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Adolescent Health Behaviors Predict Adult Success

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Abstract

The World Health Organization (WHO) asserts that the greatest risks to adolescent health are behavioral. Behaviors themselves can be observed, but the motivation behind these behaviors cannot. Using the patterning of twelve distinct health behaviors, this study first identifies homogeneous, mutually exclusive "Classes" (patterns) of behavioral health motivations among adolescents age 13 to 19. Four primary classes-healthy, moderately healthy, moderately unhealthy and unhealthy-can be distinguished based on their characteristic behaviors and tendencies. Second, survey modeling tests the ability of these behavioral classes to predict various parameters of adult success within each gender. Health behavior classes significantly predict adult earnings, social interaction, romantic relationships and friendship success, ceteris paribus. While adolescents do not typically prescribe to predictable behaviors and actions, the emphasis on healthy behaviors by some suggest an individual awareness of behavioral impacts and the tendencies of these behaviors to precipitate in adulthood.

Keywords: Adolescence; Behavior; Health; Latent Class; Urban

Introduction

Behavior is one of the most important determinants of health. Individuals are born with an amount of health capital endowed through genetic inheritance, environmental stimuli and household influences. This health capital can be increased, decreased or maintained based on individual behavioral choices. Behaviors such as alcohol consumption, cigarette smoking, and drugs use can diminish health capital, while behaviors such as adequate sleep, appropriate nutrient consumption and seatbelt wearing can maintain or increase health investment. Impacts of adolescent behaviors on health capital has been studied extensively, primarily through the influence of risk taking. Much research has been devoted to studying the types of behaviors, but few have attempted to characterize these behaviors or classify their typologies. This work characterizes behavioral health classes among youth and adolescents, based on their underlying desire to preserve, maintain or seemingly diminish their own health capital stock.

During adolescence, individuals develop emotionally, physically and socially [1,2]. They form habits, develop identities and establish preferences that will impact the growth of their current health stock [3]. While nutrition, exercise and sleep are primarily important to support health into adulthood [4-6], research illustrates that adolescents often suffer from unhealthy weight control behaviors, stress, sleep insufficiency and mental health issues [7-10]. They often lose/gain excessive amounts of weight, decrease diet quality and reduce physical activity [11-13]. More troubling are the high rates of risky behaviors, such as smoking, anti-social behavior, hazardous alcohol consumption and unprotected sexual intercourse [14-19].

Extensive analyses outline adolescent behavior involving risk, substance use and sexual activity [8,20]. Authors have examined the link between adolescent behaviors and their parents, peers and educational environments [17,18,21]. Connell et al. [19] highlights the interaction and prevalence of risk and protective behaviors in adolescents and adults with a focus on unhealthy diet, cigarette smoking, substance abuse and engaging in risky sexual behaviors in contrast with protective behaviors. Health issues associated with these behaviors include poor educational attainment, future morbidity and premature mortality [22]. Many of the primary adolescent health concerns could be prevented with appropriate behavior and lifestyle modifications [23-25].

However, analysis of adolescent health behavior and its impact on adult outcomes has not been fully elaborated. Connell, et al. [19] used latent Class Analysis (LCA) to assess the co-occurrence of adolescent substance use and sexual behavior but failed to use

health-promoting behaviors along with risky behaviors. Burke et al. [14] showed that smoking was a primary indicator of health-related behaviors, but used only 18-year-old Australians rather than formidable adolescents, while Laska, et al. [20] focused on college students. Others have specifically focused on aspects of health such as physical activity [26], parental characteristics [27] or self-injurious actions [28]. Fewer studies have taken a person-centered approach to investigate the associations between health behaviors to identify potential behavioral typologies among adolescents.

This analysis examines a nationally representative group of adolescents age 10 to 19, focusing on health and risk-related behaviors. Using twelve different areas of health-enhancing behaviors, this study analyzes intrinsic individual motivation towards health as expressed by these behaviors. Differing from other similar analyses, this study focuses on those behaviors of the adolescents themselves, but controls for household and parental characteristics. The present paper examines how cigarette smoking, alcohol consumption, sleep patterns, exercise habits, presence of body tattoos, drug use, television watching, sexual activity, diet, and seatbelt and helmet wearing to characterize health behaviors [29,30] that can be used to identify homogeneous, mutually exclusive behavioral typologies. Furthermore, it illustrates the demographic composition of each class and the extent to which parental/household characteristics contribute to class membership. Finally, intertemporal modeling shows the degree to which these behavioral typologies determine various types of adult success.

Methods and Data

This work attempts to identify characteristic adolescent health typologies and assess how well these typologies predict various adult success outcomes. Data from the National Longitudinal Study of Adolescent Health (Add Health) Restricted Use Sample-a nationally representative sample of adolescents age 10 to 19 years old-is used to assesses the classification of health behaviors and predict adult success. Add Health was created to help research the causes of adolescent health and health behavior with a special emphasis on the effects of multiple contexts of adolescent life [31]. Add Health was collected in waves occurring between the ages of 12 to 17 and 24 to 32. During each wave, respondents were surveyed in their homes to collect data on respondents' social, economic, psychological and romantic well-being with contextual data on the family, neighborhood, community, school, and relationships, providing unique opportunities to study how social environments and behaviors are linked to health outcomes.

