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Emerging Adulthood, Emergent Health Lifestyles: Sociodemographic Determinants of Trajectories of Smoking, Binge Drinking, Obesity, and Sedentary Behavior

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Abstract

During the transition to adulthood, many unhealthy behaviors are developed that in turn shape behaviors, health, and mortality in later life. However, research on unhealthy behaviors and risky transitions has mostly focused on one health problem at a time. In this article, we examine variation in health behavior trajectories, how trajectories cluster together, and how the likelihood of experiencing different behavior trajectories varies by sociodemographic characteristics. We use the National Longitudinal Study of Adolescent Health (Add Health) Waves I to IV to chart the most common health behavior trajectories over the transition to adulthood for cigarette smoking, alcohol consumption, obesity, and sedentary behavior. We find that health behavior trajectories cluster together in seven joint classes and that sociodemographic factors (including gender, parental education, and race-ethnicity) significantly predict membership in these joint trajectories.

Keywords

health behaviors, latent class analysis, obesity, sociodemographic factors, transition to adulthood

The transition to adulthood is a critical period of development in which many health practices are adopted or discarded, influencing subsequent behavioral and health trajectories (Harris et al. 2006; Schulenberg, Maggs, and Hurrelmann 1999). For instance, during this time many young people experiment with cigarettes and alcohol consumption, gain significant weight, and change their physical activity practices (Kwan et al. 2012; Maggs and Schulenberg 2004; Nelson et al. 2008; Tucker, Ellickson, and Klein 2003). Health behaviors throughout the life course affect trajectories of chronic disease and mortality (Rogers, Hummer, and Nam 2000). Although much research has examined the predictors of unhealthy behaviors and behavior changes, most research focuses on one behavior at a time (Boardman and Alexander 2011; Harris, Perreira, and Lee 2009; Pollard et al. 2010; van den Bree, Whitmer, and Pickworth 2004) rather than how risk behavior trajectories cluster together over the transition to adulthood. Understanding how and why risk behavior trajectories cluster together can help us design effective interventions and

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improve theories about engagement in risky health behaviors.

There are many competing reasons to expect that health behaviors will cluster together. On the one hand, problem behavior theory and health lifestyle theory would both predict that all negative, risky behaviors would cluster together if risky behaviors result from an underlying tendency toward deviance (Jessor 1991) or set of choices that are available and socially defined to be acceptable for a status group (Cockerham 2005). If this is the case, then interventions should focus on a range of behaviors and the underlying structural, normative, and personality factors rather than each behavior in isolation. On the other hand, only certain health behaviors may be positively correlated, and others may be negatively correlated. Moreover, patterns of health behavior trajectories may differ by socioeconomic status (SES), race-ethnicity, and gender. Research to date has not addressed how health behavior trajectories cluster together and how these trajectories vary by sociodemographic characteristics.

In this article, we use Waves I to IV of the National Longitudinal Study of Adolescent Health (Add Health) to examine three questions about health behavior trajectories over the transition to adulthood. First, we chart the most common health behavior trajectories for four behaviors—cigarette smoking, binge drinking, obesity, and sedentary behavior. We focus on these four health behaviors for several reasons. These specific risk behaviors are associated with heart disease and cancer, the leading causes of mortality (McGinnis and Foege 1993; Lantz et al. 1998; Stringhini et al. 2010), and improving population health depends on reducing death rates from these main causes. These behaviors are also major determinants of preventable morbidity and mortality (Berkman and Breslow 1983; Patterson, Haines, and Popkin 1994), and they are associated with a variety of health outcomes in adulthood, as opposed to behaviors that are associated with specific conditions (i.e., drunk driving–accident mortality). Second, we examine how trajectories of these four behaviors cluster together and describe the common joint trajectories. Last, we examine how the likelihood of experiencing different behavior trajectories varies by sex, race-ethnicity, and parental education.

BACKGROUND

Clustering of Risk Behavior Trajectories and Implications for Health Disparities

During the transition to adulthood, many unhealthy behaviors are developed that in turn shape behaviors, health, and mortality in adulthood (Hawkins, Catalano, and Miller 1992). In fact, the United States has the highest rates among rich countries of risky behaviors and chronic disease incidence in young adulthood (Warren et al. 2006), which is an important contributor to the United States' comparatively low life expectancy (Preston and Stokes 2011).

Better understanding how behavioral patterns unfold jointly over time has the potential to shed new light on important health problems. For instance, alcohol and tobacco use are related (Grant 1998; Weitzman and Chen 2005), and the health consequences of this combination of behaviors may be greater than the sum of its parts (Castellsague et al. 1999; Kalman et al. 2010), though this claim is somewhat in dispute (Mukamal 2006). Similarly, being obese, sedentary, and smoking cigarettes are all risk factors for heart disease, and the combination of these behaviors may have additive or interactive effects (Kannel et al. 1986; Khot et al. 2003).[1] People who smoke and also are sedentary may also have weaker lung function than those who partake in only one of these risk behaviors (Holmen et al. 2002).

It is important to understand how and why risk behaviors are correlated and how they cluster together. Given the clear links between health behaviors and chronic disease incidence, designing effective interventions must rely on data about how patterns of risk behaviors change over age. In contrast, although previous research has contributed a great deal to our understanding of adolescent health behaviors and cross-sectional patterns, relatively few previous investigations have researched how patterns of health behavior change over the life course. Moreover, the extent to which risk behaviors are correlated and cluster together can inform program design as well as theories about engagement in risky health behaviors.

