Latent Class Analysis of Lifestyle Characteristics and Health Risk Behaviors among College Youth

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Abstract

Few studies have examined the context of a wide range of risk behaviors among emerging adults (ages 18–25 years), approximately half of whom in the USA enroll in post-secondary educational institutions. The objective of this research was to examine behavioral patterning in weight behaviors (diet and physical activity), substance use, sexual behavior, stress, and sleep among undergraduate students. Health survey data were collected among undergraduates attending a large, public US university (*n*=2,026). Latent class analysis was used to identify homogeneous, mutually exclusive "classes" (patterns) of ten leading risk behaviors. Resulting classes differed for males and females. Female classes were defined as: (1) poor lifestyle (diet, physical activity, sleep), yet low-risk behaviors (e.g., smoking, binge drinking, sexual risk, drunk driving; 40.0% of females), (2) high risk (high substance use, intoxicated sex, drunk driving, poor diet, inadequate sleep) (24.3%), (3) moderate lifestyle, few risk behaviors (20.4%), (4) "health conscious" (favorable diet/physical activity with some unhealthy weight control; 15.4%). Male classes were: (1) poor lifestyle, low risk (with notably high stress, insufficient sleep, 9.2% of males), (2) high risk (33.6% of males, similar to class 2 in females), (3) moderate lifestyle, low risk (51.0%), and (4) "classic jocks" (high physical activity, binge drinking, 6.2%). To our knowledge, this is among the first research to examine complex lifestyle patterning among college youth, particularly with emphasis on the role of weight-related behaviors. These findings have important implications for targeting much needed health promotion strategies among emerging adults and college youth.

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Keywords

Emerging adulthood; Latent class analysis; Diet; Physical activity

Introduction

Emerging adulthood, typically defined as ages 18–25 (Arnett 2000), has been identified as a unique developmental period and a time when individuals are at risk for a range of adverse health behaviors. This may also be a critical time during which many individuals establish independence and adopt lasting health behavior patterns that are associated with increased long-term disease risk, though a limited amount of research has examined these issues across a broad array of risk behaviors (Nelson et al. 2008b). Overall, in that nearly half (47%) of Americans aged 17–24 are enrolled post-secondary students (US Census Bureau 2008), comprising a majority of the 17 million US college students enrolled in over 6,000 post-secondary institutions (Knapp et al. 2006), college and university enrollment could offer a prime opportunity for reaching large populations of emerging adults for health promotion efforts.

One major public health problem impacting emerging adults is obesity, with this age being a documented time for excess weight gain, as well as decreases in diet quality and physical activity (Larson et al. 2007; Nelson et al. 2006, 2008b; Ogden et al. 2006). In addition, data from the National Longitudinal Study of Adolescent Health illustrates that emerging adulthood is also a time for significant increases in tobacco and marijuana use, high-risk alcohol use (e.g., binge drinking), and diagnosis of sexually transmitted diseases, as well as decreases in access to healthcare (Harris et al. 2006). Other research illustrates that emerging adulthood is an age characterized by high rates of other health risks, such as unhealthy weight control behaviors, stress, sleep insufficiency and mental health issues (American College Health Association 2007; Nelson et al. 2008a, b; Voelker 2004).

Furthermore, many of the risk behaviors occurring throughout these years are likely inter-related. Though potential mechanisms for the associations between these behaviors have been proposed, very limited evidence is available to fully understand the complex linkages of health behavior and lifestyle patterns, especially at this high-risk age. Some research has illustrated independent associations between weight-related behaviors (including dietary intake, physical activity and unhealthy weight control behaviors), high-risk alcohol use and poor stress management in this population (Nelson et al. 2008a, 2009). Previous literature has also suggested links between stress, mental health and poor sleep habits among college youth (Voelker 2004). Moreover, a wide array of scientific evidence exists linking substance use, poor nutrition, physical inactivity, unhealthy weight control, and other risky behaviors among age groups (Chen et al. 2008; Neumark-Sztainer et al. 2007; Pasch et al. 2008).

To move forward in developing intervention strategies relevant to emerging adults in college settings, the overall context in which all of these behaviors occur must be considered. In designing campus health promotion strategies, it is important to understand the many challenges with which students are simultaneously struggling. For example, if most students with poor dietary intakes are also experiencing high rates of substance use, stress and other high-risk behaviors, then narrow intervention approaches specifically targeting nutrition-related behavior change (e.g., fruit and vegetable education campaigns) may not be effective in reaching students. This kind of example highlights the need to gain a basic understanding of the overall lifestyle patterns present at this age. To address these needs in the field, the objective of this research was to examine the patterning of a broad array of lifestyle characteristics and health risk behaviors among a large sample of undergraduate post-

secondary students. These analyses encompassed a range of behavioral characteristics particularly relevant to this age, including: physical activity, dietary intake, unhealthy weight control, tobacco use, high risk alcohol use, drunk driving, risky sexual behavior, stress management and sleep. Latent class analysis (LCA) was used to identify homogeneous, mutually exclusive behavioral typologies existing within the data.