While one's motivation to be healthy cannot be directly observed, their health-related behaviors can. Twelve primary health behaviors are used to analyze typologies-1) wearing a helmet on a bike, 2) wearing a seatbelt in the car, 3) sleeping a sufficient amount, 4) exercising regularly, 5) experimentation with tobacco, 6) experimentation with alcohol, 7) experimentation with marijuana, 8) having sexual intercourse, 9) trading sex in exchange for drugs or money, 10) having a body tattoo, 11) watching television and 12) eating vegetables daily. Each behavior was dichotomized for ease of interpretation and transparency. Response patterns to these behaviors are used to place respondents into classes based on their tendency profiles. Survey items used to characterize health behaviors are listed in (Table 1). Responses to these 12 behavioral health items are listed in (Table 2). As expected, about half of respondents have tried alcohol and cigarettes, but very few have a tattoo or have traded sex for drugs or money. Three-quarters of men and women exercise regularly, get enough sleep and eat vegetables. Over 80 percent watched television less than five times last week and most wear a seatbelt when riding in or driving a car.

Adolescent Health Related Behaviors	
Behavior	Context
Alcohol	1=Consumes alcohol 2 to 3 days per month or less
	2= Consumes alcohol 1 or 2 times per week or more frequently
Cigarette Smoking	1=Has tried smoking a cigarette, at least 1 or 2 puffs
	2=Has never tried smoking a cigarette, not even just 1 or 2 puffs
Sleep	1=Usually gets enough sleep
	2=Does not usually get enough sleep
Exercise	1= During the past week, exercised three times or more (exercises such as jogging, walking, karate, jumping rope, gymnastics or dancing)
	2=During the past week, exercised two of fewer times
Tattoos	1=Has a permanent tattoo
	2=Does not have a permanent tattoo
Helmet	1= Wears a bike helmet regularly
	2= Does not wear a bike helmet regularly
Seatbelt	1=Wears a seatbelt in the car regularly
	2= Does not wear a seatbelt in the car regularly
Vegetables	1=Ate vegetables yesterday
	2=Did not eat vegetables yesterday
TV/Video Games	1=Watched TV/played video games >=5xs last week
	2=Watched TV/played video games<5xs last week
Sexual Intercourse	1=Has had sexual intercourse
	2=Has never had sexual intercourse
Marijuana	1=Has tried marijuana on at least one occasion
	2=Has not tried marijuana
Money for Sex	1=Has accepted drugs or money in exchange for sex

Table 1: Dichotomized Health Behaviors.

Health Behavior Response Profiles					
		Strata	4	Strata	4
		Clusters	132	Clusters	131
		N	10263	N	10480
		Male		Female	
		Percent	Std Err	Percent	Std Err
Helmet	(Yes)	5.8227	0.6041	5.5499	0.6644
	(No)	94.1773	0.6041	94.4501	0.6644
Seatbelt	(Yes)	66.3052	1.4503	76.2138	1.3253
	(No)	33.6948	1.4503	23.7862	1.3253
Sufficient Sleep	(Yes)	76.6921	0.8133	70.8549	0.9952
	(No)	23.3079	0.8133	29.1451	0.9952
Regular Exercise	(Yes)	73.8635	0.9176	60.4284	1.1659
	(No)	26.1365	0.9176	39.5716	1.1659
Tried Smoking	(Yes)	58.3303	1.1459	58.3126	1.3601
	(No)	41.6697	1.1459	41.6874	1.3601
Tried Alcohol <2-3 times/month	(Yes)	57.4816	1.3692	55.8764	1.5531
	(No)	42.5184	1.3692	44.1236	1.5531
Tried Marijuana	(Yes)	29.3725	1.344	25.6649	1.2798
	(No)	70.6275	1.344	74.3351	1.2798
Had Sexual Intercourse	(Yes)	39.0173	1.6882	36.2096	1.8145
	(No)	60.9827	1.6882	63.7904	1.8145
Exchanged Sex for Drugs or Money	(Yes)	1.9046	0.2019	0.7209	0.1164
	(No)	98.0954	0.2019	99.2791	0.1164
Has a Body Tattoo	(Yes)	5.2703	0.4819	4.2576	0.3772
	(No)	94.7297	0.4819	95.7424	0.3772
TV/Video Games >5xs Last Week	(Yes)	18.159	0.7283	21.4773	0.794
	(No)	81.841	0.7283	78.5227	0.794
Ate Vegetables Yesterday	(Yes)	68.298	0.9036	67.626	0.8815
	(No)	31.702	0.9036	32.374	0.8815
All estimates are weighted using cross sectional sampling weights Respondents clustered by school identifier and stratified by region					

Table 2: Health Behavior Response Profiles.