Problem Behavior Theory, Health Lifestyle Theory, and Risk Behavior Trajectories

One open question about health behavior trajectories over the transition to adulthood is how they coevolve from adolescence through the transition to adulthood. On the one hand, all negative, risky behaviors may cluster together. Two prominent theoretical traditions predict this outcome. First, *problem behavior theory* is a social-psychological framework, developed in the 1960s and since revised, that argues that risky behaviors result from a person's underlying tendency toward deviant behavior or underlying riskiness (Jessor 1991; Jessor and Jessor 1977; Osgood and Wilson 1990). Each individual is assumed to have some level of

disposition to deviance that is influenced by one's personality and perceived environment. Early tests of this framework focused on illegal, deviant behaviors (Donovan and Jessor 1985; Jessor, Chase, and Donovan 1980), but more recent studies extended the set of behaviors to include health behaviors. Even though some health behaviors are not illegal or overtly deviant, it can be argued that alcohol use, problem drinking, cigarette smoking, illicit drug use, and even overeating and obesity are all relevant if they go against social norms and prosocial behaviors of relevant institutions and larger society.

Second, *health lifestyle theory* theorizes that health lifestyles are "collective patterns of health-related behavior based on choices from options available to people according to their life chances" (Cockerham 2013:138; see also Cockerham 2000, 2005; Cockerham, Rütten, and Abel 1997). Thus, both health-promoting and health-depressing behaviors are expressions of one's habitus, which is itself the product of the interplay of choice (agency) and chance (social structure; Cockerham 2000, 2005, 2013). Social position, as manifested in one's race-ethnicity, gender, and SES, functions both to define the set of realistically available behavioral choices and to provide a code of decision making by defining behaviors considered to be (in)appropriate.

This idea of a single health-compromising lifestyle (Elliott 1993) leads to several important predictions about health behavior trajectories and how best to structure interventions. First, it would predict that all negative health behaviors cluster together. People who practice risky smoking are also likely to be obese, be sedentary, and binge drink. Second, it predicts that negative health behaviors will lead to risky trajectories across multiple behaviors. Last, it suggests that interventions that target a particular behavior without addressing the underlying deviance, personality, or environment will be unsuccessful. If this prediction is true, individuals engaging in these behaviors will be likely to display higher incidences of health problems and mortality rates as a result of health behaviors than those without this behavior pattern.

Alternative Theories of Risk Behavior Trajectories

Alternatively, it could be that only certain combinations of health behaviors are correlated. One reason for this is that there are biological links between health behaviors. For example, one's ability to do physical activity may be limited by the decreased lung capacity due to smoking, implying that these trajectories would be negatively correlated. Another reason is that common genetic influences may increase the likelihood of pursuing pairs of behaviors, such as drinking and smoking (Daw, Nowotny, and Boardman 2013). However, this is unlikely to explain all behavioral combinations. A second alternative explanation is that some groups of health behaviors may be chosen together in order to fulfill health goals. For example, one might increase physical activity, decrease drinking, and smoke in order to lose weight (Bish et al. 2005; Jeffery et al. 2000; Klesges and Klesges 1988), resulting in a combination of healthy and unhealthy behavior trajectories. A third alternative reason why all risk behavior trajectories may not all cluster together is that people may reward themselves for making one positive health behavior change with another unhealthy behavior, such as allowing oneself to smoke as a reward for exercising (Audrain-McGovern, Rodriguez, and Moss 2003).

Although there have been many studies examining one health behavior trajectory over the transition to adulthood (Oesterle et al. 2004; Pollard et al. 2010), and others have modeled an underlying latent cluster of health behaviors cross-sectionally (Marshal et al. 2009; Wang, Worsley, and Hunter 2012), far fewer examine how multiple behavior trajectories cluster together. For example, Frazier et al. (2000) examined how cigar use is correlated with other high-risk behaviors at a point in time. Previous research has also examined trends in the co-use of tobacco and alcohol in adolescence (Daw et al. 2013), but this study did not examine health behavior trajectories. Another study examined how trajectories of cannabis and alcohol use are correlated among people in Australia (Patton et al. 2007). Many studies have examined the relationship between smoking and physical activity (for a review, see Kaczynski et al. 2008). Although most studies find that smoking and physical activity are negatively correlated, some find a positive or insignificant associations (Kaczynski et al. 2008). Frech (2012) uses the Add Health data set to examine an index of six healthy behaviors over time—including getting adequate sleep and exercise, eating breakfast, maintaining a healthy weight, and not smoking or binge drinking—but not on how these separate behaviors cluster together. In our article, we use a data-driven approach to identify the most common joint trajectories of smoking, drinking, obesity, and physical activity during the transition to adulthood among a representative sample of U.S. adolescents over the transition to adulthood. We then use these results to extend explanations for how and why risk behavior trajectories cluster together.

Sociodemographic Variation in Risk Behavior and Trajectory Membership

It is well documented that there are clear differences in health behaviors by SES, race-ethnicity, and gender. However, disadvantaged groups are not more likely to be in every high-risk behavioral category. For example, blacks have lower rates of smoking in adolescence than whites and Hispanics (Ellickson, Perlman, and Klein 2003; Ellickson et al. 2004). Although smoking among low-SES groups is more common among adults (Jarvis and Wardle 1999), patterns among adolescents are less clear (Hanson and Chen 2007). Girls are less physically active than boys in adolescence and the transition to adulthood, and black and low-SES girls have higher rates of inactivity during this time (Kimm et al. 2002). There are strong, robust SES differences in overweight/obese status for girls, but for boys, these differences disappear after controlling for key confounding factors (Yang et al. 2008).

