ORIGINAL ARTICLE

Latent Class Analysis of Adolescent Health Behaviors

Molly Jacobs

Department of Health Sciences Information and Management, East Carolina University, 600 Moye Blvd. Mail Stop 668, Health Sciences Building 4340E, Greenville, NC 27834

ABSTRACT

Background: Behavior is one of the most important components in health. While the impacts of adolescent risky activities have been studied extensively, less attention has been paid to health. This study examines the patterning of health behaviors among adolescents age of 10–19 years. **Methods:** Latent class analysis identified homogeneous, mutually exclusive "classes" (patterns) of eight, leading health behaviors - sleep, alcohol consumption, cigarette smoking, physicians' visits, meal autonomy, wearing braces, general health assessment, and having a permanent tattoo. **Results:** Resulting classes include (1) healthy, (2) moderately healthy, and (3) unhealthy. The characteristic behaviors and tendencies of each class differed by gender. **Conclsion:** This study attempts to classify adolescents by their own health behavior without including parental attributes. While adolescents do not typically prescribe to predictable behaviors and actions, the emphasis on healthy behaviors by some suggests an individual awareness of behavioral impacts and importance of healthy lifestyle choices.

Key words: Adolescence, behavior, health, latent class, urban

INTRODUCTION

Behavior is one of the most important components in health. Behavioral factors play a role in each of the twelve leading causes of death, including heart disease, cancer, and stroke. Behaviors such as the use of alcohol, tobacco, firearms, and motor vehicles; diet and activity patterns; sexual behavior; and illicit use of drugs can impact a variety of physical and emotional health factors. The impacts of these behaviors among adolescents have been studied extensively. The impacts of sleep, diet, cigarettes, drugs, and alcohol on adolescent health are clearly defined. However, much less attention has been paid to the coincidence of health behaviors. Much research has been devoted to studying the types of behaviors, but few have analyzed the trends of classes of behaviors. This study characterizes behavioral health classes among youth and adolescent, based on their actions, tendencies, and lifestyle choices.

According to the World Health Organization, adolescence begins with the onset of physiologically normal puberty and ends when an adult identity and behavior are accepted. This period of development corresponds roughly to the period between the ages of 10 and 19 years.[1] During this time, individuals establish enduring health behaviors, independence, and patterns.[2] This is the time to form positive habits that will improve adolescents' long-term health. Nutrition, exercise, and sleep are primarily important to support health into adulthood.[3-5] Many of the behaviors formed and lifestyle choices made in adolescence have lasting implications.[6] Thus, there is a definite need to investigate the health behaviors of adolescents as it is important to characterize and identify healthy behavior patterns in youth as they carry into adulthood.

However, research illustrates that emerging adulthood is an age characterized by high rates of health risks such as unhealthy weight control behaviors, stress, sleep insufficiency, and mental health issues.[7-10] This age range has been documented as one of excessive weight gain often caused by a decrease in diet quality and physical activity.[11-13]

Address for correspondence:
Molly Jacobs, Department of Health Sciences Information and Management, East Carolina University, 600 Moye Blvd. Mail Stop 668, Health Sciences Building 4340E, Greenville, NC 27834. E-mail: jacobsm17@ecu.edu

Many of these health issues are preventable. In fact, nearly all the CDCs top 10 public health problems could be prevented with appropriate behavior and lifestyle modification.[14-16]

Health-related behaviors among adolescence have been studied from the concept of risk and the health consequences of risky behaviors. Risky behaviors such as smoking, alcohol consumption and unprotected intercourse is associated with increase risk of low educational attainment, future morbidity and premature mortality,[17-22] and the harm that they cause is well-known and is associated with increased risk of poor educational attainment, future morbidity and premature mortality.[23]

Extensive analysis outlines adolescent behavior involving risk, substance use, and sexual activity.[8,24] Authors have examined the link between adolescent behaviors and their parents, peers, and educational environments[18-20,25] highlighting 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.

However, adolescents' orientation toward own health-promoting behaviors has not been thoroughly examined. Connell *et al*.[18] used latent class analysis (LCA) to assess the cooccurrence of adolescent substance use and sexual behavior but failed to use health-promoting behaviors along with risky behaviors. Burke *et al*.[17] 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*.[24] 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. None have examined classes of health behaviors among young, adolescent males and females while determining those associated demographic covariates.