Respondent demographic controls utilized in the analysis include age, race, ethnicity and urban/rural status. Given the close ties between adolescents and parents, parental controls including parental education, parental employment status, parental age and parental marital status are also included. Additionally, situational controls including household size, presence of smoking in the household and presence of alcohol in the household are also included. These mean values are listed in (Table 3). Households are, on average, composed of four individuals but range from one to six. Twenty-percent of the sample is black and 10 to 12 percent are Hispanic. Thirty percent of respondents reside in rural areas and nearly half, 45 percent, contain at least one cigarette smoker. Simple statistics for demographic controls are given in (Table 3).

Add Health Wave I and Wave IV Respondent Data				
	Male		Female	
	Mean	Std Dev	Mean	Std Dev
Age Wave I	14.843	0.129	14.669	0.123
Black	0.172	0.022	0.183	0.022
Hispanic	0.152	0.019	0.147	0.018
Urban	0.671	0.027	0.661	0.027
Rural	0.716	0.024	0.721	0.025
BMI Wave IV	28.185	0.117	28.263	0.184
Household Size Wave IV	2.374	0.039	2.587	0.044
Evidence of Smoking in HH	0.761	0.012	0.764	0.012
Evidence of Drinking in HH	0.961	0.003	0.963	0.004
Responding Parent Complete HS	0.277	0.015	0.292	0.015
Responding Parent Work	0.272	0.011	0.275	0.01
Responding Parent Married	0.276	0.014	0.289	0.012
Responding Parent Age	41.546	0.172	41.297	0.207
Biological Father in HH	0.411	0.015	0.433	0.013
	N=9288		N=9634	
All estimates are weighted using cross sectional sampling weights Respondents clustered by school identifier and stratified by region				

Table 3: Sample Demographic Characteristics.

In this research, I hypothesize that individuals have an underlying desire to be healthy. This health motivation varies among individuals and cannot be directly observed. However, it manifests in meaningful patterns of health behaviors (i.e. sleep, cigarette smoking, etc.). This analysis identifies the underlying motivation for health based on responses to the twelve health behaviors identified above. While there are several empirical methods capable of classifying adolescents based on response data, this analysis utilizes Latent Class Analysis (LCA). LCA is a statistical tool used to identify homogeneous, mutually exclusive groups (or "Classes") that exist within a heterogeneous population. Numerous examples of its application, particularly in identifying latent behavioral patterns, have been recently published [32-36].

LCA is similar to cluster and factor analysis. The main difference is that factor analysis has to do with correlations between variables, while LCA is concerned with the structure of groups (or cases). Another difference is that LCA includes discrete latent categorical variables that have a multinomial distribution. Factor analysis uses continuous latent variables that have a normal distribution [37]. LCA examines qualitative differences between groups of people, while factor analysis identifies how people or objects differ qualitatively along one or more continua. LCA is a newer methodology, which grew out of the social sciences, where many variables are not found on a continuum. LCA gives scientists a way to limit these typologies to those combinations of interest.

To study the underlying health motivation of adolescents using LCA, a series of LCA models were fit using SAS version 9.4 (Release 9.4. Cary, NC: SAS Institute Inc.) PROC LCA command procedure [38]. PROC LCA produces maximum likelihood estimates for parameters using the EM algorithm. Missing data on individual survey items is handled within the EM algorithm and is assumed to be missing at random [38]. To select the appropriate number of classes and maximize model fit, a two-class model was first fit to the data and compared with successively fit models which specified an increasing number of latent classes (up to six classes). Classes were added to the model until no further statistical and theoretical improvements were observed. Model fit was evaluated empirically using the Akaike Information Criterion (AIC), with lower values reflecting an improved fit. The AIC criteria is a widely accepted for LCA methods [38,39]. The AIC criteria across models fit was examined separately for males and females. The most parsimonious LCA model was retained.

Since Add Health survey design involves multistage sampling, unequal probabilities of selection of the observations and stratification occurred. Therefore, observations were weighted using cross-sectional sample weights intended to reflect adolescents who were enrolled in US schools during the 1994-1995 academic year. Finally, race, ethnicity, rural/urban status, smokers in the household, drinkers in the household, parental age, parental marital status and parental income were included as a covariate. Given the known differences in prevalence and patterning of health behaviors between males and females, analyses were stratified by gender. Of the 6504 male and female survey respondents, four were missing age and gender, and were excluded in the analysis. Five hundred iterations of each model were run using various randomly generated

seed values to ensure that the solution was correctly identified. The resulting fit criterion values were compared across the 100 iterations; the dominant solution-the most frequently generated-was identified as the maximum likelihood solution.