Methods

Setting, sample and design

In 2004 Boynton Health Service at the University of Minnesota conducted a mailed random sample survey of 6,000 degree-seeking, fee-paying students enrolled at the University of Minnesota's Twin Cities campus. The 10-page health risk survey has been conducted at the University of Minnesota every 3 years since 1995. Surveys were returned anonymously, and participants separately returned a postcard (which was addressed, postage-paid and included with each mailed survey) on which they indicated their consent to participate in this university needs assessment. Following the initial mailing, a second mailing was sent to those students who had not responded. As an incentive for participation, students responding to the mailing were entered into a random lottery drawing to receive either one of two $250 gift certificates or one of 40 $50 gift certificates.

Of the 6,000 surveys sent out to students, 147 were undeliverable and 3,206 were completed and returned, yielding a response rate of 54.8%. Of these, 2,026 (63.6%) were undergraduate students. Respondents included both undergraduate and graduate/professional students; however, due to the substantial differences between undergraduate and graduate students (e.g., lifestyle characteristics, age, living situation, income), the primary goal of this study was to examine the patterning of health risk behaviors among undergraduate students only. Though data on survey non-responders is not available, it is estimated that the response rate for undergraduate students alone was approximately 66.0%, based on university enrollment data during the spring of 2004. For completed surveys, the missingness of data on key variables and covariates ranged from 0.5% (for gender) to 1.8% (for cigarette smoking in the past month) of the total sample. Analyses of these data were approved by the University of Minnesota Institutional Review Board.

Health risk behaviors addressed in the survey included:

Physical activity

Using survey items similar to those included in national surveillance systems, students reported frequency of participating in vigorous physical activity (number of days in the past week engaging in ≥20 min of exercise or physical activity "that made you breathe hard (e.g. running, swimming laps, fast bicycling, basketball or similar activities)"). Per national recommendations, physical activity was dichotomized as achieving this level of activity at a cut-point of 3 days/week (Haskell et al. 2007), and the data were recoded with '1' indicating ≥3 days/week and '2' indicating<3 days/week. An analogous recoding scheme was also adopted for all of the following dichotomized health risk behaviors, with '1' representing a healthier behavior and '2' representing a less healthy behavior.

Dietary intake

Students reported select dietary behaviors associated with weight and other important health indicators. Daily servings of total fruits and vegetables in the past week were independently assessed, with response options ranging from 0 to 6 or more servings per day. These items were combined to assess overall intake, as well as likelihood of meeting national recommendations to consume a minimum of five daily servings of fruits and vegetables (US

Department of Health and Human Services 2005). Usual frequency of eating fast food meals was also assessed, with response options of: never, once a year or less, a few times a year, one to two times per month, one time per week, several times per week, daily, several times per day. Given previous research demonstrating increased health risks associated with eating fast food several times per week or more (Boutelle et al. 2007; French et al. 2000, 2001; Pereira et al. 2005), this was selected as a cut-point for dichotomizing fast food intake.

Unhealthy weight control behaviors

Students reported how frequently in the past year they had engaged in unhealthy weight control behaviors (e.g., using laxatives, taking diet pills, binge eating, inducing vomiting). Response options were: never, once a year or less, a few times a year, one to two times/month, one time/week, several times per week, daily, several times per day. Similar to previous research suggesting that the presence of any unhealthy weight control behavior is "high risk" (Neumark-Sztainer et al. 1999), students reporting at least one unhealthy weight control behavior in the past year were classified as high risk.

Stress management and sleep

Participants were asked to rate their ability to effectively manage their stress in the past month on a scale of 1–10 (1=ineffective, 10=very effective), and poor stress management was classified as those reporting ≤5 on this scale (Nelson et al. 2008a). In addition, students were asked to report how many days in the past week "[you] got enough sleep so that [you] feel rested when you wake up in the morning?" For these analyses, inadequate sleep was dichotomized at less than five nights, as a means of defining "most" nights of the week, as has been used in previous research in other fields (Haskell et al. 2007).

Tobacco, alcohol and other risky behaviors

Students responded to survey items covering a wide range of additional risk behaviors. These included:

1.   Smoking cigarettes in the past 30 days (seven response options, ranging from 0 to all 30 days). Given the widely recognized risks associated with any tobacco use (US Surgeon General's Report 2004), the final analyses compared any versus no smoking in the past 30 days.

2.   Binge drinking (≥5 drinks at one sitting) of alcohol in the past 2 weeks (seven response options ranging from "I don't drink" or 0 to ≥10 times). Binge drinking was dichotomized as any versus no binge drinking in the past 2 weeks, based on previous research (Nelson et al. 2009).