Empirical work has found some support for the idea that health behaviors might cluster differently by sex, race, and social class. For example, Zweig, Lindberg, and McGinley (2001) use the first wave of Add Health and find gender differences in the clustering of eight risk behaviors. Other research examining the relationship between smoking and physical activity found mixed results for gender differences in the correlations of these behaviors. For instance, smoking and exercise were negatively related for adolescent females but not adolescent males (Kaczynski et al. 2008). There have been far fewer studies of subgroup differences in the clustering of health behaviors by race and social class. Zweig et al. (2001) found few differences in health behavior clustering by SES using Wave I of Add Health. There is some limited evidence that the relationship between physical activity and smoking varies by education (Kaczynski et al. 2008). Boardman and Alexander (2011) document black–white differences in mental health and stress trajectories and examine racial differences in smoking, drinking, and body mass index (BMI) in response to stress, but do not examine how these behaviors cluster together. Zweig et al. (2001) found that among adolescent girls (but not boys), whites had higher risk profiles than blacks. In this analysis, we examine how the likelihood of falling into different health behavior trajectory classes differs by race-ethnicity, parental education, and gender.

Research Questions

In this paper, we address three research questions:

1. What are the most common health behavior trajectories over the transition to adulthood? We chart trajectories for cigarette smoking, alcohol consumption, obesity, and sedentary behavior.
2. How do the trajectories of these four behaviors cluster together, and what are the characteristics of these joint trajectories?
3. How does the likelihood of experiencing different behavior trajectories vary by sex, race-ethnicity, and parental education?

DATA AND METHODS

Add Health

To examine health behavior trajectories over the transition to adulthood, we used the first four waves of Add Health. These data were ideal for the project because they included questions about key health behaviors for a large, nationally representative sample of respondents at four points during the transition to adulthood; respondents were in grades 7 to 12 in Wave I and were ages 24 to 32 in Wave IV. Our analytic sample consisted of each person with valid data on the examined health behaviors in all four waves of Add Health ($N = 9{,}783$).

Measures of Health Behaviors

We charted health behavior trajectories for four behaviors—smoking, drinking, obesity, and inactivity, which are important for chronic disease development and adult health and mortality (Lantz et al. 1998; Rogers et al. 2000). Respondents were asked how often they smoked cigarettes or drank beer, wine, or liquor. Responses were "never," "once or twice," "once a month or less," "two or three days a month," "once or twice a week," "three to five days a week," or "nearly every day." For our latent class analysis (LCA), we defined these variables dichotomously. For smoking, we examined whether the respondent was a smoker or not. For binge drinking, we examined whether the respondent drank more than five drinks in a row in the past 12 months. Our measure of binge drinking has been commonly used in past research (e.g., Frazier et al. 2000; Marshal et al. 2009; Zweig et al. 2001) and captures any binge-drinking episode rather than only more frequent binge drinking, which is important when studying the drinking behavior of underage respondents. Obesity was calculated at each wave by dividing weight in kilograms by height in meters squared, with the cutoff at BMI of 30 or above. In Wave I, we used self-reported weight and height in

our calculation of BMI because that was the only measure available. Waves II and III, however, included biometric data collected by the interviewer, and we use these measures in our calculation. In Wave IV, we used the BMI measure computed by Add Health from biometric data.

Respondents were asked about different types of exercise that they did in the past week. In the first two waves, they were asked about activities such as rollerblading; bicycling; active sports, like baseball and football; cardiovascular activities, like jogging and gymnastics; and so on. Response categories were "not at all," "one to two times," "three to four times," or "five or more times per week." In Waves III and IV of the survey, a different (but similar) list of activities was employed, with a continuous responses category set from zero to seven times per week. Following past research (Berrigan et al. 2003; Frech 2012; Grobschädl et al. 2013), we estimated how many times per week respondents had exercised and converted this measure to a binary variable indicating three times a week or less.

Other Measures

Age was measured as the time in years between time of birth and time of in-home interview in Wave I. *Parental education* was measured using parent in-home interviews in Wave I and was expressed as a dichotomous variable that measured whether or not the highest educated parent has a college degree or higher. *Race-ethnicity* was measured using a two-part question: the first asked the respondent to report whether they were of Hispanic or Latino origin; the second asked the respondent to mark all racial categories that applied to them out of a list including "white," "black or African American," "American Indian or Native American," "Asian or Pacific Islander," or "Other." We combined and recoded these indicators to construct five categories: non-Hispanic white, non-Hispanic black, Hispanic of any race, Asian or Pacific Islander, or other (combining multirace, Native American, and individuals who only marked "Other").

Statistical Methods

In order to understand individual differences in separate and joint health behavior trajectories, we turned to LCA methods. LCA estimates a model with n classes and then examines the log odds of an individual i falling into a given class relative to the reference class. LCA models were estimated using the LCA Stata plugin and all models were weighted using the four-wave longitudinal weights (Lanza et al. 2011). We estimated a series of LCA models (with different predetermined numbers of classes) for each of the four health behaviors we examined, over four waves of Add Health. We also estimated a series of combined LCA models for all four health behaviors across the four waves combined. That is, we used four waves of data on four health behaviors to generate a single LCA model, which was the primary purpose of our analysis. Individual health behavior trajectories were studied to provide additional evidence on the interdependence of health behavior trajectories.

To select the preferred model in each case, we varied the number of latent classes and then selected the best-fitting identified model. We used three measures of model fit (G^2, Akaike information criterion, and Bayesian information criterion) and two indicators of model identification (degrees of freedom and percentage of seeds associated with best-fitting model). Positive degrees of freedom are a necessary but not sufficient condition for LCA model identification (Collins and Lanza 2009). As an additional check on model identification, we estimated each model with 500 randomly generated seeds and examined what percentage was associated with the same best-fitting model. This provided important information on model identification, because models in which a high percentage of seeds converges on a single solution are much more likely to represent global, rather than local, maxima of the likelihood function (Collins and Lanza 2009).