Once the optimal number of classes were determined and the model was fit, each respondent was assigned to a particular category based on their characteristic behavior. These classes were then used in the final stage of analysis to determine the relationship between adolescent health behaviors and adult success outcomes. Adult success can be measured in a variety way using many different social capital metrics. To capture various types of success, this paper utilizes survey items that capture various types of adult success. These items include income, number of close friends, number of romantic cohabitating partners, income and feeling happy. They are intended to measure success in the workforce, classroom, personal relationship, lifestyle and physical fortitude respectively. Mean values of these success metrics are listed in (Table 4) along with other Wave IV demographic controls.

Wave IV Adult Success Outcomes and Demographic Control Variables					
		Male		Female	
Variable	Range	Mean	Std Err	Mean	Std Err
Household Income Level	01-Dec	8.187	0.079	7.824	0.089
Highest Educational Level to Date	Jan-13	5.327	0.091	5.832	0.083
# Partners Ever Lived With	0-20	0.938	0.033	0.796	0.024
# Partners Ever Married	0-3	0.445	0.018	0.571	0.018
General Physical Health	01-May	2.303	0.021	2.387	0.026
# Sexual Partners Ever	01-May	2.846	0.053	2.871	0.045
Seldom feel blue	01-May	2.699	0.023	2.796	0.02
Number of friends	01-May	3.195	0.028	3.066	0.025
Happy days last week	01-Mar	2.152	0.016	2.159	0.015
Household Size	Jan-16	2.359	0.043	2.562	0.049
BMI Wave IV	12.5-55.5	28.188	0.155	28.279	0.199
All estimates are weighted using cross sectional sampling weights Respondents clustered by school identifier and stratified by region					

Table 4: Wave IV Adult Success Outcomes and Demographic Control Variables.

Income is categorized into intervals denoted one through twelve. One represents less than $5,000 annually, while twelve represents $150,000 or more annually. The average income is roughly eight for both genders-$40,000 to $49,999 annually. Educational level is captured using discrete values one through thirteen with one being less than an eighth-grade education and thirteen representing education beyond a bachelor's degree. Men and women average between five a six-vocational training or some college. Relationship success is capture by the number of romantic of sexual partners the respondent has lived with for more than one month. Since many social groups choose to cohabitate rather than marry, this metric is intended to capture endured, personal

and romantic success. A higher number of cohabitating individuals likely represents shorter, more tumultuous romantic relationships. While smaller numbers likely show stability and commitment. Both men and women average one individual suggesting a stable relationship status. Since romantic success can be independent of physical or sexual satisfaction, the number of sexual partners is also included as an outcome measure. Social success is measured by the number of close friends the respondent reports having. Finally, overall happiness is assessed from reports of dis/agreeance with the statement "I seldom feel blue." Respondents can select from strongly agree, agree, neither agree or disagree, disagree or strongly disagree. The average is 3 to 4-either neutral or agreement with the statement.

All measures of adult success are categorized by a finite number of discrete, censored values. Therefore, a limited dependent variable model is appropriate. The goal is to calculate the relationship between the number of cohabitating partners and the covariates, controlling for selection into the world of romantic, dating involvement and bounded by an upper limit. Logistic regression analysis is often used to investigate the relationship between such discrete categorization responses and a set of explanatory variables. These models assume that the response variable is linearly related to the explanatory variables through a link function which the statistician can specify. The SAS SURVEYLOGISTIC procedure fits linear logistic regression models for discrete response survey data by the method of maximum likelihood. For statistical inferences, PROC SURVEYLOGISTIC incorporates complex survey sample designs, including designs with stratification, clustering, and unequal weighting. The maximum likelihood estimation is carried out with the Newton-Raphson algorithm. In addition, sampling weights and cluster specifications control for race, ethnicity, BMI and household size which are included in the model.

Results

The AIC comparisons of relative fit showed that four latent classes of health behavior provided optimal model fit and parsimony. Given the differences in male and female adolescents, it is possible to utilize a grouping function so that gender-specific parameters are estimated [38]. Thus, probability estimates can vary by gender. To test whether gender-specific parameters or gender-invariance were appropriate, a four-class model had been selected and two nested. Then, multi-group LCA procedures were compared, one freely estimated model and one with parameter estimation restricted across genders. Comparison of the fit statistics across the restricted and unrestricted models indicated that measurement invariance should be rejected, and gender-specific parameters should be estimated.

