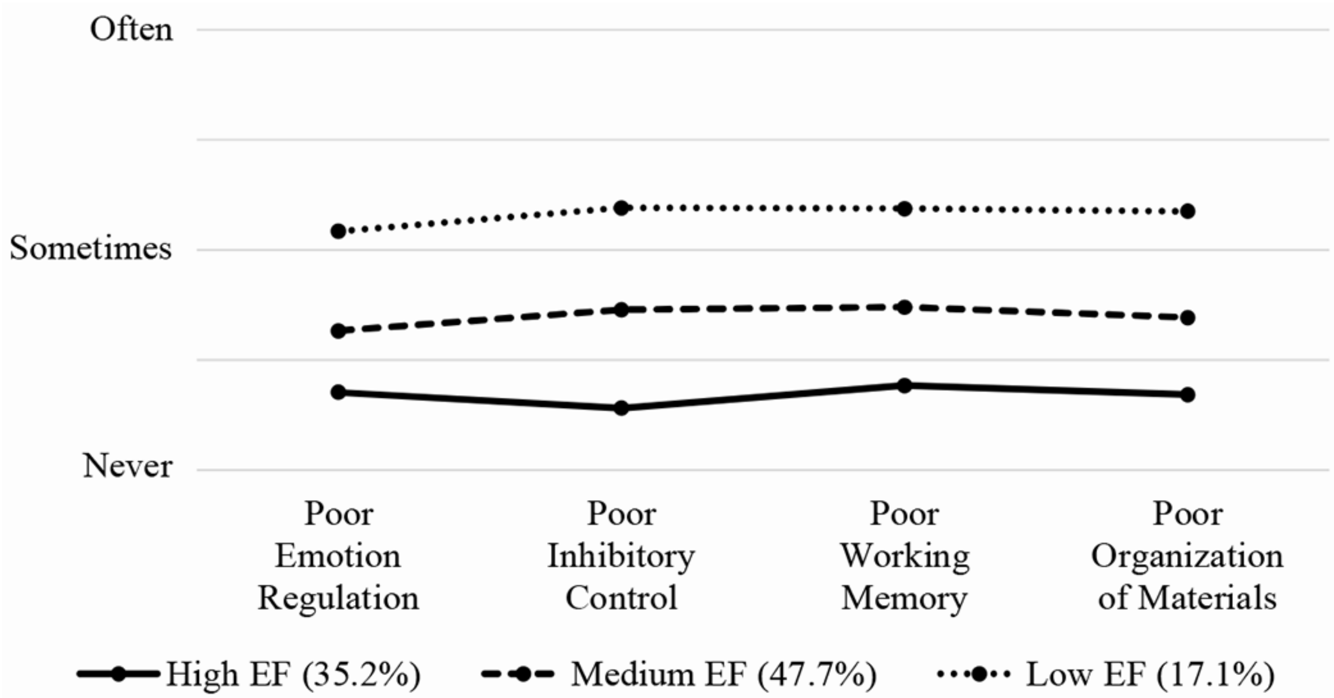

Fig. 2.
Visual depiction of latent profiles of executive function (EF) at the initial assessment.