Our analysis proceeds as follows. First, we characterize the distributions of key variables and present these results in Table 1. Second, we provide a detailed look at the characteristics of the classes identified in the LCA models for each health behavior and the associated rates of unhealthy behaviors across the four waves of data in Table 2. Next, we analyze joint health behavior trajectories in three ways. First, we analyze cross-tabulations of the separate behaviors' classes (Table 3). Second, we estimate an LCA model using all four behaviors over all four waves and present the distribution of classes and the associated joint patterns of health behaviors in Table 4 (with background data bars to aid comprehension). Finally, we analyze the sociodemographic composition of classes identified in the combined LCA model using multinomial logistic regression models with robust standard errors that predict best-fitting class membership as a function of gender, parental education, and race-ethnicity (Table 5).

Table 1. Sample Characteristics of the National Longitudinal Study of Adolescent Health, 1994–2008 (N = 9,783).

Characteristic	Percent
Race (n = 9,777)	
White	69.84
Black	14.20
Hispanic	11.69
Asian	3.07
Other	1.20
Gender (n = 9,783)	
Male	50.10
Female	49.90
Parental education (n = 8,696)	
< College	67.16
College	32.84
Percent smoking cigarettes (n = 9,783)	
Wave I	25.27
Wave II	34.37
Wave III	35.16
Wave IV	38.48
Percent binge drinking (n = 9,783)	
Wave I	23.17
Wave II	29.08
Wave III	52.81
Wave IV	52.07
Percent obese (n = 9,783)	
Wave I	6.69
Wave II	9.88
Wave III	21.37
Wave IV	36.25
Percent sedentary (n = 9,783)	
Wave I	53.53
Wave II	51.66
Wave III	43.43
Wave IV	40.70

Model results are presented using model-implied predicted probabilities of class membership to assign each respondent to their best fitting class, while simultaneously controlling for the other sociodemographic characteristics.[2] We also present two separate hypothesis tests: (1) typical ones testing whether each coefficient is zero (indicated by asterisks) and (2) the results of a Wald test to determine the joint significance of a single variable across the equations (indicated by carets). Thus, for example, when the predicted probability that females are "healthy but increasingly obese" has three asterisks next to it, this indicates that the regression coefficient for female (compared to male) statistically significantly predicts membership in that group compared to the reference category of the dependent variable. In contrast, when the attribute "female" has three carets next to it, this indicates that the results of the Wald test indicate that the six female coefficients (across all nonreference categories of the dependent variable) are jointly statistically significant.

RESULTS

Descriptive Statistics

We present the sample characteristics in Table 1. The sociodemographic characteristics of our analytic sample match the secondary school-age population in the United States in 1994, our population of interest, albeit with certain oversamples (Harris 2013). Almost 7 in 10 respondents are non-Hispanic white, with about 14% black, 12% Hispanic, and 3% Asian. The sample is roughly equally likely to be female as male. Approximately one third of respondents have a parent with at least a college degree.

Table 1 also shows that there is substantial temporal variability in the proportion of the population partaking in each of the four examined risky health behaviors and much change between waves. At first interview, one quarter of respondents' smoke cigarettes, and just under one quarter binge drink. Both of these behaviors become more common as respondents age, such that at the fourth interview, 38% of respondents smoke and more than half binge drink. This large increase across waves in the proportion who binge drink is expected given our low threshold definition of binge drinking. Obesity is uncommon at first interview but increases over time from only 7% to 36% of respondents having a BMI of 30 or more between Waves I and IV. Of the four behaviors, sedentary behavior is the only risk behavior that becomes less prevalent with age, decreasing from 54% to 41% between Waves I and IV.

Individual Behavioral Classes

Second, we describe the latent behavior trajectories for the four behaviors we examine (the model selection results are shown in Appendix Table A1, available in the online version of the article). In each case, a three-class model was the best-fitting, identified model (Table 2). Across the four behaviors, the largest classes are the consistently healthy groups, each including more than half of the sample.

Table 2. Summary of Latent Classes for Four Health Behavior Trajectories from Latent Class Models in the National Longitudinal Study of Adolescent Health, 1994–2008 (N = 9,783).

		Percent Engaging in Behavior over Time			
Trajectory	Percent of Sample	Wave I	Wave II	Wave III	Wave IV
Consistently healthy					
Smoking	58.87	3.77	7.58	4.56	10.14
Binge drinking	52.27	5.79	8.58	17.42	24.58
Obesity	77.92	.16	.22	2.26	19.68
Sedentary	56.99	24.12	20.01	26.79	25.52
Consistently unhealthy					
Smoking	30.74	67.17	98.27	74.45	71.19
Binge drinking	20.60	100.00	78.78	77.26	67.35
Obesity	10.71	60.06	91.44	83.43	92.88
Sedentary	20.25	81.29	81.99	100.00	100.00
Shifting behavior over time					
Smoking	10.38	27.01	.00	90.57	100.00
Binge drinking	27.12	.00	31.22	100.00	91.25
Obesity	11.37	2.39	.00	97.61	100.00
Sedentary	22.76	100.00	100.00	33.63	25.31

Fifty-nine percent of respondents are consistent nonsmokers, 52% are low to moderate binge drinkers, almost 78% are consistently non-obese, and 57% have consistently low sedentary behavior. The second group of classes for each behavior is the consistently unhealthy group. This includes 31% of the sample who are consistent smokers, 21% who are high and steady binge drinkers, 11% who are consistently obese, and 20% who are consistently sedentary. The third set of latent classes represents classes where behaviors shift appreciably over time. For smoking, binge drinking, and obesity, this class represents respondents who become increasingly unhealthy in their behaviors over time. Ten percent of respondents are in a group with an increasing probability of smoking over time, 27% are in an increasing-binge-drinking category, and 11% have an increasing propensity to be obese over time. For the last health behavior, we see a decreasing propensity to be sedentary over time (23%).