(Table 5) shows the latent class model estimation results by gender for the 12 behavioral parameters. By using categorical behavioral indicators, the latent class model has the advantage of making no assumptions about the distributions of the indicators other than that of local independence; that is, the assumption that within a latent class the indicators are independent. The following sets of parameters are estimated; γ parameters, which represent latent class membership probabilities, ρ parameters, which are item-response probabilities conditional on latent class membership and β parameters which are logistic regression coefficients for covariates,

Latent Class Analysis of Adolescent Health Behaviors										
	Response Category	Class 1	Class 2	Class 3	Class 4	Response Category	Class 1	Class 2	Class 3	Class 4
	Male					Female				
Latent Class Membership Probabilities										
		0.243892	0.23772	0.233628	0.28476		0.29813	0.248475	0.216177	0.237218
Logistic Regression Coefficients for Covariates										
			-2.24974	6.926674	8.082592			-0.02806	4.489054	9.012973
Black			1.605902	-1.56988	-1.97353			0.835776	-1.29758	-2.51718
Hispanic			0.078276	-0.44307	-0.47288			-0.06556	-0.3068	-1.10122
Smoking in Household			-0.16905	-1.28697	-0.75787			-1.08064	-1.9497	-1.63284
Alcohol in Household			-1.26406	-1.52367	-1.18497			-0.78462	-0.86234	-0.76569
Highest Parental Education			0.347083	0.963406	1.385118			0.149503	0.882023	1.289379
Responding Parent Works			-0.2666	-0.03738	0.301486			-0.20251	-0.10677	0.174438

Responding Parent Married			0.523072	1.135903	0.752567			0.543558	0.971522	0.742896
Responding Parent Age			0.029135	0.032227	0.000734			0.026747	0.02359	0.004294
Urban Resident			0.106973	-0.33866	-0.52739			0.124653	-0.18191	-0.40667
Rural Resident			-0.19554	-0.67364	-1.01527			-0.00028	0.356891	-0.21738
Item-Response Probabilities Conditional on Latent Class Membership										
Bicycle Helmet	1	0.173374	0.047749	0.006963	0.004583	1	0.173374	0.047749	0.006963	0.004583
Seatbelt in Car	1	0.947535	0.794138	0.521704	0.581334	1	0.947535	0.794138	0.521704	0.581334
Sufficient Sleep	1	0.833556	0.722086	0.624788	0.778138	1	0.833556	0.722086	0.624788	0.778138
Exercise Regularly	1	0.760064	0.73705	0.56723	0.644894	1	0.760064	0.73705	0.56723	0.644894
Tried Cigarettes	1	0.18444	0.92227	0.911908	0.366457	1	0.18444	0.92227	0.911908	0.366457
Tried Alcohol	1	0.168107	0.902749	0.922857	0.322309	1	0.168107	0.902749	0.922857	0.322309
Tried Marijuana	1	0.001498	0.360389	0.757103	0.037406	1	0.001498	0.360389	0.757103	0.037406
Had Sexual Intercourse	1	0.028071	0.303863	0.871915	0.317733	1	0.028071	0.303863	0.871915	0.317733
Trade Sex of Drugs/Money	1	0.001506	0.000269	0.046952	0.007245	1	0.001506	0.000269	0.046952	0.007245
Body Tattoo	1	1.69E-07	0.014284	0.144653	0.020358	1	1.69E-07	0.014284	0.144653	0.020358
Watch TV/Video Games	1	0.18852	0.193724	0.233449	0.138313	1	0.18852	0.193724	0.233449	0.138313
Eats Vegetables	1	0.815127	0.763066	0.572978	0.559088	1	0.815127	0.763066	0.572978	0.559088
Bicycle Helmet	2	0.826626	0.952251	0.993037	0.995417	2	0.826626	0.952251	0.993037	0.995417
Seatbelt in Car	2	0.052465	0.205862	0.478296	0.418666	2	0.052465	0.205862	0.478296	0.418666
Sufficient Sleep	2	0.166444	0.277914	0.375212	0.221862	2	0.166444	0.277914	0.375212	0.221862
Exercise Regularly	2	0.239936	0.26295	0.43277	0.355106	2	0.239936	0.26295	0.43277	0.355106
Tried Cigarettes	2	0.81556	0.07773	0.088092	0.633543	2	0.81556	0.07773	0.088092	0.633543
Tried Alcohol	2	0.831893	0.097251	0.077143	0.677691	2	0.831893	0.097251	0.077143	0.677691
Tried Marijuana	2	0.998502	0.639611	0.242897	0.962594	2	0.998502	0.639611	0.242897	0.962594
Had Sexual Intercourse	2	0.971929	0.696137	0.128085	0.682267	2	0.971929	0.696137	0.128085	0.682267
Trade Sex of Drugs/Money	2	0.998494	0.999731	0.953048	0.992755	2	0.998494	0.999731	0.953048	0.992755
Body Tattoo	2	0.785234	0.985716	0.855347	0.979642	2	0.874213	0.985716	0.855347	0.979642
Watch TV/Video Games	2	0.81148	0.806276	0.766551	0.861687	2	0.81148	0.806276	0.766551	0.861687
Eats Vegetables	2	0.184873	0.236934	0.427022	0.440912	2	0.184873	0.236934	0.427022	0.440912
All estimates are weighted using cross sectional sampling weights										

Table 5: Latent Class Analysis of Adolescent Health Behaviors.

The top portion of the table represents the probability for membership in each class. Note that the probabilities differ by gender. Males have a 23 to 24 percent chance of being in classes 1, 2 and 3, but closer to a 30 percent chance of being in class 4-the largest of the four probability values. Women, however, have nearly a 30 percent chance of typifying class 1 behaviors and smaller likelihoods of other groups. This suggests not only the females tend to adhere to healthier behaviors during adolescence, but also that males largely adhere to unhealthy lifestyles.