This analysis differs from others in that it examines a nationally representative group of adolescents age of 10–19 years, focusing on health-related behaviors. Using eight different areas of health-enhancing behaviors, this study analyzes intrinsic individual motivation toward health as expressed by these behaviors. Differing from other similar analyses, this study focuses on those behaviors of the adolescents themselves, rather than including parental practices and behaviors. The present paper examines cigarette smoking, general health rating, alcohol consumption, meal autonomy, sleep patterns, wearing braces, exercise habits, routine physical check-ups, and presence of permanent body tattoos to characterize health behavior.[29,30] First, how alcohol, smoking tattoos, meal autonomy, sleep, wearing braces, general health rating, physicians' visits, and exercise are correlated among adolescents are examined. Second, three homogeneous, mutually exclusive behavioral typologies within the data are identified. Third, the extent to which age contributes to class membership is determined. Finally, the race, gender, and residential composition of each class are characterized.

This paper proceeds in the following order. Section II offers a description of the data, key variables of interest, and analysis techniques. Then, Section III presents the estimation results followed by a discussion of the findings and broader implications.

METHODS AND DATA

Data from the National Longitudinal Study of Adolescent Health (Add Health) - a nationally representative sample of adolescents age of 10–19 years old - assess the classification of health behaviors. 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 (Harris). Add Health was collected in four waves, but only information from Waves I and II collected in 1994–1995 and 1996 are utilized in this analysis. Respondents were surveyed in their homes to collect data on respondents' social, economic, psychological, and physical 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.

Eight primary health behaviors are used to analyze typologies: Frequency of alcohol use, cigarette smoking, general health rating, food choice autonomy, wearing braces, tattoos, sleep, meal autonomy, exercise, and physicians' visit. For the present investigation, a single dichotomous variable constructed for each behavior. The behavioral items and their classifications are presented below. Demographic information was elicited through the standardized Add Health items of age, race, ethnicity, household size, and rural environment.

Behavior	Context
Alcohol	1=Consumes alcohol 2–3 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 3 times or more (exercises such as jogging, walking, karate, jumping rope, gymnastics, or dancing)
	2=During the past week, exercised two or fewer times
Tattoos	1=Has a permanent tattoo
	2=Does not have a permanent tattoo
Autonomy	1=Parents let you make your own decisions about what you eat
	2=Parents do not let you make your own decisions about what you eat
Physicians visits	1=Has had a routine physical examination in the past year
	2=Has not had a routine physical examination in the past year
Braces	1=Has worn or is wearing braces
	2=Has not worn and is not wearing braces
General health	1=General health is excellent, very good, or good health
	2=General health is fair or poor health

Table 1: Add health Wave I respondent data

Covariate	*n*	Mean	SD	Min.	Max.
Male					
Age	2.247	14.84	1.74	10	19
Household size	2.161	4.31	1.15	1	6
Black	2.161	0.16	0.43	0	1
Hispanic	2.161	0.12	0.32	0	1
Household smokers	2.742	0.47	0.50	0	1
Rural	934	28.45			
Suburban	1.176	35.82			
Urban	1.173	35.73			
Female					
Age	2.485	14.68	1.72	11	19
Household size	2.435	4.33	1.14	1	6
Black	2.435	0.17	0.43	0	1
Hispanic	2.435	0.12	0.32	0	1
Household smokers	2.888	0.47	0.50	0	1
Rural	672	27.35			
Suburban	988	40.21			
Urban	797	32.44			

Mean values of demographic variables are presented in Table 1. Age was translated into three groups - young adolescents (age 10–12), middle age adolescents (age 13–15), and older adolescents (age 16–19). Households are on average composed of four individuals but range from 1 to 6. 20% of the samle is black and 10-12% is is Hispanic. 30% of respondents reside in rural areas and nearly half, 45%, contain at least one cigarette smoker. Over 80% of male and female respondents make their own decisions about food rather than relying on their parents to arrange meals - a measure of adolescent autonomy.