Relationships between Individual Behavioral Classes

In Table 2, we showed that the consistently healthy and unhealthy trajectories had similar sample proportions in each group across the various health behaviors. Now, we test to what extent these health behavior trajectories cluster together. Are the same people experiencing risky trajectories across all behaviors, or do they group together in more complex ways?

Table 3 provides some preliminary evidence on this question, presented as observed-to-expected ratios, where the observed values indicate the frequency of that combination of LCA class values and the expected values are those that would be seen if the two variables were fully statistically independent, calculated as $p_x p_y N$, where p_x is the proportion of the sample in the category in question. Values >1 indicate a positive association between the categories, and values <1 indicate a negative association between the categories. These cells are grayscaled so that darker cells indicate higher values. Table 3 shows that there are substantial relationships between the examined trajectories, especially for two combinations: smoking and drinking, and obesity and inactivity. Specifically, the observed-to-expected ratio for the unhealthy trajectories for smoking and drinking are 2.14 times more common than would be expected under independence, and the unhealthy drinking–healthy smoking combination is only .52 times as common as would be expected under independence. Furthermore, the combination of unhealthy smoking and healthy drinking trajectories are observed only .61 times as often as would be expected under independence, and shifting (deteriorating) trajectories of smoking and drinking are observed 1.51 times as often as would be expected under independence. For the

Table 3. Expected-to-observed Ratios in Cross-tabulation of Assigned Classes across Health Behavior Trajectories in the National Longitudinal Study of Adolescent Health, 1994–2008 (*N* = 9,783).

		Binge Drinking			Obesity			Sedentary		
Health Behavior	Trajectory	Healthy	Unhealthy	Shifting	Healthy	Unhealthy	Shifting	Healthy	Unhealthy	Shifting
Smoking	Healthy	1.20	.52	.94	1.01	.91	1.05	.98	1.05	1.03
	Unhealthy	.61	2.14	.98	.99	1.17	.94	1.08	.87	.90
	Shifting	.85	.82	1.51	1.00	1.12	.88	.93	1.05	1.14
Binge drinking	Healthy	—	—	—	.98	1.09	1.09	1.06	.88	.95
	Unhealthy	—	—	—	1.01	.96	.95	1.06	.98	.86
	Shifting	—	—	—	1.05	.82	.82	.82	1.30	1.24
Obesity	Healthy	—	—	—	—	—	—	.96	1.04	1.07
	Unhealthy	—	—	—	—	—	—	1.19	.83	.60
	Shifting	—	—	—	—	—	—	1.09	.87	.88

Strength of Association Legend:

Table 4. Percentage Engaging in Health Behaviors by Latent Class Analysis Class and Wave in the National Longitudinal Study of Adolescent Health, 1994–2008 (*N* = 9,783).

Class Group	Class Label	Percent of Sample	Wave	Smoking	Binge Drinking	Obesity	Sedentary Behavior
Most Healthy	Consistently Healthy	19.2	I	6	4	0	19
			II	6	6	0	18
			III	2	26	1	22
			IV	7	30	22	21
	Healthy but Increasingly Obese	12.4	I	2	6	30	42
			II	5	9	44	44
			III	9	34	91	43
			IV	17	31	96	33
Smokers and Drinkers	Active, Thin Smokers and Drinkers	17.3	I	86	67	0	42
			II	92	68	0	36
			III	79	67	3	34
			IV	75	62	17	39
	Adult-onset Smoking, Drinking, and Activity	15.6	I	12	2	0	65
			II	38	15	1	67
			III	84	68	4	45
			IV	85	66	21	43
Sedentary Drinkers	Sedentary, Drinking Ex-smokers	8.7	I	23	67	1	68
			II	35	85	0	59
			III	5	78	12	58
			IV	8	76	26	59
	Adult-onset Drinking and Increased Activity	18.4	I	2	2	0	90
			II	5	3	0	91
			III	2	48	2	67
			IV	10	53	21	59
Least Healthy	Active, Increasingly Obese Smokers and Drinkers	8.5	I	62	45	34	48
			II	82	55	51	39
			III	69	62	89	39
			IV	72	54	96	36

latter two variables, the combination of consistently unhealthy obesity levels and shifting (improving) sedentary behavior is observed only .60 as many times as would be expected under independence, with weaker associations between other combinations of values. In short, there is substantial evidence that health behavior trajectories are interrelated in the transition to adulthood, especially between smoking and drinking on the one hand and obesity and sedentary behaviors on the other.

To more formally investigate this interdependence, we estimated LCA models for all four health behaviors in every wave in a single model. The best-fitting model, with seven classes, is presented in Table 4. These seven classes are further grouped into four superclasses for heuristic purposes. Table 4 also presents the probability (shown as %) of engaging in each behavior in each wave, among respondents in that latent trajectory group, with bar graphs in the background of each cell to aid the reader in visually deducing the relevant patterns. These numbers represent the levels of engagement in each risk behavior over time in each of the seven trajectory classes.

Table 4 makes it very apparent that health behavior trajectories over the transition to adulthood cluster together in important ways and that there are a wide variety of joint health behavioral paths that are relatively well populated. First, there are two joint classes whose members engage in relatively healthy behavioral profiles consistently across the life course. The first and largest group presented we label the "Consistently Healthy" group, which includes 19.2% of the sample. This

Table 5. Margins and Hypothesis Tests from Multinomial Logistic Regression Predicting Latent Class Membership in the National Longitudinal Study of Adolescent Health, 1994–2008 (N = 8,099).