3.   Engaging in risky sexual behavior. Students were asked "were you intoxicated the last time you had oral, vaginal or anal intercourse?" Response options were: not applicable (not sexually active), yes, no, not sure. Similar to other work in this area (Eisenberg et al. 2005), high risk was identified by responses of yes and not sure.

4.   Drunk driving. Students were asked "in the past 30 days how many times did you operate a car or other vehicle when you had been impaired due to alcohol consumption?" Given the well-known risks associated with drunk driving and emphasis on this area from widely disseminated public health campaigns, responses ranged from 0 to ≥6 times, and any intoxicated driving was considered high risk (US Surgeon General 2004).

Sociodemographic characteristics

Self-reported data were collected on gender, year in school (1st–5th year undergraduate student) and age.

Data management and descriptive statistics

Surveys were completed by students on scan-ready forms and scanned to create an electronic database. Standard data cleaning involved identifying a limited number of unlikely outlying values from open-ended response items (e.g., weight, height, age). Basic descriptive statistics were calculated, and the prevalence of key variables was examined. Data management and descriptive statistics were calculated using Stata software, version 9.0 (STATA Corporation, College Station, TX, 2005).

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 (Adamson et al. 2007; Agrawal et al. 2007; Dierker et al. 2007; Padmadas et al. 2006; Reboussin et al. 2006). In this research, we hypothesized that complex lifestyle patterns exist within this large sample of college students, and that these meaningful patterns may encompass a wide range of health behaviors (e.g., diet, physical activity, substance use, stress, sleep and other risk behaviors). Therefore, we sought to identify the underlying patterns (or classes) of behavior based on student responses to ten specified lifestyle characteristics and risk behaviors using LCA. The selection of the variables included in these analyses was based on previous literature suggesting risks associated with these behaviors within the context of a larger conceptual framework for lifestyle characteristics, particularly within a college setting, 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. Similar to previous applications of these LCA methods, dichotomous variable specifications were selected for the final analysis to enhance the interpretability of the findings. As described above, risk-based cut-points were carefully selected based on previous research (where available). Behaviors associated with higher health risk were coded as '2,' and lower risk as '1.'

Using SAS version 9.1 (Release 9.1. Cary, NC: SAS Institute Inc.), the PROC LCA command procedure was used to estimate model parameters (Lanza et al. 2007). 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 (Lanza et al. 2007).

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 five classes). Given the known differences in prevalence and patterning of risk behaviors between males and females, analyses were stratified by gender. Of the 2026 undergraduate survey respondents, three were missing data on gender, and thus were excluded from these analyses. To ensure that the maximum likelihood solution was correctly identified within these models, 100 iterations of each model (i.e., from two to five classes) were run using randomly generated seed values. The resulting G^2 criterion values were compared across the 100 iterations; the dominant solution (i.e., that which most frequently resulted in the same G^2 value using the randomly generated seeds) was identified as the maximum likelihood solution.

In selecting the final model solution, we specifically examined the BIC and AIC criteria across models fit separately for males and females. The BIC and AIC criteria are widely accepted for LCA methods (Lanza et al. 2007), even though BIC performs slightly better than the AIC (Yang 2006). Previous work has shown that the AIC tends to overestimate and BIC tends to underestimate the number of classes present (McLachlan and Peel 2000). We have included criteria for gender-specific two-, three-, four-, and five-class models in Table 1. For illustrative purposes, we also present two additional fit criteria, in addition to those available through the PROC LCA procedure, which may provide additional insights into model fit; these indices include BIC* (BIC using an adjusted sample size calculation) and CAIC (a consistent version of AIC). Yang (2006) provides a detailed discussion of the development and utility of these indices.

In that these indices may not uniformly point to a single model specification (and may over- or underestimate the number of classes present), the specific model estimates for both four- and five-class models were examined to select a final model specification based on the interpretability of the findings, as well as theory and previous findings in the literature. Based on these criteria, we identified that the four-class model was the most appropriate for the data. In our models, the G^2 estimates were less than the model's degrees of freedom, a proposed rule of thumb for identifying a reasonably good model fit (Lanza et al. 2003).

Finally, within PROC LCA a grouping function can be utilized so that group-specific parameters may be generated (Lanza et al. 2007). Thus, probability estimates are allowed to vary by group membership. To assess for measurement invariance once we had selected our final four-class model, we ran two nested, multi-group LCA procedures to compare the freely estimated model with a model where measurement parameter estimation was restricted across groups (i.e. for males and females; Lanza et al. 2007). By comparing the G^2 difference of these models ($G^2_{restricted} - G^2_{unrestricted} = 132.93$) to a chi-square distribution with the degrees of freedom (*df*) equal to the difference in degrees of freedom between the model ($df_{restricted} - df_{unrestricted} = 40$), our analyses indicated that measurement invariance should be rejected ($p < 0.001$) and males and females should be estimated separately. Lanza et al. (2007) provide an extensive review of these procedures.