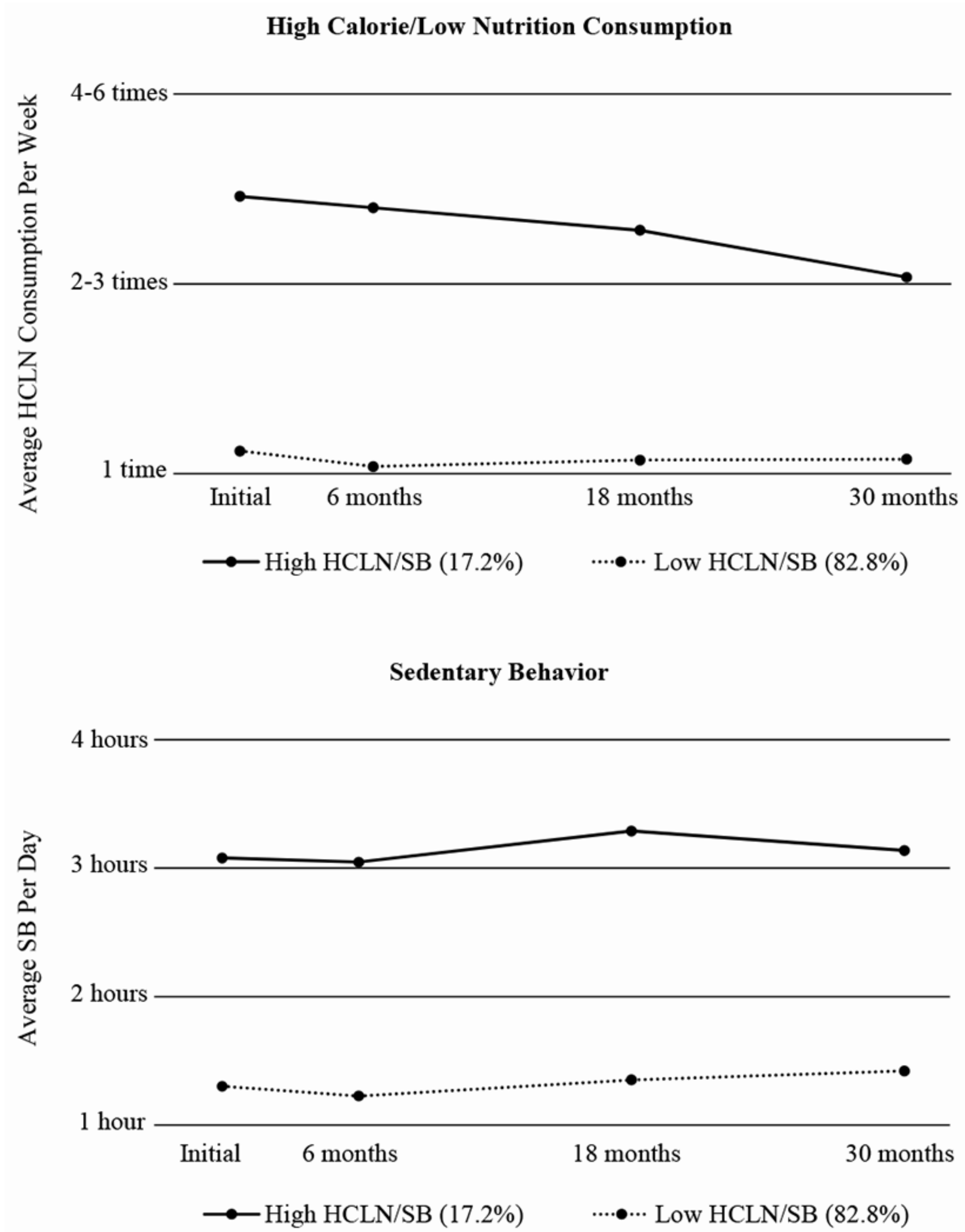

Fig. 3.

Visual depiction of longitudinal latent profiles of high calorie/low nutrition (HCLN) consumption and sedentary behavior (SB) across four assessment periods.

Table 1.

Descriptive statistics for 709 students from 29 schools

Grade, assessment, and variable	Statistics
4th Grade: Initial Assessment	
Gender, *n* (%)	
Male	354 (49.9%)
Female	355 (50.1%)
Ethnicity, *n* (%)	
Hispanic	182 (25.7%)
Non-Hispanic	527 (74.3%)
Socioeconomic Status, *n* (%)	
Received a Free Lunch at School	148 (20.9%)
Did Not Receive a Free Lunch at School	561 (79.1%)
Intervention Assignment, *n* (%)	
Intervention	377 (53.2%)
Control	332 (46.8%)
Behavioral Rating Inventory of Executive Function, mean (*SD*)	
Emotion Regulation	1.6 (0.4)
Inhibitory Control	1.6 (0.4)
Working Memory	1.7 (0.4)
Organization of Materials	1.7 (0.4)
High Calorie/Low Nutrition Consumption, mean (*SD*)	2.4 (1.0)
Sedentary Behavior, mean (SD)	2.6 (1.3)
4th Grade: 6-Month Follow-Up Assessment	
High Calorie/Low Nutrition Consumption, mean (*SD*)	2.3 (0.9)
Sedentary Behavior, mean (*SD*)	2.5 (1.2)
5th Grade: 18-Month Follow-Up Assessment	
High Calorie/Low Nutrition Consumption, mean (*SD*)	2.3 (0.9)
Sedentary Behavior, mean (*SD*)	2.7 (1.2)
6th Grade: 30-Month Follow-Up Assessment	
High Calorie/Low Nutrition Consumption, mean (*SD*)	2.2 (0.9)
Sedentary Behavior, mean (*SD*)	2.7 (1.2)