	Most Healthy		Smokers and Drinkers		Sedentary Drinkers		Least Healthy
Variable	Consistently Healthy (Ref.)	Healthy but Increasingly Obese	Active, Thin Smokers and Drinkers	Adult-onset Smoking, Drinking, and Activity	Sedentary, Drinking Ex-smokers	Adult-onset Drinking and Increased Activity	Active, Increasingly Obese Smokers and Drinkers
Gender							
Male (ref.)	.128	.111	.163	.192	.104	.218	.084
Female^^^	.252	.133***	.176***	.129***	.068***	.157***	.085***
Parental education							
< College degree (ref.)	.182	.136	.182	.160	.080	.163	.097
College degree^^^	.207	.092***	.144**	.161	.100	.287*	.057***
Race							
White (ref.)	.158	.105	.203	.175	.090	.180	.089
Black^^^	.301	.194	.060***	.119***	.053***	.211***	.062***
Hispanic^^^	.216	.130	.134***	.116***	.114	.200	.090
Asian^^^	.313	.097**	.092***	.180*	.068**	.203**	.047*
Other	.175	.173	.148	.139	.053	.196	.116

Note: Conventional significance tests are shown in asterisks; Wald significance tests in carets.
*p < .05, **p < .01, ***p < .001.

group is marked by very low rates of smoking across the life course, very low rates of binge drinking and obesity in secondary school (but moderate increases in adulthood), and consistently low rates of sedentary behavior (floating around one quarter of the group in each wave). A similar but less healthy group is that which we have named the "Healthy but Increasingly Obese" class (12.4% of the sample): this group shows somewhat steeper increases in smoking and binge drinking but still relatively low prevalences thereof, as well as consistently moderate rates of sedentary behavior compared to other behavioral classes. Despite these relatively healthy behavioral profiles, however, this group shows evidence of a rapid increase in obesity across the four waves of data, to the degree that 96% of this group is obese by Wave IV.

The next group of two LCA classes we characterize as "Smokers and Drinkers" due to their relatively healthy obesity and sedentary behaviors but high prevalence of smoking and binge drinking. However, these two groups exhibit distinct patterns. The first, which we characterize as "Active, Thin Smokers and Drinkers," make up 17.3% of the sample and show consistently high prevalence of smoking and binge drinking across the four waves of Add Health. Like every group, they exhibit an uptick in obesity in Wave IV, but otherwise the health behavior profile of this group is very consistent throughout the transition to adulthood (except that binge drinking and especially smoking does decline somewhat in Waves III and IV). The second group in this superclass, which we term the "Adult-onset Smoking, Drinking, and Activity" group (15.6% of the sample), shows a very different pattern, with very low rates of smoking, binge drinking, and physical activity in the first two waves of the data (i.e., secondary school) but large increases in these behaviors beginning in Wave III and maintained in Wave IV.

The third superclass of two classes we term "Sedentary Drinkers" due to their common high rates of sedentary behavior and fairly high rates of binge drinking. Again, however, these two groups exhibit distinct clusters and time patterning of behaviors. One group, which we designate "Sedentary, Drinking Ex-smokers" (8.7% of the sample), is so named for its consistently high rates of sedentary behavior across the four waves of data, its very high rate of binge drinking across all four waves, and its moderately high rate of smoking in Waves I and II, which is much lower in subsequent waves. The other member of this superclass is the second most populated class behind the Consistently Healthy group—we have labeled it the "Adult-onset Drinking and Increased Activity" group (18.4% of the sample). In secondary school, this group exhibits extremely low rates of smoking, binge drinking, and obesity but extremely high rates of sedentary behavior. In early and mid-adulthood, however, this group begins to binge drink at relatively high rates and also has markedly lower rates of sedentary behavior (but still high compared to other classes in the same waves).

The final superclass ("Least Healthy") consists of a single LCA class, which we term the "Active, Increasingly Obese Smokers and Drinkers" (8.5% of the sample). Except for the somewhat high level of physical activity, this group is the most consistently unhealthy of the seven examined, as it has consistently high levels of smoking and binge drinking across the four waves of data and rapidly increasing obesity rates from Wave I to IV, tying the Healthy but Increasingly Obese group for the highest level observed in the later waves. Although other groups exhibit consistently more unhealthy behavioral patterns for each individual behavioral trajectory, this is the only class that has markedly high rates of unhealthy outcomes across the four waves of data on three of the four indicators examined.

Finally, in Table 5, we test the null hypothesis that sociodemographic groups are equally likely to be found in each of the seven joint classes of health behavior trajectories just described. These results demonstrate that this is not the case and, furthermore, that relatively disadvantaged groups do not disproportionately sort into health behavior profiles that are uniformly less salubrious. First, Table 5 shows evidence of extremely strong gender effects on combined class membership. This is especially pronounced for the Most Healthy groups: compared to men, women are nearly twice as likely (25% vs. 13%) to be found in the Consistently Healthy class and are significantly more likely (13% vs. 11%) to be found in the Healthy but Increasingly Obese class. For intermediately healthy classes, large differences are also observed, as women (compared to men) are more likely to be placed in the group of Active, Thin Smokers and Drinkers and less likely to be placed in the groups Adult-onset Smoking, Drinking, and Activity; Sedentary, Drinking Ex-smokers; and Adult-onset Drinking and Increased Activity. The total effect of gender on class membership is also statistically significant on the basis of a Wald test.

Less consistent patterns are observed by parental educational attainment. Higher-SES youths are more likely to be in the Consistently Healthy (21% vs. 18%) and Adult-onset Drinking and Increased Activity (29% vs. 16%) groups compared to

lower-SES youths. However, they are about equally likely as less advantaged youths to be in the Adult-onset Smoking, Drinking, and Activity group and the Sedentary, Drinking Ex-smokers group—there are no statistically significant differences in these comparisons. Finally, they are significantly less likely to be categorized in the classes labeled Healthy but Increasingly Obese (9% vs. 14%); Active, Thin Smokers and Drinkers (14% vs. 18%); and Active, Increasingly Obese Smokers and Drinkers (6% vs. 10%). The total effect of parental college education is statistically significant in a Wald test.