Results

Descriptive Characteristics of the Sample

Approximately 38% of the undergraduates responding to the survey were male. Nearly 83% of the analysis sample was White/Caucasian, with the remaining 17% being African American/Black, American Indian, Asian Pacific Islander, Latino/Hispanic, other or mixed race, which reflects the racial/ethnic composition of the campus. The mean age of the sample was 21.8±4.2 years (median 21 years). These characteristics largely reflect the composition of undergraduate students enrolled at the University (which was 17% non-White, mean age 21.8 years), with the exception of gender (48% males enrolled as undergraduates; University of Minnseota Office of Institutional Research and Reporting).

Table 2 details prevalence estimates for the ten risk behaviors included in the LCA analysis. The prevalence of these behaviors ranged from 10.2% (being intoxicated during last sexual intercourse) to 75.9% (achieving inadequate sleep on ≥5 days in the past week), reflecting the broad range of characteristics captured within these analyses.

Latent Class Findings

Four latent classes were identified for each of two sub-groups of undergraduates: females and males. The response probabilities for each of the ten risk-associated behaviors are

detailed by each of the latent classes in Table 3. These probabilities can be used to characterize the four classes.

Comparison between gender sub-groups yielded a differentiation in class definition among females and males. Figure 1 facilitates comparison of the classes across gender groups.

The four distinct classes were detected among females:

1. *Class 1* (poor lifestyle, low risk) in females are considered poor in terms of the factors traditionally characterized as lifestyle and wellness factors (e.g., diet, physical activity, sleep), yet unlikely to engage in behaviors traditionally-characterized as risk behaviors (e.g., smoking, binge drinking, sexual risk taking, drunk driving). For example, among females these participants have the highest probability of: not exercising (item-response probability 0.78), having poor diets (e.g. low fruit/vegetable intakes, 0.72) and having poor sleep habits (0.87). This class comprised approximately 40% of the sample, and was the largest of any of the four female classes.

2. *Class 2* (higher risk) may be characterized as high risk, particularly in regard to those more traditionally conceptualized risk behaviors. Class 2 has the highest probability of smoking, binge drinking, intoxicated sex and drunk driving. In addition, members of class 2 were also more likely to report poor fruit/vegetable consumption (0.68) and inadequate sleep (0.81). This class represents nearly one in four females (24.3%).

3. *Class 3* (moderate lifestyle, low risk) comprising 20.4% of the sample, appeared moderate in lifestyle characteristics and low in risk behaviors. This class had the lowest probability of unhealthy weight control behaviors (0.11), smoking (0.01), and poor sleep (0.53). Other risk behaviors were also low (e.g., binge drinking, intoxicated sex, drunk driving), though there was substantial heterogeneity amongst some lifestyle characteristics (diet, physical activity).

4. *Class 4* ("health conscious") among females could be considered health conscious with some disordered eating characteristics. This class yielded the most favorable diet and physical activity characteristics (with the lowest probability of poor exercise (0.16), poor fruit and vegetable intake (0.21) and frequent fast food intake (0.00)), yet also had the highest probability of unhealthy weight control behaviors (0.55). In comparison to the other classes, the probabilities of smoking, binge drinking and poor stress management were moderate in class 4, whereas those of intoxicated sex and drunk driving were low. This class represents 15.4% of females in the sample.

Among males, four distinct classes were also detected, which had some similarities to females:

1. *Class 1* (poor lifestyle, low risk) for undergraduate men was characterized by poor lifestyle factors (e.g., physical activity, diet) but low risk behaviors (e.g., alcohol use, risky sexual behavior). In this class there was a 100% probability of poor stress management and insufficient sleep, which was much more pronounced than any of the findings observed elsewhere in our data. Class 1 represents 9% of men.

2. *Class 2* (the higher risk class) had a high probability of traditional risk behaviors, and notably a 95% probability of binge drinking among men. Class 2 represents one in three undergraduate males (33.6%).

3. *Class 3* (moderate lifestyle, low risk) had the lowest probability of frequent fast food intake (0.21) and poor fruit/vegetable intake (0.63, which is still high, despite

being low relative to the other classes), though there is still notable heterogeneity within the class amongst these factors. The probabilities of smoking (0.08), binge drinking (0.11), intoxicated sex (0.03), and drunk driving (0.01) were lowest for class 3. Approximately half of undergraduate men (51.0%) were categorized in this class.

4. *Class 4*, characterizing 6.2% of males, possibly represents a class of what could be called "classic" jocks. Male members of this class had the lowest probability of inadequate physical activity (0.32), coupled with relatively high probabilities of binge drinking (0.88), intoxicated sex (0.85) and drunk driving (0.54), particularly compared to the other classes. Males in this class had inadequate sleep patterns (0.89) and had the highest probability of unhealthy weight control behaviors (0.50) as compared to other classes among the males.

