Substance Use and Obesity Trajectories in African Americans Entering Adulthood

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Introduction: The transition to adulthood can be stressful for minority adolescents, and many may cope through unhealthy behaviors, including substance use and obesity-related behaviors. This study tested substance use and obesity trajectories over time in African American youth, longitudinal associations of trajectories with mental and physical health in adulthood, and whether self-control and sex predict trajectories.

Methods: Two longitudinal studies of 516 and 992 African American adolescents. In Study 1, substance use and obesity trajectories were assessed from ages 19 to 25 years. At age 25 years, internalizing and externalizing problems, metabolic syndrome, and inflammatory biomarkers were measured. In Study 2, substance use and obesity trajectories were assessed from ages 17 to 29 years. Depression, delinquency, diabetes, blood pressure, and inflammatory biomarkers were measured at age 29 years. Data analyses were conducted in 2017.

Results: Across both studies, the majority of African American adolescents evinced poor health behavior trajectories (latent class growth analyses), with 23%−27% showing increasing substance use over time, 18%−27% showing increasing obesity over time, and 9%−11% showing increases in both. ANCOVAs for trajectory analyses revealed that males were more likely to evince increasing substance use, with females more likely to show increasing obesity. Substance use trajectories were associated with poorer mental health in adulthood; obesity trajectories with poorer physical health in adulthood. Those with good health behavior trajectories had higher self-control in early adolescence.

Conclusions: The transition to adulthood is a vulnerable period for many African Americans. Given the commonalities of substance use and obesity in their rewarding/stress-relieving properties, similar prevention efforts may help stem the rise of both in these youth.
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INTRODUCTION

The transition to young adulthood is stressful for many adolescents, particularly those from low-income, minority families. Along with poverty and discrimination,[1,2] many youth encounter limited job opportunities with low wages and poor conditions, making the transition to productive adult roles difficult and demoralizing.[3−5]

One way individuals cope with stressors of inequality is by engaging in unhealthy behaviors.[6,7] In particular, these stressors may facilitate substance use (smoking, alcohol, drug use) and overeating of comfort foods.[7]

These behaviors share similarities. Both have short-term psychological benefits in alleviating stress.[7] Both have addictive qualities, such that people can have difficulty controlling their behaviors around these substances.[8−10] Both are related to impulsivity.[11] As well, the rewarding properties of both are mediated through

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dopaminergic pathways in the ventral striatum,[8,10,12] and there is evidence that both compete for the same brain reward pathways.[9,10]

Previous research on these behaviors traditionally focused on either childhood or adulthood, but not the transition from one to the other.[13] Additionally, research on longitudinal trajectories typically focused on one behavior,[14,15] but not both within one study. The first study goal is to characterize the developmental trajectories of both substance use and obesity during the transition to adulthood in African American youth, with two distinct trajectories hypothesized: youth on the path to substance use and youth on the path to obesity.

This study also tested the consequences of these behaviors for adult health.[7] Substance use increases risks for mental health problems, including depression, anxiety, and delinquent behaviors.[16−19] Obesity heightens risk for type 2 diabetes, metabolic syndrome (MetS), and cardiovascular disease.[20−23] Thus with substance use, risks may be primarily to mental (not physical) health, whereas with weight gain, risks may be to physical (not mental) health. The second study goal is to test associations of developmental trajectories of substance use and obesity with adult mental and physical health outcomes. For physical health, cardiometabolic outcomes relevant in young adulthood are assessed, including MetS, diabetes, and inflammatory markers predictive of cardiovascular disease.[24−26] For mental health, youth psychopathology researchers conceptualize two broadband dimensions: internalizing problems (including anxiety, depression) and externalizing problems (including delinquent and aggressive behaviors).[27,28]

Next, factors that predicted which youth went onto which trajectories were tested, focusing on one demographic and one psychological factor. Previous research suggests sex differences in these behaviors.[7] African American females show high rates of obesity over the life course,[29] perhaps because comfort eating is a culturally accepted approach to dealing with inequality stressors in this group. By contrast, African American males show higher rates of substance use in adulthood,[30] perhaps because this approach to dealing with stressors is more culturally accepted in this group. This study hypothesizes that females would more often go onto the obesity trajectory, whereas males would more often go onto the substance use trajectory.