Behavioral category response frequencies for the health behaviors listed above are found in Table 2. Values are presented separately for males and females in Waves I and II. Responses follow the expected trajectories. More individuals consume alcohol regularly, smoke cigarettes, and have permanent tattoos while fewer individuals exercise, get sufficient sleep, and have had a routine annual examination. Males and females show only minor difference in their response frequencies and behavior patterns.

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.[31-35] In this research, I hypothesized individuals have an underlying, intrinsic desire to be healthy. This health motivation varies among individuals and cannot be directly observed. However, it manifests in meaningful patterns of a wide range of health behaviors (i.e., sleep, physicians visits, cigarette smoking, etc.). I sought to identify the underlying motivation for health based on responses to eight specified health-impacting behaviors using LCA.

The selection of the variables included in these analyses was based on previous literature, suggesting that willingness to work toward a healthy lifestyle was characterized by actions that either directly or indirectly impact physical health, as well as the availability of data within this existing data source. To study the underlying structure of these data, a series of LCA models were fit and examined. Like previous applications of these LCA methods, dichotomous variable specifications were selected for the final analysis to enhance the interpretability of the findings.

Using SAS version 9.4 (Release 9.4. Cary, NC: SAS Institute Inc.), the PROC LCA command procedure was used to estimate model parameters.[36] PROC LCA produces maximum likelihood estimates for parameters using the EM algorithm. Missing data on individual survey items are handled within the EM algorithm and are assumed to be missing at random.[36]

Table 2: Add Health behavioral categories

Covariate	Wave I *n* (%)		Wave II *n* (%)	
		Male		
Alcohol	Missing	1396	Missing	2052
	1	1121 (64.02)	1	582 (53.15)
	2	630 (35.98)	2	513 (46.85)
Exercise	Missing	3	Missing	833
	1	1614 (51.34)	1	1185 (51.21)
	2	1530 (48.66)	2	1129 (48.79)
Cigarette smoking	Missing	41	Missing	522
	1	1372 (44.17)	1	1806 (68.8)
	2	1734 (55.83)	2	819 (31.2)
Sleep	Missing	6	Missing	833
	1	2396 (76.28)	1	1736 (75.02)
	2	745 (23.72)	2	578 (24.98)
Physical examination	Missing	14	Missing	837
	1	2124 (67.79)	1	1501 (64.98)
	2	1009 (32.21)	2	809 (35.02)
Tattoo	Missing	6	Missing	772
	1	162 (5.16)	1	246 (10.36)
	2	2979 (94.84)	2	2129 (89.64)
General health	Missing	123	Missing	834
	1	2265 (74.9)	1	1720 (74.36)
	2	759 (25.1)	2	593 (25.64)
Braces	Missing	247	Missing	692
	1	421 (14.52)	1	560 (22.81)
	2	2479 (85.48)	2	1895 (77.19)
Autonomy	Missing	60	Missing	887
	1	2463 (79.79)	1	1857 (82.17)
	2	624 (20.21)	2	403 (17.83)
Alcohol	Missing	1562	Missing	2165
	1	1300 (72.46)	1	808 (67.84)
	2	494 (27.54)	2	383 (32.16)
Exercise	Missing	2	Missing	837
	1	1753 (52.27)	1	1338 (53.12)
	2	1601 (47.73)	2	1181 (46.88)
Cigarette smoking	Missing	13	Missing	508
	1	1491 (44.6)	1	1931 (67.8)
	2	1852 (55.4)	2	917 (32.2)
Sleep	Missing	5	Missing	838
	1	2376 (70.9)	1	1694 (67.28)
	2	975 (29.1)	2	824 (32.72)
Physical examination	Missing	12	Missing	841
	1	2216 (66.27)	1	1693 (67.32)
	2	1128 (33.73)	2	822 (32.68)

(Contd...)

Table 2: *(Continued)*

Covariate	Wave I *n* (%)		Wave II *n* (%)	
		Male		
Tattoo	Missing	3	Missing	770
	1	142 (4.24)	1	211 (8.16)
	2	3211 (95.76)	2	2375 (91.84)
General health	Missing	185	Missing	837
	1	2130 (67.17)	1	1637 (64.99)
	2	1041 (32.83)	2	882 (35.01)
Braces	Missing	321	Missing	627
	1	643 (21.19)	1	862 (31.59)
	2	2392 (78.81)	2	1867 (68.41)
Autonomy	Missing	78	Missing	918
	1	2728 (83.22)	1	2105 (86.34)
	2	550 (16.78)	2	333 (13.66)

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). 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 analyses. 500 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.