Comparison of the Classes by Gender

The classes yield some similarities and differences by gender. The higher-risk classes (class 2 for females and males) were similarly characterized by high-risk behaviors, though among males this class had a low probability of poor stress management (0.17), whereas among females the probability of poor stress management was substantially higher (0.41). The probability of membership for the higher-risk classes was comparable between males (34%) and females (24%). The moderate lifestyle/low-risk classes (class 3 for females and males) were also similar in how they were characterized; however this class represented many more males (51%) compared to females (20%). The poor lifestyle/low-risk classes (class 1 for females and males) yielded some similarities across gender, with the exception that poor stress management was substantially higher among males in this class (1.0) compared to females (0.51). In addition, this class represented only 9% of males, versus 40% of females. Finally, two classes were uniquely defined within the gender groups; these included classic jocks (class 4 for males) and health conscious (class 4 for females) classes.

Discussion

Overall, these findings suggest that a meaningful patterning of risk behaviors and lifestyle characteristics occurs among college youth. This patterning helps link a wide array of factors such as diet, physical activity, stress, sleep, tobacco use, high-risk alcohol use and risky sexual behaviors. In addition, our analyses identified four distinct behavioral patterns for both males and females. Though some classes were similarly observed across gender (such as high risk, poor lifestyle/low risk and moderate lifestyle/low-risk classes), class membership by gender was not necessarily equivalent. In addition, unique classes were also identified within gender groups, including health conscious (with some disordered eating) among females and classic jocks among males. These findings highlight important issues in the potential need for gender-focused prevention programming on campuses. To our knowledge, this is the first research to examine complex lifestyle patterning among college youth, particularly with emphasis on the role of weight-and lifestyle-related behaviors. These analyses provide important insights into the health needs of this unique population and help us better understand how to target much-needed health promotion strategies among emerging adults. In addition, this work demonstrates the utility of sophisticated analytic tools, such as LCA, in understanding complex relationships like these. Such insights would not be possible within the constraints of standard statistical approaches to data analysis, such as linear or logistic regression.

Selection of the Number of Classes

Given that the traditional fit indices used in model selection (e.g., BIC, AIC) may not uniformly point to a single model specification (and may over or underestimate the number

of classes present), investigators must also select a final model specification and the total number of classes by considering issues such as interpretability of results, theory and previous findings in the scientific literature. In our data, we identified that the four-class model was the most appropriate for both males and females. Not only did the four-class models fit with several of our a priori hypotheses (e.g., that there would be a class of students high in traditional risk behaviors, as well as the fact that there would be a combination of more and less favorable wellness and lifestyle factors distributed within the student who were low in traditional risk behaviors), but it also fit with previous research. For example, previous work has found that binge drinking may be particularly associated with adverse wellness-related factors among males, compared to females (Nelson et al. 2009); this finding is consistent with our classic jock class that emerged among males only. In addition, the emergence of the health conscious class among females only is supported by the high prevalence of weight concerns and disordered eating practices among females, particularly of this age, compared to males (Nelson et al. 2008b).

Implications of Classes of Risk Behaviors

Our findings indicate that among college youth, all major classes of individuals are in need of improvement in diet-and physical activity-related risk behaviors. In contrast, the traditional risk behaviors assessed here (e.g., tobacco use, alcohol use, risky sexual behavior) show clear distinctions across classes, with some classes reporting very high risk behavior and others reporting very low risk behavior. However, even within the most favorable behavioral profiles identified (i.e., moderate lifestyle/low-risk, class 3 for both males and females) many individuals in these classes were not meeting recommendations for routine physical activity and/or dietary intake. For example, though individuals in the moderate lifestyle/low risk class exhibited favorable behavioral characteristics in comparison to the other classes, they still had a relatively high probability of having sub-optimal fruit and vegetable intake (0.62 for females, 0.63 for males) and inadequate vigorous physical activity (0.52 for females, 0.55 for males). These results are somewhat surprising, particularly in that there was no latent class identified in which none of the selected health risk behaviors (i.e., including diet-and physical activity-related factors) were exhibited. These findings underscore the substantial need for effective diet and physical activity promotion strategies targeting many different types of students that attend post-secondary institutions.