Additionally, previous research has implicated impulsivity as common to both substance use and eating problems.[11] Self-regulation failures play a role in the consumption of substances and diet violations.[31] This study hypothesized that youth who in early adolescence showed high self-control (being planful, avoiding temptations) will be protected against going onto substance

use or obesity trajectories during the transition to adulthood.

This study presents results from a 15-year longitudinal study of rural, southern African American youth, testing the hypotheses that: (1) there will be distinct trajectories of substance use and obesity as African American youth transition to adulthood, (2) trajectories will be associated with mental and physical health problems in adulthood, and (3) sex and self-control will predict substance use and obesity trajectories. Results were confirmed in a second data set: the National Longitudinal Study of Adolescent Health (Add Health), a 14-year longitudinal nationally representative study of U.S. adolescents (focusing analyses on the subsample of African Americans).

STUDY 1 METHODS

The Appendix (available online) provides additional details.

Study Population

Data were drawn from the Strong African American Families Healthy Adult Project (SHAPE). SHAPE enrolled 667 African American children (mean age=11 years; see Brody et al.[32] for a full description). All were from rural towns in Georgia; economically, the sample was working poor (Appendix, available online).

Seventy-seven percent (*n*=516) provided data during follow-up waves (ages 19−25 years) on substance use and BMI. The latent class trajectory analyses focused on this group. For analyses with physical and mental health outcomes, 391 participants were used who were selected (for cost purposes) for a substudy of health, and provided blood samples at age 25 years. At baseline, participants were randomized into a parenting intervention; because intervention status was not associated with independent or dependent variables in this article, participants were combined, and intervention status included as a covariate. Data collection spanned 2001−2016; data were analyzed in 2017. Approval was received from the University of Georgia's IRB and written assent/consent was obtained.

Measures

When youth were aged 19, 20, 21, and 25 years, they reported past-month cigarette, alcohol, and marijuana use.[33] Consistent with previous research,[34,35] substance use was operationalized as one construct composed of these three behaviors.

BMI was assessed at ages 19, 20, 21, and 25 years by interviewers. Obesity was defined as BMI ≥ 30.

At age 25 years, MetS was diagnosed according to the International Diabetes Federation guidelines.[36]

Table 1. Sample Characteristics for SHAPE and Add Health

Characteristics	SHAPE sample, % (*n*=516)	Add Health sample, % (*n*=992)
Youth sex (female)	54.5	60.6
Parent education (less than high school)	18.1	14.7
Parent education (high school or GED)	33.5	34.5
Parent education (college graduate or higher)	48.5	50.8
Family poverty status	54.7	24.5
Parent unemployment status	34.3	23.6
Single-parent status	60.9	49.0

Add Health, National Longitudinal Study of Adolescent Health; GED, General Educational Development test; SHAPE, Strong African American Families Healthy Adult Project.

At age 25 years, C-reactive protein (CRP) and pro-inflammatory cytokines (interleukins 6 and 10, tumor necrosis factor−α) were measured. Cytokines were standardized and summed.

At age 25 years, depressive symptoms and anxiety were measured[37,38] and combined into one composite. Externalizing problems were assessed.[39]

At ages 11−13 years, teachers rated participants' self-control.[40]

Statistical Analysis

Latent growth curve models were executed to characterize trajectories of substance use and obesity across ages 19−25 years. A Zero Inflated Poisson model was used for substance use. A latent growth curve model with binary outcomes (logistic regression) was used for obesity. Full information maximum likelihood models were used to estimate missing values. Latent class growth analyses were used to determine how many distinct classes of trajectories there were for each behavior (substance use, obesity). Participants were coded based on which classes they fell into across each of the two health behaviors; thus four groups were created (those in both the low obesity and low substance use trajectory classes, low obesity/high substance use, high obesity/low substance use, high obesity/high substance use).

Associations of trajectory groups with adult mental and physical health outcomes, and with earlier predictors, were tested. One-way ANCOVAs examined whether mental and physical health differed among the four substance use/obesity groups (sex and intervention status controlled). One-way ANCOVAs examined associations of the four substance use/obesity groups with self-control (sex and intervention status controlled) and with sex (intervention status controlled).

STUDY 1 RESULTS

Table 1 presents demographic information. Table 2 and the Appendix (available online) present results.