Models were fit in an exploratory fashion using both statistical and theoretical endpoints. A two-class model was examined first. Next, 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 are a widely accepted for LCA methods.[36,37] I examined the AIC criteria across models fit separately for males and females. The most parsimonious LCA model was retained. Next, bivariate analyses (e.g., ANOVA) were conducted to compare the classes on background (i.e., age, sex, race, rural status, autonomy, etc.) and health characteristics (i.e., alcohol, cigarettes, braces, tattoos, etc.).

Finally, Add Health survey design includes clustered observations due to multistage sampling, unequal probabilities of selection of the observations, and stratification. If these aspects of complex survey data are ignored, point estimates and standard errors may be biased, leading to incorrect inferences. Therefore, sampling weights were used for sample to reflect adolescents who were enrolled in the US schools during the 1994–1995 academic years. Finally, respondent age is included as a covariate with Group 1 - respondents 10–12 - serving as the reference group. The inclusion of this covariate controls for the effect of age in classification and determines whether class membership varies with age.

RESULTS

The AIC comparisons of relative fit showed that three latent classes of health behavior provided optimal model fit and parsimony. Given the differences in male and female adolescent, it is possible to utilize a grouping function so that gender-specific parameters are estimated.[36] Thus, probability estimates can vary by gender. To test whether gender-specific parameters or gender invariance were appropriate, a three-class model had been selected and two nested. Then, multigroup 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 3 shows the behavioral class sizes by gender and age. Behavioral classes displaying varying degrees of healthy behavior. Class 1, healthy, consists of respondents who adhere to the healthiest behaviors in both waves. Class 2, moderately healthy, consists of individuals who are primarily healthy but occasionally falter in their commitment to a healthy lifestyle. Class 3, the smallest group, elects less healthy lifestyle choices. 25% of females adhere to healthy behaviors, compared to only 16% of males. Furthermore, a larger percentage of males are classified as unhealthy

Table 3: Health class size and distribution by gender

Health behavior class	Class	*n* (%)
Male		
Healthy	1	522 (16.6)
Moderately healthy	2	1430 (45.48)
Unhealthy	3	1192 (37.91)
Female		
Healthy	1	792 (23.6)
Moderately healthy	2	1465 (43.65)
Unhealthy	3	1099 (32.75)

compared to females. These differences justify the rejection of gender invariance discussed above.

The behavioral responses are listed in Table 4. The numbers represent the probability that an individual in the respective class responded affirmatively to the topic listed. For example, a male in the healthy class had a 99% probability of wearing or having worn braces. In addition, females in Class 1 have a high probability of drinking <2–3 times per month and a very low probability of have a tattoo. Class 3, unhealthy, is not likely to have worn braces but has a higher probability of having tried smoking cigarettes. Class 2 displays a mix of moderately healthy lifestyle and behaviors choices.

Age was added as covariates to examine its association with class membership. These associations were modeled using a logistic link function, producing a set of logistic regression coefficients that show how the covariates predict subgroup membership.[38] 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 - age 10–12 years - corresponding to a different level on the covariate. Coefficient and significance levels are listed in Table 5. These results suggest a strong age effect. As respondents get older, they display less healthy behaviors. Their representation in the healthy class diminishes while the number in the unhealthy class increases as they age. This inverse relationship between class and age suggests that independence from parents or guardians could lead to a less healthy lifestyle.

Behavioral classes of additional demographic groups are listed in Table 6 by gender. While adolescents are less likely to be healthy as they age, they are more likely to be healthy if they reside in suburban areas, compared to urban or rural. Minority race and ethnicity reduce the probability of the healthiest classes. Adolescents in households with smokers have a large representation in the unhealthy group. Household size classifications differ between males and females. For females, healthy behavior appears to diminish as household size gets larger. For males, healthy class representation is greatest among those in 3–4-person household.