Clearly a variety of health promotion needs exist on campus. In our sample, approximately one in every four females and one in three males were classified in the high risk classes, exhibiting elevated risk for both traditional risk behaviors (e.g., substance use) as well as lifestyle characteristics (e.g., diet, physical activity). These students may be in the greatest need of health-related interventions, though the intervention strategies best-suited to the needs of these individuals may differ widely from the intervention strategies that would be most appropriate for other student groups (such as those in the poor lifestyle/low-risk and/or moderate lifestyle/low-risk classes). Students who may be facing increased challenges and difficulties, and thus engage in risky behavior as a means of coping with these challenges, may not receive a beneficial impact, for example, from a "5-a-day" fruit and vegetable marketing campaign on campuses. Rather, to effectively improve factors like diet and activity among these high-risk students, a quite different approach may be needed, such as intervention strategies focusing on building coping mechanisms to promote resiliency amidst unhealthy social norms and helping students in managing their overall lives and the stresses that may accompany them. The college years are a challenging time for many youths, representing an age when responsibilities are increasing dramatically and individuals are required to begin making a range of important decisions, all while balancing the other increasing demands of work, school, friends and family. Quite simply, diet and physical

activity may not currently be high priorities for some students, and health promotion strategies need to be cognizant of this as they are developed and implemented in the hopes of improving campus health.

In contrast to the high-risk classes of students, other classes exhibit much lower probabilities for engaging in traditional risk behaviors (e.g., poor lifestyle/low risk, moderate lifestyle/ low-risk classes), and thus a more straightforward approach to improving diet and physical activity may be appropriate for these individuals. However, despite the low prevalence of risky behavior in these groups, it is important to note that the presence of other adverse lifestyle factors may or may not act as a barrier to or serve to discourage healthy diet and physical activity patterns. For example, poor stress management and inadequate sleep are prominent in the lives of many college students, as supported by these findings as well as previous work in the area (Nelson et al. 2008a; Tsai and Li 2004; Voelker 2004). Only a few studies to date have explored how these factors are associated with poor dietary intake, physical inactivity and adverse weight-related outcomes, particularly among emerging adults, but there is growing evidence to suggest that such associations exist (Cizza et al. 2005; Gangwisch et al. 2005; Nelson et al. 2008a). Additional work is needed to gain a better understanding of these issues.

Overall, our findings indicate that while similar in several respects, males and females exhibit different behavioral patterns during these years. Though more males were classified in the moderate lifestyle class compared to females (51.0% versus 20.4%, respectively), simple descriptive analyses indicate that males overall had a higher prevalence of a range of adverse behaviors compared to females, including less fruit/vegetable intake, more frequent fast food consumption, more cigarette use, more high-risk alcohol use, and more risky sexual behavior. This work suggests that males have specific health needs that differ from that of females. However, of the limited work that has been conducted to explore weight status, eating patterns and physical activity among emerging adults, most has focused on females (Butler et al. 2004; Hovell et al. 1985; Levitsky et al. 2004; Matvienko et al. 2001; Megel et al. 1994; Morrow et al. 2006); young men of this age have largely not been targeted in this research to date. Among college and university students, national data indicates that males are less academically and institutionally engaged than females (National Survey of Student Engagement 2007), and thus may be particularly difficult to engage in campus-based health promotion interventions and events, particularly those focused around weight status and eating habits. Recent research following students from enrollment as freshmen until graduation as seniors found that college males gained an average of 9.3 lbs during this time, whereas females only averaged 3.8 lbs of weight gain (Racette et al. 2008). Though to some extent this may reflect continued skeletal and muscle gain among males of this age, it likely reflects excess body fat gain as well. Thus, additional work is needed to understand how best to engage and intervene with males at this age, as well as the means by which researchers can better facilitate recruitment of young men into research studies.

Limitations

Despite the interesting implications of these findings, several limitations of our work are important to note. The University of Minnesota is one of the largest public universities in the USA, which may limit the ability to generalize these findings to students attending small, private or 2-year post-secondary institutions across the country. However, of students currently enrolled in US post-secondary institutions, nearly 77% attend public institutions and over half of these (almost 6.5 million) attend large public universities with over 15,000 students (National Center for Education Statistics 2006). Similar to previous research in this area, the survey response rate among males was disproportionately low. It is possible that the males that responded to the survey are not representative of all enrolled, undergraduate males, though we can only speculate as to the ways in which they might differ. In addition,

the survey tools used to collect our data may limit our findings. To maximize the efficiency of our needs assessment efforts, much of the survey has been based on single-item indicators of risk. More in-depth assessments of each of the behavioral factors assessed in these analyses likely would reduce error and provide higher validity in characterizing behavioral patterns. Furthermore, though dichotomizing risk variables is an approach that is commonly used in LCA and may aid in the interpretability and communication of findings, there may be some loss of sensitivity that results from categorizing the data in this way.

Finally, though post-secondary institutional settings may provide an important framework for the delivery of health promotion interventions, it is important to note that a significant proportion of high-risk youth at this age is not enrolled in colleges and universities. Much additional research is needed to understand the lifestyles and health behaviors of these populations.