Latent class growth analysis fit indices suggested a parsimonious two-class solution (low and increasing over time versus high and increasing over time) for both substance use and obesity trajectories (Appendix, available online). The percentages in each of the four groups were: low substance use/low obesity 35.5%, low substance use/high obesity 26.9%, high substance use/low obesity 26.6%, and high substance use/high obesity 11.0%.

A group main effect was found for: MetS, $F(3, 386)$ =13.046, $p<0.001$; pro-inflammatory cytokines, $F(3, 386)$ =6.345, $p<0.001$; and CRP, $F(3, 386)$=44.504, $p<0.001$. Post-hoc comparisons revealed that at age 25 years, MetS was more prevalent in the high obesity groups than the low obesity groups (Appendix Table 3, available online).

Results for inflammatory biomarkers mirrored MetS; participants in the high obesity groups had higher cytokines and CRP at age 25 years than participants in the low obesity groups.

Main effects of group emerged for: internalizing problems, $F(3, 403)$=4.252, $p<0.005$; and externalizing problems, $F(3, 403)$=11.075, $p<0.001$. Post-hoc analyses revealed that participants in the high substance use groups experienced greater internalizing and externalizing problems at age 25 years than those in the low substance use groups.

Females were more likely to be in the high obesity/low substance use group and males were more likely to be in the high substance use/low obesity group, $F(3, 511)$ =23.424, $p<0.001$ (Table 4).

A main effect was found, $F(3, 511)$=6.274, $p<0.001$, indicating that the low substance use/low obesity group was rated by teachers at ages 11−13 years as having higher self-control than participants in the other groups.

Appendix Table 4 (available online) presents post-hoc tests.

STUDY 2 METHODS

The Appendix (available online) provides details.

Study Population

Data were drawn from Add Health, a nationally representative sample of adolescents in seventh to 12th grades (see Harris[41] for a full description). The sample for this

Table 2. Differences in Preadolescent Self-Control and Young Adult Physical and Mental Health by Trajectory Groups, Ages 19−25 Years: SHAPE

Variables	Trajectory groups				F
	Low substance use/low obesity	Low substance use/high obesity	High substance use/low obesity	High substance use/high obesity	
Ages 11−13 years (teacher), n	183	139	137	57	
Self-control, M (SE)	31.209[a] (0.607)	29.283[b] (0.709)	27.715[b] (0.731)	27.013[b] (1.084)	**6.274*****
Age 25 years (physical health), n	126	114	103	48	
Metabolic syndrome, n (%)	10 (7.9)[a]	35 (30.7)[b]	6 (5.8)[a]	16 (33.3)[b]	**13.046*****
Cytokine composite, M (SE)	0.803[a] (0.052)	1.090[b] (0.056)	0.899[a] (0.061)	1.121[b] (0.085)	**6.345*****
CRP (log), M (SE)	0.340[a] (0.032)	0.803[b] (0.034)	0.394[a] (0.037)	0.757[b] (0.051)	**44.504*****
Age 25 years (mental health), n	136	117	104	51	
Internalizing problems, M (SE)	−0.229[a] (0.149)	−0.247[a] (0.164)	0.281[b] (0.178)	0.605[b] (0.243)	**4.252****
Externalizing problems, M (SE)	4.439[a] (0.605)	5.092[a] (0.664)	8.532[b] (0.723)	9.788[b] (0.984)	**11.075*****

Note: All tests controlled for sex and intervention status. Boldface indicates statistical significance (**$p<0.01$, ***$p<0.001$).
[a,b]Means with different superscripts are significantly different from each other based on post-hoc LSD comparisons ($p<0.05$).
CRP, C-reactive protein; LSD, least significant difference; SHAPE, Strong African American Families Healthy Adult Project.

study included participants ages 15−17 years at Wave 1 (focusing on later adolescence, same as Brody et al.[42]), who self-identified as African American, and who had complete data on substance use and BMI at Waves 2 (1 year post-baseline), 3 (7 years post-baseline), and 4 (14 years post-baseline) (*n*=992). Data collection occurred between 1994 and 2008; data were analyzed in 2017.

Measures
Respondents reported past-month smoking and marijuana use during Waves 2−4. Given the low frequency, a dichotomous variable was formed, indicating whether or not cigarettes or marijuana were used.

BMI was calculated from in-home assessments during Waves 2−4. Obesity was defined as BMI ≥ 30.