Finally, differences in group membership by race-ethnicity exhibit some very telling patterns. Compared to whites, for instance, black youths are much more likely to be in the Consistently Healthy (30% vs. 16%) and Adult-onset Drinking and Increased Activity (21% vs. 18%) groups. Also compared to whites, they are much less likely to be found in the Active, Thin Smokers and Drinkers (6% vs. 20%); Adult-onset Smoking, Drinking, and Activity (12% vs. 18%); Sedentary, Drinking Ex-smokers (5% vs. 9%); and Active, Increasingly Obese Smokers and Drinkers (6% vs. 9%) classes. Other racial-ethnic minority groups show the same, relatively high propensity to be in the Consistently Healthy group compared to whites but have different patterns across other categories. Hispanic youths also have a lower probability of being in the Active, Thin Smokers and Drinkers (13% vs. 20%) category and less likely to be in the Adult-onset Drinking and Increased Activity (12% vs. 18%) category compared to whites, but these differences are smaller than that seen among black youth. In contrast to black youths, Hispanic youths are about equally likely to be in the Least Healthy group compared to whites (9%) and are about equally likely as whites to be in the Sedentary, Drinking Ex-smokers group (11% vs. 9%, not significantly different). Finally, Asian Americans have the highest probability of being in the Consistently Healthy category (31%), are significantly less likely than whites and other groups to be in the Healthy but Increasingly Obese category (10% vs. 11% for whites) and are similarly less likely than whites to be in the Active, Thin Smokers and Drinkers (9% vs. 20%) and Sedentary, Drinking Ex-smokers (7% vs. 9%) classes. They are also much less likely than whites to be in the Least Healthy class (5% vs. 9%) and about equally likely to be in the Adult-onset Smoking, Drinking, and Activity class (18%). The effects of black, Hispanic, and Asian categories are all significant across estimated equations according to the results of separate Wald tests.

DISCUSSION

Health behaviors throughout the transition to adulthood are critical for shaping health in adulthood. Although much work has examined the predictors of unhealthy behaviors in adolescence, most research has addressed one behavior or problem and its predictors (Harris et al. 2009; Pollard et al. 2010; van den Bree et al. 2004) or examined how health behaviors are correlated at a single point in time (Berrigan et al. 2003; Frazier et al. 2000; Satre, Gordon, and Weisner 2007). In this article, we examine how health behavior *trajectories* cluster together during the transition to adulthood. The grouping of behavioral patterns can help us design more effective interventions and also improve theories about engagement in risky behaviors.

Our first contribution addresses the extent to which health behavior trajectories are all clustered together, as both problem behavior theory and health lifestyle theory would predict (Cockerham 2005, 2013; Jessor 1991; Osgood and Wilson 1990), or whether some behaviors are clustered together more than others, either due to biology or social factors (Bish et al. 2005; Jeffery et al. 2000; Klesges and Klesges 1988). We find a large degree of variation in how strongly pairs of health behavior trajectories cluster together. On the one hand, we find several groups with consistent healthy or unhealthy behaviors, which lends some support to problem behavior theory. For example, our Consistently Healthy group (19.2% of the sample) and the Least Healthy group (8.5% of the sample) comprise respondents with relatively stable trajectories of behaviors over the transition to adulthood. Nearly 30% of the sample is not negligible and may speak to underlying levels of "healthiness" or "unhealthiness" in this population. However, even the Least Healthy group is not uniformly the least healthy across health behaviors. Instead, it has the highest eventual rate of obesity but far from the highest rates of smoking, binge drinking, and especially sedentary behavior. On the other hand, the Most Healthy group is consistently healthy compared to other classes on all four dimensions.

Furthermore, more than two thirds of the sample do not fall into these stable healthy or unhealthy trajectories where health profiles align so strongly. Rather, most of the other groups are made up of respondents who experience some change—where most of that change is toward less healthy profiles—over the transition to adulthood. As others have observed (Arnett 1992; Schulenberg et al. 1999), this is a critical aspect of the transition to

adulthood—many poor health behaviors are adopted during this time, often with long-lasting consequences. In particular, these findings show that all health behavior classes show evidence of substantial increases in obesity prevalence by Wave IV, when the respondents are in their early to mid-30s. In addition, the prevalence of binge drinking is higher in Wave IV for all classes except Active, Thin Smokers and Drinkers, for whom the prevalence declines from 67% to 62%. However, one health-promoting change is also consistently observed across all classes—decreasing sedentary behavior. Although groups vary in their baseline activity level, every class shows decreases in the prevalence of sedentary behavior across the four waves of Add Health. However, no consistent age pattern is observed for smoking behavior across these classes.

Our second contribution is to test how sociodemographic characteristics are associated with being in different clusters of health risk trajectories over the transition to adulthood. If disadvantaged groups have higher likelihoods of being in consistently or increasingly unhealthy groups, then the interactive effects of these negative health behaviors could be very important for the development of health disparities over this period of the life course. If not, though, researchers should take care not to assume that disadvantaged groups are at higher risk of all of these behaviors at once.