Conclusions

Additional research is also needed in this area to explore the transience of risk behavior patterning as emerging adults age and as undergraduate students leave college. Though some may feel that undergraduate college life is a unique period characterized by fleeting lifestyle patterns, recent research has suggested that there may be some similarities between undergraduate youth and older age groups (i.e., those in their late 20s, 30s and beyond; Nelson et al. 2009). However, these emerging adult years seemingly continue to increase in duration, with the continued delays in the age at which both men and women achieve major "adult" events such as leaving their parents' homes, obtaining stable employment, getting married, and having children (Galston 2007). Given these delays, emerging adult behavior patterns may be displayed across a growing number of years, both allowing these patterns to have a greater impact on long-term health and disease risk and providing more of an opportunity for patterns to firmly take root and become long-term patterns that are sustained well into adulthood.

In summary, these findings suggest a unique co-variation in risk behaviors and lifestyle characteristics occurring among college youth, resulting in patterns of a wide range of factors such as diet, physical activity, stress, sleep, substance use and risky sexual behaviors. These analyses provide important insights into how we might target much-needed health promotion strategies among college youth that would best suit their needs. Much additional research, however, is needed to understand the modifiable determinants of these behavioral patterns and the specific mechanisms through which effective intervention can take place.

Acknowledgments

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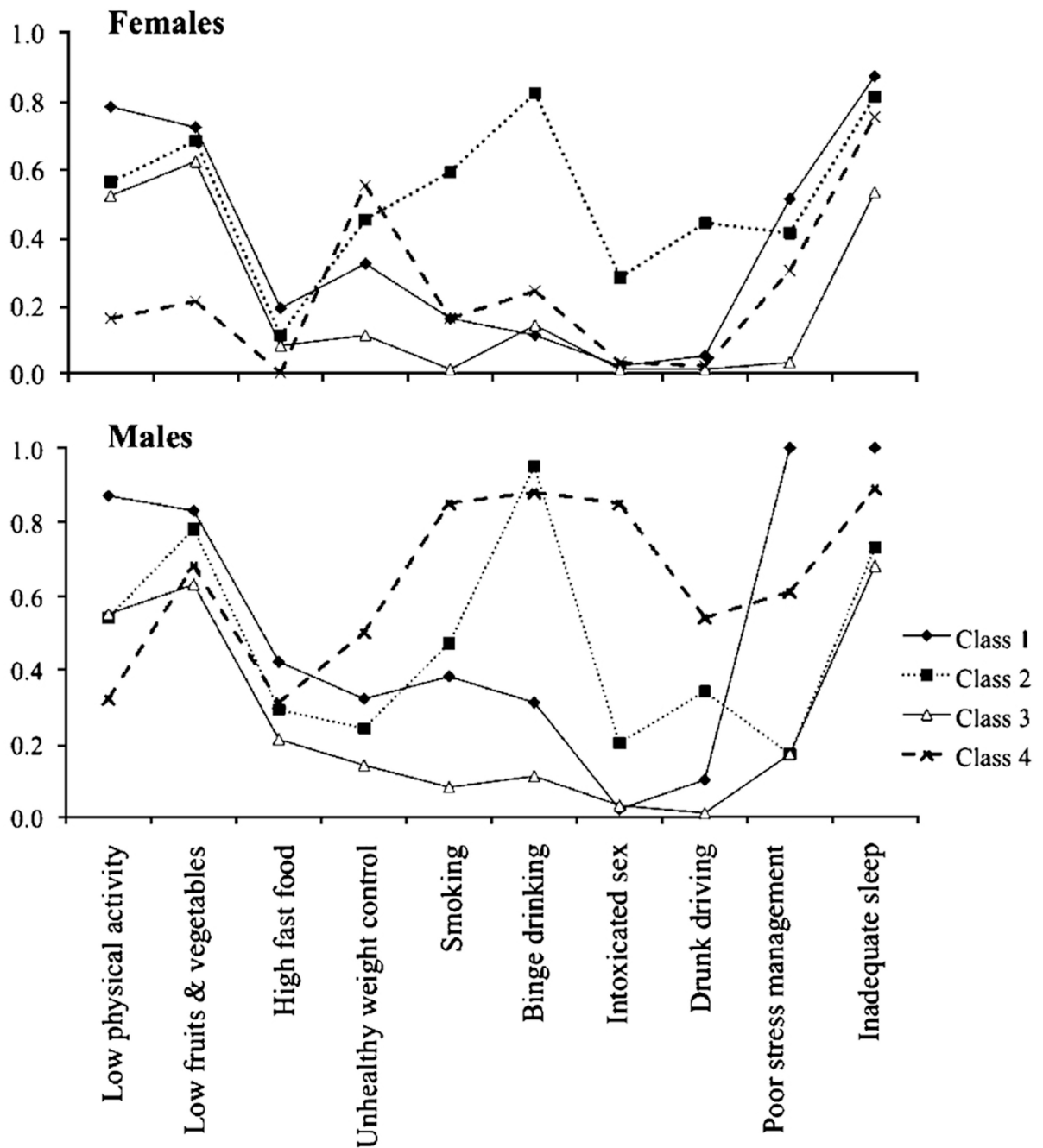**Fig. 1.**
Graphical displays of item-response probabilities for various risk behaviors across each of
the four classes resulting from LCA. **A** In females, *class 1* is poor lifestyle/low risk, *2* higher
risk, *3* moderate lifestyle/low risk, *4* health conscious. **B** In males, *class 1* is poor lifestyle/
low risk, *2* is higher risk, *3* is moderate lifestyle/low risk, *4* is classic jock