Behavioral classes displayed varying degrees of healthy behavior. Class one, healthy, consists of respondents who adhere to the healthiest behaviors primarily avoiding unhealthy habits. Class two, moderately healthy, consists of individuals who are primarily healthy, but occasionally falter in their commitment to a healthy lifestyle. Classes three, moderately unhealthy, consists of Individuals who frequently appear largely unhealthy and, class four, elects less healthy lifestyle choices most frequently. The first portion of the table lists the covariate coefficients. Covariates were modeled using a logistic link function, producing a set of logistic regression coefficients that show how the covariates predict subgroup membership [40]. These coefficients (when exponentiated and transformed into an odds ratio) are associated with an increase (or decrease) in odds of membership relative to the reference class corresponding to a different level on the covariate.

The standard interpretation of the ordered logit coefficient is that for a one-unit increase in the predictor, the response variable level is expected to change by its respective regression coefficient in the ordered log-odds scale while the other variables in the model are held constant. All variables represent comparative odds of class membership relative to class 1-the reference group. While the regression coefficients are not very intuitive, they do provide important demographic controls for the estimation of latent classes. They also indicate that class membership is relatively heterogeneous regarding residence, race and ethnicity. Parental factors appear to be largely deterministic and indicative of adolescent behavior. For example, households with evidence of alcohol or cigarette consumption are more likely to contain youth in the less healthy classes. Alternatively, adolescents in household with married, relatively older parents are less likely to be in class 4. Interestingly, having a responding parent who works outside the home increases the likelihood of class 4 substantially. Perhaps the absence of a parental figure in the household reduces attention to health and a healthy lifestyle.

The final panel of the table shows the males and female response probabilities for each item and class. For example, an individual in class 1 has a 94 percent probability of wearing a seatbelt in the car. Alternatively, a member of class 1 has a 17 percent probability of wearing a helmet while biking, compared to only a 0.46 percent chance if they are a member of class 4. While these response probabilities follow the expected results, they illustrate two important facts. First, the individuals in the healthy groups follow healthy lifestyles and avoid risky behaviors and substance. Second, they show the large differences in behavior between the four groups, illustrating that at least some adolescents are aware of how behavior can impact lifelong health.

Finally, based on these probabilities and their response behaviors, each adolescent is assigned a class based on their likelihood of membership. Their assigned class is broken down by demographic component in (Table 6). Thirty percent of females adhere to healthy behaviors, compared to only 26 percent of males. Furthermore, 29 percentage of males are classified as unhealthy compared to only 22 percent of females. These differences justify the rejection of gender invariance discussed above.

Health Class Size and Distribution by Gender			
Health Behavior Class	Class	Percent	Std Err
	Male		
Healthy	1	26.0531	1.4456
Moderately Healthy	2	22.8698	1.2944
Moderately Unhealthy	3	22.3857	1.4765
Unhealthy	4	28.6915	1.5715
	Female		
Healthy	1	31.7087	1.6377
Moderately Healthy	2	24.193	1.1278
Moderately Unhealthy	3	22.2547	1.3977
Unhealthy	4	21.8436	1.6762
All estimates are weighted using cross sectional sampling weights Respondents clustered by school identifier and stratified by region			

Table 6: Health Class Size and Distribution by Gender.

Finally, the relationship between these classes calculated from Wave I respondent behaviors and Wave IV outcomes are examined. Recall that Wave I is the first year of the Add Health survey collected in 1994 and 1995. Wave IV was collected on the original Wave I respondents in 2008 when they were 24 to 32 years old. To assess the relationship between behavioral classes and adult success outcomes, this study utilizes five adult outcomes which capture various forms of success. In order to assess romantic, social, earnings, relationship and emotional success, this study utilizes five separate elements from the Add Health survey. Each success element is assessed in a separate regression and males and females are analyzed separately controlling for age, race, ethnicity, household size and Body Mass Index (BMI).

(Table 7) presents all success outcome regressions. Income is negatively related to behavioral class. In other words, as income increases respondents are more likely to fall in a healthy class. Classes 1 and 2 represent very healthy and moderately healthy classes respectively. These individuals are more likely to earn higher incomes later in life. Age and household size are positively related to income, while being black is associated with lower. For women, BMI and income are negatively related suggesting that those with higher BMI earn less than those with lower BMI.