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 the age of 10–19 years, this is a large age range. Young adolescents could potentially be quite different from older adolescents. Despite testing the impact of age through covariate inclusion, results could be difficult to generalize.

While dichotomizing behavioral variable is an approach often taken in this type of analysis and make interpretability and communication of results easier, it may obscure details within the data. Furthermore, parental traits likely play a role in adolescent behavior. This analysis does not account for the differences between parents and the impact this might have on their children. 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 are always a factor. Much additional research is needed to understand the lifestyles and health behaviors of these populations.

DISCUSSION AND CONCLUSION

The primary aim of this study was to identify unique classes of adolescents based on their health behaviors and explore the differences in demographics between the emergent classes. Using LCA, a3-class solution emerged as the best fitting model for both males and females. Indices of model fit were found to be acceptable, and the latent classes represented meaningful classes that provide more detail than previous investigations that rely on risky behaviors alone. Classes were identified as lying on the spectrum from health to unhealthy. Membership in the unhealthy class was surprisingly high with 30–40% of both genders subscribing to poor health-related behaviors. Demographic characteristics played a role in influencing adolescent behavior with older adolescents being less healthy.

While a very unhealthy class for both males and females was identified, the activities that dominated these classes differed. For males, making their own food choices and drinking alcohol frequently were keyed while for females, not receiving a physical examination and having a tattoo stood out as main contributors. The unhealthy class includes large segments of youth (approximately a 30–40% of males and females) that is generally follow unhealthy behavioral regimes. However, it does not appear that there is any true, homogeneous either healthy or unhealthy group. While those classified as the most healthy/unhealthy tend to generally follow these characteristic behaviors, they also diverge

Table 4: Health behavior probabilities by class

Gender		Healthy	→	Unhealthy
Male				
Covariate	**Definition**		**Wave I**	
Alcohol	Consumes alcohol 2–3 days a month or less	0.6198	0.7967	0.5418
Exercise	Exercised 3 times or more past week	0.5318	0.5020	0.4792
Smoking	Has tried smoking at least 1 or 2 puffs	0.4040	0.7956	0.0002
Sleep	Usually gets enough sleep	0.7046	0.8468	0.6923
Physical examination	Has had a routine physical examination in the past year	0.7530	0.6583	0.6056
Tattoo	Has a tattoo	0.0379	0.0105	0.1023
Autonomy	Makes own choices regarding meals	0.8228	0.7524	0.8191
Braces	Has worn or is wearing braces	0.9986	0.0000	0.0001
Health	Health is excellent, very good, or good	0.8177	0.7661	0.6622
			Wave II	
Alcohol	Consumes alcohol 2-3 days a month or less	0.5250	0.6597	0.4346
Exercise	Exercised 3 times or more past week	0.6105	0.5173	0.4807
Smoking	Has tried smoking at least 1 or 2 puffs	0.6580	0.9999	0.1700
Sleep	Usually gets enough sleep	0.6848	0.8096	0.7225
Physical examination	Has had a routine physical examination in the past year	0.7062	0.6581	0.6037
Tattoo	Has a tattoo	0.0710	0.0305	0.1940
Autonomy	Makes own choices regarding meals	0.8536	0.7880	0.8304
Braces	Has worn or is wearing braces	0.9995	0.0378	0.0190
Health	Health is excellent, very good, or good	0.8033	0.7852	0.6338
Female				
			Wave I	
Alcohol	Consumes alcohol 2–3 days a month or less	0.6631	0.8761	0.6548
Exercise	Exercised 3 times or more past week	0.5019	0.5019	0.4997
Smoking	Has tried smoking at least 1 or 2 puffs	0.3994	0.7877	0.0002
Sleep	Usually gets enough sleep	0.6756	0.7827	0.6599
Physical examination	Has had a routine physical examination in the past year	0.6922	0.6282	0.6360
Tattoo	Has a tattoo	0.0331	0.0078	0.0937
Autonomy	Makes own choices regarding meals	0.8669	0.7875	0.8532
Braces	Has worn or is wearing braces	0.9978	0.0001	0.0001
Health	Health is excellent, very good, or good	0.7115	0.7038	0.5698
			Wave II	
Alcohol	Consumes alcohol 2–3 days a month or less	0.6369	0.8084	0.6169
Exercise	Exercised 3 times or more past week	0.4520	0.5749	0.5273
Smoking	Has tried smoking at least 1 or 2 puffs	0.6163	0.9999	0.1254
Sleep	Usually gets enough sleep	0.6535	0.7568	0.5928
Physical examination	Has had a routine physical examination in the past year	0.7013	0.6303	0.6564
Tattoo	Has a tattoo	0.0620	0.0179	0.1728

(Contd...)