Table 1

Criteria to assess model fit for gender-specific LCA models

	Females				Males			
	2 class	3 class	4 class	5 class	2 class	3 class	4 class	5 class
AIC	788.6	727.2	701.7	710.5	704.2	675.8	669.6	659.2
BIC	896.6	891.6	922.7	988.0	801.6	824.2	868.9	909.5
BIC*	829.9	750.3	706.8	697.6	734.9	687.9	663.2	634.2
CAIC	917.6	842.2	802.9	797.8	822.6	779.8	759.2	734.4
G^2	746.6	663.2	615.7	602.5	662.2	611.8	583.6	551.2
DF	1002	991	980	969	1002	991	980	969

AIC Akaike Information Criterion, *BIC* Bayesian Information Criterion, *BIC** Bayesian Information Criterion using sample size adjustment, *CAIC* Consisent AIC (Yang 2006)

Table 2

Prevalence of key behavioral factors among undergraduate college students

	Gender		Total (%)
	Female (%)	Male (%)	
Vigorous physical activity (≥20 min) on <3 days/week	57.8	56.1	57.1
<5 daily servings of fruits/vegetables	61.3	70.1[*]	64.6
Fast food at least several times per week	11.9	26.4[*]	17.4
≥1 unhealthy weight control behavior[a] in past year	34.3	21.1[*]	29.4
Smoked cigarette(s) in the past 30 days	23.2	28.7[*]	25.2
Binge drank (alcohol) in the past 2 weeks	30.8	45.9[*]	36.5
Was intoxicated during last sexual intercourse	8.4	13.4[*]	10.2
Drove drunk in the past 30 days	12.9	16.0	14.0
Poor stress management[b]	35.3	27.0[*]	32.2
Inadequate sleep on ≥5 days in the past week	77.0	73.9	75.9
Total (n=2,023)	62.3	37.7	-

Total sample=2,023 (all undergraduate survey responders with non-missing gender data), though sample sizes for individual analyses vary slightly due to missing data

[a] Unhealthy weight control behaviors include using laxatives, taking diet pills, binge eating and inducing vomiting

[b] Stress management was reported on a scale ranging from 1 (not effective) to 10 (very effective). Poor stress management was classified as ≤5

[*] $p<0.01$

Table 3

Latent class analyses among undergraduate students: Probability of latent class membership and item-response probabilities within each of the four classes

	Females				Males			
	Class 1: Poor lifestyle, low risk	Class 2: Higher risk	Class 3: Moderate lifestyle, low risk	Class 4: Health conscious	Class 1: Poor lifestyle, low risk	Class 2: Higher risk	Class 3: Moderate lifestyle, low risk	Class 4: Classic jock
Probability of latent class membership within classes	40.0% (n=504)	24.3% (n=306)	20.4% (n=257)	15.4% (n=194)	9.2% (n=70)	33.6% (n=256)	51.0% (n=389)	6.2% (n=47)
Health behaviors[a]								
Vigorous physical activity (≥20 min) on <3 days/week	0.78	0.56	0.52	0.16	0.87	0.54	0.55	0.32
<5 daily servings of fruits/vegetables	0.72	0.68	0.62	0.21	0.83	0.78	0.63	0.68
Fast food at least several times per week	0.19	0.11	0.08	0.00	0.42	0.29	0.21	0.31
≥1 unhealthy weight control behavior in past year	0.32	0.45	0.11	0.55	0.32	0.24	0.14	0.50
Smoked cigarette(s) in the past 30 days	0.16	0.59	0.01	0.16	0.38	0.47	0.08	0.85
Binge drank in the past 2 weeks	0.11	0.82	0.14	0.24	0.31	0.95	0.11	0.88
Was intoxicated during last sexual intercourse	0.02	0.28	0.01	0.03	0.02	0.20	0.03	0.85
Drove drunk in the past 30 days	0.05	0.44	0.01	0.02	0.10	0.34	0.01	0.54
Poor stress management	0.51	0.41	0.03	0.30	1.00	0.17	0.17	0.61
Inadequate sleep on ≥5 days in the past week	0.87	0.81	0.53	0.75	1.00	0.73	0.68	0.89

Sample sizes are estimated based on probability of latent class membership within classes

[a] Item-response probabilities within each class