Adult Outcome								
	Household Income Category				Romantic/Sexual Partners Cohabitated > 1 Mon			
		Male		Female		Male		Female
N		2898		3664		2892		3662
Log Likelihood		-5923		-7659		-2526		-3102
AIC		11883		15354		5070		6222
Schwarz		11990		15466		5124		6278
Parameter Estimates								
Parameter	Estimate	Std Dev	Estimate	Std Dev	Estimate	Std Dev	Estimate	Std Dev
Intercept1	2.402395***	0.397576	2.658289***	0.305444	2.489416***	0.368163	2.134567***	0.332653
Age	0.097436***	0.018975	0.036427**	0.017537	-0.08036***	0.021415	-0.10785***	0.019705
Household Size	0.062476*	0.02704	0.032583	0.022522	-0.060075	0.029255	-0.00942	0.023787
Black	-0.389613	0.104895	-1.044893***	0.09243	0.359343***	0.113447	-0.220665**	0.101558
Hispanic	0.035139	0.113528	0.266252**	0.100843	-0.244489*	0.128393	-0.236877**	0.114296
BMI	0.002796	0.005264	-0.028828***	0.003891	-0.153992***	0.017024	-0.119981***	0.01338
Income					-0.009977*	0.005985	-0.01174**	0.004463
Wave 1 Latent Class	-0.083122	0.031453	-0.098352***	0.031018	0.150158***	0.034697	0.333585***	0.034446
Intercept	2 0.899549***	0.183493	0.746074***	0.079181	2.565791***	0.072199	2.769885***	0.069727
Intercept	3 1.849073***	0.21876	1.457515***	0.09614				
Intercept	4 2.424286***	0.227614	1.873075***	0.101251				
Intercept5	2.905281***	0.231887	2.303512***	0.104733				
Intercept6	3.417484***	0.234688	2.677104***	0.106887				
Intercept7	4.127797***	0.236986	3.266836***	0.109484				
Intercept8	4.724665***	0.23823	3.833869***	0.111518				
Intercept9	5.793704***	0.240116	5.094722***	0.11626				
Intercept10	6.877178***	0.24292	6.098422***	0.121737				
Intercept11	8.279222***	0.252325	7.528407***	0.139104				
All estimates are weight using cross sectional sampling weights Respondents clustered by public school district identifier Data stratified by region Significance level: ***=99%, **=95%, *=90%								

Table 7: Adult Outcome.

The total number of romantic/sexual partners with which the respondent has cohabitated for longer than one month is positively related to class-those with more cohabitating partners are more likely to be in a higher, unhealthy behavioral class. While this may seem counterintuitive, more cohabitating partner signifies a higher number of romantic relationships, likely shorter in duration and possibly more tumultuous. A larger number of partners could signify more frequent break-ups or ill-designed decisions to cohabitate with romantic partners. Age is negatively related to number of cohabitating partners suggesting that older individuals are more likely to have stable, long term relationships. Blacks have a higher number of partners and Hispanics have a lower number. As household size and BMI go up, number of partners decreases, as expected. The same relationships are observed when number of sexual partners is used as the dependent variable, suggesting less stable, shorter-term relationships.

Social success is evaluated as the number of close friends' respondents report to having. Logically, those with more friends experience a higher level of social success. Latent behavioral class is inversely related to number of friends-those with more friends have healthier behavioral tendencies or experience higher levels of social success. Finally, respondents assess how strongly they agree with the statement, "I seldom feel blue." Selections include values from one indicating strong agreement to five representing strong disagreement. Using this rubric in the model, the analysis shows that disagreement is positively related to class. Thus, those at high, unhealthy classes are more likely to disagree or strongly disagree. These results suggest that those with healthier behaviors are more likely to agree with the statement that they seldom feel blue, suggesting that healthy class membership is related to happiness or satisfaction. In general, these outcome regressions suggest that adolescent behavioral class is related to adult success, happiness or satisfaction. Intuitively, health stock is an initial endowment that can be either enhanced or deleted through healthy behaviors. Those adolescents who maintain or grow their health capital, are more likely to experience success in a variety of different areas as adults.

However, it is important to mention several limitations that should be taken into consideration when interpreting these results. Adolescence is a very dynamic time in life when many types of changes are occurring simultaneously. It is not possible to account for all the physical, emotional and environmental dynamics occurring during these years. Second, while adolescence is defined as age 10 to 19, this is a large age range. Young adolescents could potentially be quite different from older adolescents. Despite testing the impact of age via covariate inclusion, results could be difficult to generalize.

While dichotomizing behavioral variables is an approach often taken in this type of analysis and makes interpretability and communication of results easier, it may obscure details within the data. Furthermore, heterogeneity of parental figures cannot be fully accounted for. Parenting styles undoubtedly play a role in adolescent behavior, but they cannot be fully observed and controlled. Finally, as is always the case with survey data, response rates can vary among groups. While sample weights are used to mitigate variability, missing data is always a factor. Much additional research is needed to understand the lifestyles and health behaviors of these populations.