Our results for race-ethnicity suggest that blacks and Hispanics do not always have a higher likelihood of being in groups with very risky health behavior trajectories. Rather, blacks have higher propensities than whites to be in several of the healthy groups and are less likely to be in the consistently unhealthy groups. This has been shown for one or two behaviors separately but not for entire clusters of health behavioral trajectories. Health lifestyle theory suggests that this result implies that members of different racial-ethnic groups either face different choice sets or are socialized to believe that these behaviors are more or less appropriate for persons like them. For instance, blacks are nearly twice as likely as whites to be rated as consistently healthy in their behaviors, are more likely to be in the Adult-onset Drinking and Increased Activity class than whites, and are much less likely to fall into the Least Healthy, Smokers and Drinkers, and Sedentary, Drinking Ex-smokers superclasses and classes. Although nontrivial proportions of blacks engage in binge drinking and are obese, they are far less likely to be assigned to classes that involve substantial smoking rates. This is unlikely to reflect the unavailability of cigarettes given the higher rates of cigarette smoking among older blacks compared to older whites; rather, this is likely to be attributable to strong identity-based norms against cigarette smoking among younger blacks.

Turning to parental education, we also find overall differences in the sorting into different clusters of health behavior trajectories over the transition to adulthood. However, those with low parental education are not always significantly more likely to be in the less healthy clusters of trajectories and least likely to be in the healthy groups. Respondents with high and low parental education are equally likely to be in the Consistently Healthy group as well as two other behavior clusters. The clusters where these groups depart by a large margin are the Least Healthy group (10% for lower educated vs. 6% for higher educated parents) and the Adult-onset Drinking and Increased Activity group, where high-SES respondents are more likely to be in this group than those with low SES. However, it is important to note that the magnitude of these differences is not very large, especially relative to differences by gender and race-ethnicity.

Sorting into health behavior clusters is more straightforward for gender. Women generally are more likely to be in the more healthy behavior clusters and less likely to be in the least healthy clusters. However, this is not to say that women are uniformly sorted into the healthiest categories—although 39% of women versus 24% of men are found in the Most Healthy superclass. Among the less healthy groups, women are more likely to be located in the Active, Thin Smokers and Drinkers class and slightly more likely than men to be in the Least Healthy class. Men are more common in all other groups. It may be that many women have stronger normative proscriptions against obesity than against smoking and drinking behavior.

In short, although problem behavior theory and health lifestyle theory could potentially account for the extremes of these joint health behavior trajectory distributions, they do not help to explain differences in the intermediate classes that contain 60% of the sample. What, then, can account for these patterns? One possibility is that physiological processes or common genetic dispositions may partially explain the connection between these behaviors. For instance, the moderate relationship between sedentary and obesity trajectories is likely partially due to the physical activity's direct effect on calories burned and therefore body mass. In a different vein, previous research has found that co-use of cigarettes and alcohol among U.S. 18-year-olds is increasingly driven by factors that influence

them jointly, not separately, which potentially includes common genetic influences (Daw et al. 2013). Second, healthy behavioral profiles may be jointly pursued with a common goal in mind, as individuals may quit smoking, reduce drinking, and increase physical activity with the goal of promoting overall health and/or reducing their BMI. For instance, the shifting (increasingly active) class for sedentary behavior is associated with the shifting (increasingly obese) category for obesity, suggesting that individuals whose weight increases may react with greater physical activity to combat this trend. Finally, it may be that respondents are trading off one behavior against another—for instance, someone who has worked out that day may feel that they have earned a slice of pie or a cigarette. However, the association of smoking and drinking behavior with obesity trajectories is generally moderate, and in the case of obesity and sedentary behavior, it is very difficult to disentangle these associations. Further research should seek to evaluate these hypotheses.

This analysis is not without its limitations. First, we model each health risk behavior with a dichotomous variable. We do this because we are testing whether the respondent is engaging in that risky behavior at each point in time, not the frequency of intensity with which he or she does so. Different patterns may be observed in research examining the intensity of each behavior. Second, our analytical approach of estimating latent classes and analyzing their determinants still leaves considerable room for heterogeneity within each class. This leaves open the possibility that there are important subtleties in the determinants of and linkages between different health behavior trajectories and their determinants. Third, due to data availability, these analyses rely upon self-reports to generate the latent classes of interest, which may not be fully reliable in all instances. Fourth, it may be that there are many other health behaviors and outcomes that are similarly associated with the four that we examine, such as diet, illicit drug use, and so on. However, incorporating these measures into this analysis would greatly increase the complexity of the analysis and interpretive task. Last, we focused on three predictors of health behavior trajectories that are core to sociology (race, class, and gender), but there are other important predictors that can be examined in future research, such as nativity, urbanicity, and income.

In conclusion, the four health behaviors we investigate are widely studied cross-sectionally and longitudinally, but the dependencies between them over the transition to adulthood have not been previously investigated, nor have the sociodemographic determinants of these joint trajectories. Our analysis finds strong dependencies between many health behavior trajectories and strong associations with gender, parental education, and race-ethnicity. Future work should examine how trajectories of these behaviors cluster together in later life as well as the long-term health consequences of their joint distribution across socially meaningful sociodemographic groups.

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NOTES

1. Of course, obesity itself is not a health behavior, although it is behaviorally influenced. We use the term *health behavior* for all four outcomes in this article as a matter of rhetorical convenience (as do others, such as Boardman and Alexander 2011; Frech 2012; Lantz et al. 1998; Yang et al. 2008). Although *diet* would be an appropriate substitute, our data do not include consistently measured and clearly interpretable indicators of healthy diet across all waves. Thus, when we refer to smoking, drinking, sedentariness, and overweight collectively as health behaviors, they may be interpreted as health risk factors.
2. We did not set other variables at their means or at a given value for each predicted probability calculation. Rather, these values were calculated with each nonfocal determinant employed as observed in the data, while the focal determinant was treated as though each observation had each defined value of the focal determinant.

SUPPLEMENTAL MATERIAL

Appendix Table A1 is available in the online version of the article.

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