Table 4: (*Continued*)

Gender		Healthy	→	Unhealthy
Autonomy	Makes own choices regarding meals	0.8921	0.8174	0.8932
Braces	Has worn or is wearing braces	0.9997	0.0628	0.0321
Health	Health is excellent, very good, or good	0.7057	0.6750	0.5282

Table 5: LCA covariate significance tests

Covariate	Exclusion LL	Change in 2*LL	Deg. freedom	*P* value
Age	−49829.42	47.6	4	0.000

Table 6: Latent class demographic composition

Covariate	Latent classes		
	Healthy	→	Unhealthy
	1	2	3
Male			
Black	6.35	59.97	33.68
Hispanic	8.94	49.72	41.34
Rural	16.05	43.6	40.35
Suburban	21.94	43.19	34.88
Urban	11.26	49.91	38.84
Household smoker	12.87	43.08	44.05
Age			
10	0	0	100
11	0	100	0
12	8.1	70	21.9
13	13.29	60.13	26.58
14	15.33	51.01	33.67
15	15.71	48.1	36.19
16	22.38	38.33	39.29
17	24.3	28.49	47.21
18	20	27.27	52.73
19	4.17	33.33	62.5
Household size			
1	5.88	29.41	64.71
2	13.33	40.83	45.83
3	20.95	38.65	40.4
4	19.81	50.07	30.12
5	15.64	47.1	37.26
6	13.62	48.5	37.87
Female			
Black	7.45	65.6	26.95
Hispanic	16.36	51.95	31.69
Rural	20.56	42.18	37.26
Suburban	31.21	39.88	28.91
Urban	17.65	49.19	33.16
Household smoker	19.31	39	41.69
Age			
11	22.22	77.78	0
12	18.75	60.16	21.09
13	17.48	55.78	26.74
14	21.09	43.48	35.43
15	24.22	40.58	35.2
16	25.68	41.36	32.95
17	29.87	34.55	35.58
18	30.34	29.21	40.45
19	18.18	54.55	27.27
Household size			
1	28.57	57.14	14.29
2	17.65	47.06	35.29
3	27.94	37.92	34.15
4	26.48	43.29	30.23
5	23.4	46.62	29.98
6	14.76	49.12	36.12

(Contd...)

Table 6: (*Continued*)

Covariate	Latent classes		
	Healthy	→	Unhealthy
	1	2	3

frequently. No single class is truly uniform in their behavioral patterns.

Since this study is the first of its kind to assess adolescent health behaviors using LCA, it is difficult to directly compare the results to other studies. However, a few studies have used cluster analysis to classify adolescents based on their risky or self-injurious behaviors. Laska *et al*.[24] described patterns 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*.[18] 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

and Olino[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 resulted in braces. In addition, since 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. Since 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.

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 of 10–19 years. A variety of health-related behaviors were measured covering many aspects of health including receipt of care, substance use, 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 two waves of cross-sectional data appropriate. The categorization and characterization of adolescent behavior provide information important for the development of intervention and education strategies. Given the significant concern regarding the high prevalence 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.

This study was the first to attempt to classify adolescents by their own health behavior without including parental outcomes or attributes. While adolescents do not typically prescribe to predictable behaviors and actions, the emphasis on healthy behaviors by some groups suggests an individual awareness of behavioral impacts and importance of healthy lifestyle choices. These findings have important implications for targeting much-needed health promotion strategies among adolescents themselves. Since adolescents' age of 10–12 years displayed healthier behaviors than those 16–19 years, motivating or fostering the continuation of healthy practices as youth age appears important. 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 over the lifespan.[39,40].

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