Discussion and Conclusion

This analysis assessed the intertemporal relationship between adolescent health behavior and various forms of adult success. Using 12 dichotomous health behavior variables, latent class analysis assigned respondents. LCA revealed that the 4-class solution provided the best fitting model for both males and females. Indices of model fit were found to be acceptable and latent classes represented meaningful groups that provided more detail than previous investigations. Classes represented varying degrees of health and health awareness. Class 1, very healthy, contained the healthiest individuals who adhere primarily to healthy practices while avoiding risk. Class 2, moderately healthy, represented a mix of healthy and risky behaviors. Class 3, moderately unhealthy, also contained individuals who adhered some healthy practices, but also frequently engaged in risky behaviors. Class 4 was the least healthy class with respondents frequently engaging in risky behaviors and making poor health choices.

The largest class of males was Class 4, while the largest among females was Class 1. In general, as individuals age, they tend to take more risks and engage in more unhealthy detrimental behavior. Adolescents in household where drinking and smoking are common, parents are unmarried and parents work outside the home are less likely to display healthy behaviors. Controlling for parental characteristics and behaviors is important given that adolescents often live with one or more parental figures and their lives are shaped by these household influences.

This analysis extended beyond previous studies in that it included both health and risk-taking behaviors into a unique model framework. Also, it analyzed only the behavior of respondents themselves, but included parental and household characteristics as controls. Laska, et al. [20] described patterns of behaviors and lifestyle characteristics among college youth. They linked an array of factors such as diet, physical activity, stress, sleep, tobacco use, high-risk alcohol use and risky sexual behaviors. They found four distinct groups among males and females but showed that class membership by gender was not equivalent. Connell et al. [19] characterized four classes of substance use and sexual risk behaviors for high school youth. These classes did not vary by gender and were closely related. Finally, Klonsky, et al. [28] used LCA to identify four subgroups of self-injurers when comparing measures of depression, anxiety, borderline personality disorder,

and suicidality.

The current study has several limitations that should be noted. First, this analysis did not distinguish voluntary behaviors from parental induced or encouraged behaviors. For example, adolescents might not have chosen to wear braces and undergo orthodontic care if left up to their own discretion; however, parental encouragement and facilitation of orthodontic work could have results in braces. Additionally, because the probability of membership in a class did not equal 1 for everyone, there is some uncertainty associated with assigning individuals to their respective latent class. Because this uncertainty was not modeled in the multinomial logistic regression, it is important that the results be interpreted as such. Nonetheless, these analyses have shown the merits of LCA for identifying and describing groups of adolescents based on their health-related behaviors and have provided potential contextual explanations for the patterns observed.

This study extended beyond that of previous analyses to include the relationship between these adolescent latent classes and adult success outcomes. Given that Waves I and IV of the Add Health data include the same respondent pool, it was possible to analyze the intertemporal relationship between health behavior and success on an individual level. Five survey elements-number of sexual partners, number of cohabitating romantic partners, number of friends, earnings and agreement that one rarely feels blue-capture various aspect of success and satisfaction. Each of these items was significantly related to various demographic controls as well as the latent class. In general, individuals who display more healthy behaviors as adolescents have higher earnings, more friends, more stable, long term relationship and report seldom feeling blue. While this analysis cannot directly link these behaviors to the adult outcome, the strong, intertemporal relationship suggests that the underlying motivation behind these behaviors does manifest in adulthood.

The strengths of this study include the relatively generous size of the sample, which includes an even distribution of males and females that span ages 12 to 17 in Wave I and 24 to 32 in Wave IV. A variety of healthy related and risky behaviors were measured covering many aspects of health including wearing a helmet, substance use, diet, sleep patterns and personal habits. In addition, while cross-sectional analyses are typically viewed as a limitation in observational research, in LCA, the latent variable is assumed to be static or unchanging making the use of one wave of cross-sectional data appropriate. The categorization and characterization of adolescent behavior, holding constant parental attributes, provides information important for the development of intervention and education strategies. Given the significant concern regarding the high prevalence of risky behaviors, obesity and sleep deficiency youth, these findings may be useful as part of the empirical basis in the guidance and planning of tailored interventions based on patterns of behaviors.

Furthermore, the strong relationship between these adolescent behavioral groupings and adult outcomes underscores the importance of habit formation. Habits are learned patterns of behavior that, from practice, become embedded in individual behavior. Habits, both healthy and unhealthy, are performed unmindfully with a minimum of conscious thought. The establishment of healthy habits at an early age, therefore, will ensure adherence throughout life. The impact of these healthy behaviors extends beyond purely mental and physical health, into other areas including work force, social and romantic arenas.

This study was the first to classify adolescents by their own health behavior and relate these behaviors to adult success. While adolescents are not typically predictable, the emphasis on healthy and risk minimizing behaviors by some suggests an individual awareness of behavioral impacts. These findings have important implications for targeting much needed health promotion strategies among adolescents themselves. Since adolescents age 12 to 17 who displayed healthy behaviors achieved greater success in adulthood, the motivation and encouragement of healthy practices early in life is pivotal. Since adolescence is the time when diet, physical activity, sedentary behavior and psychological health is established, the changes that occur during these years can determine the trajectory of personal health and individual success over the lifespan [41,42].

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