Table 2.

Summary of information used to determine latent profiles.

	1 Profile	2 Profiles	3 Profiles	4 Profiles
A. Executive Function				
AIC	2914.599	2173.439	1987.441	1922.695
SSA-BIC	2925.708	2191.491	2012.436	1954.633
LMR (*p*)	-	<.001	.006	.057
BLRT (*p*)	-	<.001	.007	.061
B. High Calorie/Low Nutrition Consumption and Sedentary Behavior				
AIC	17032.512	15808.065	15406.562	15232.650
SSA-BIC	17054.730	15842.781	15453.775	15292.360
LMR (*p*)	-	.006	.115	.326
BLRT (*p*)	-	.006	.119	.331

Note: AIC = Akaike's Information Criterion, SSA-BIC = Sample size adjusted Bayesian Information Criterion, LMR (*p*) = *p* value of Lo-Mendell-Rubin test, and BLRT (*p*) = *p* value of bootstrap likelihood ratio test.

Table 3.

Odds ratios depicting the effect of covariates.

Executive Function	Covariates	*OR*	[95% *CI*]	*p*
A. Effects of Covariates on Executive Function Latent Profile				
Low	Gender (Male)		Reference	
	Ethnicity (Hispanic)			
	SES (Free Lunch)			
	Intervention Assignment			
Medium	Gender (Male)	0.72	[0.43, 1.20]	.206
	Ethnicity (Hispanic)	1.71	[0.87, 3.37]	.118
	SES (Free Lunch)	**0.37**	**[0.19, 0.71]**	**.003**
	Intervention Assignment	1.11	[0.66, 1.87]	.681
High	Gender (Male)	**0.60**	**[0.37, 0.99]**	**.045**
	Ethnicity (Hispanic)	1.72	[0.92, 3.23]	.090
	SES (Free Lunch)	0.64	[0.36, 1.15]	.135
	Intervention Assignment	**1.99**	**[1.20, 3.29]**	**.007**
B. Effects of Covariates on Relationship Between Executive Function Latent Profile and High Calorie/Low Nutrition Consumption and Sedentary Behavior Latent Profile				
Low	Gender (Male)	**11.88**	**[2.63, 53.74]**	**.001**
	Ethnicity (Hispanic)	1.14	[0.23, 5.68]	.877
	SES (Free Lunch)	2.95	[0.86, 10.08]	.084
	Intervention Assignment	0.72	[0.24, 2.16]	.561
Medium	Gender (Male)	2.28	[0.97, 5.35]	.058
	Ethnicity (Hispanic)	1.19	[0.37, 3.8]	.767
	SES (Free Lunch)	1.61	[0.41, 6.35]	.499
	Intervention Assignment	0.43	[0.17, 1.1]	.078
High	Gender (Male)	**2.74**	**[1.11, 6.78]**	**.029**
	Ethnicity (Hispanic)	1.36	[0.46, 3.98]	.576
	SES (Free Lunch)	**4.55**	**[1.59, 13.01]**	**.005**
	Intervention Assignment	1.86	[0.66, 5.28]	.241

Note: Depicts the odds of belonging to the high HCLN/SB longitudinal latent profile as compared to the low HCLN/SB longitudinal latent profile. SES = Socio-economic status.