Physical health measures included blood pressure, CRP, and diabetes measured by trained interviewers at Wave 4. Whole blood spots were collected for CRP, HbA1C, and glucose. Diabetes classification is explained in the Appendix (available online).

At Wave 4, depressive symptoms and delinquency were measured.[37,43]

As a proxy for self-control, grades/grade point averages were assessed at Wave 1 from student transcript data, with the rationale that those who are higher in self-control would have higher grades.[44]

The same analytic approach was followed as with SHAPE, except that sample weights (which adjust for unequal selection probability and allow unbiased estimates of population parameters) were included as a covariate.

STUDY 2 RESULTS

Table 3 and the Appendix (available online) present results.

Latent class growth analyses fit indices suggested a parsimonious two-group solution (low and increasing over time versus high and increasing over time) for both substance use and obesity trajectories (Appendix, available online). The percentages in each group were: low substance use/low obesity 50.1%, low substance use/high obesity 18.0%, high substance use/low obesity 23.0%, and high substance use/high obesity 8.9%.

A main effect was found for: systolic blood pressure, $F(3, 953)=19.732$, $p<0.001$; diastolic blood pressure, $F(3, 953)=11.798$, $p<0.001$; CRP, $F(3, 852)=49.787$, $p<0.001$; and diabetes, $F(3, 986)=8.061$, $p<0.001$. Post-hoc comparisons revealed that at Wave 4, higher blood pressure, CRP, and diabetes were found in the high obesity groups compared with the low obesity groups.

Main effects emerged for: depression, $F(3, 986)=5.345$, $p=0.001$; and delinquency, $F(3, 986)=18.449$, $p<0.001$. Post-hoc comparisons revealed that youth in the high substance use groups reported greater depression and delinquent behaviors at Wave 4 than those in the low substance use groups.

Females were more likely to be in the high obesity/low substance use and low obesity/low substance use group. Males were more likely to be in the high substance use/low obesity group, $F(3, 987)=33.239$, $p<0.001$ (Table 4).

A significant main effect, $F(3, 966)=11.235$, $p<0.001$, indicated that youth in the low substance use/low obesity

Table 3. Differences in Adolescent GPA and Young Adult Physical and Mental Health by Trajectory Groups, Ages 17−29 Years: Add Health

Variables	Trajectory groups				F
	Low substance use/low obesity	Low substance use/high obesity	High substance use/low obesity	High substance use/high obesity	
Age 17 years, n	491	175	222	84	
GPA, M (SE)	2.721[a] (0.031)	2.584[b] (0.052)	2.478[b,c] (0.047)	2.341[c] (0.074)	**11.235*****
Age 29 years (physical health), n	497	179	228	88	
Diabetes status, n (%)	54 (10.9)[a]	38 (21.2)[b]	26 (11.4)[a]	23 (26.1)[b]	**8.061*****
Blood pressure, n	481	172	221	85	
Systolic blood pressure, M (SE)	123.031[a] (0.601)	129.827[b] (1.018)	123.036[a] (0.913)	131.548[b] (1.426)	**19.732*****
Diastolic blood pressure, M (SE)	78.432[a] (0.465)	81.980[b] (0.787)	77.912[a] (0.706)	83.780[b] (1.102)	**11.798*****
CRP, n	427	157	196	78	
CRP (log), M (SE)	0.485[a] (0.018)	0.823[b] (0.030)	0.504[a] (0.027)	0.857[b] (0.041)	**49.787*****
Age 29 years (mental health), n	497	179	228	88	
Depressive symptoms, M (SE)	2.555[a] (0.115)	2.523[a] (0.193)	3.125[b] (0.174)	3.510[b] (0.272)	**5.345****
Delinquent behaviors, M (SE)	0.206[a] (0.060)	0.337[a] (0.102)	1.011[b] (0.092)	0.669[c] (0.143)	**18.449*****

Note: All tests controlled for sex and sample weights. Boldface indicates statistical significance (**p<0.01, ***p<0.001).
[a,b,c]Means with different superscripts are significantly different from each other based on post-hoc LSD comparisons (p<0.05).
Add Health, National Longitudinal Study of Adolescent Health; CRP, C-reactive protein; GPA, grade-point average; LSD, least significant difference.

group had higher grade point averages at Wave 1 than the other three groups.

Appendix Table 5 (available online) presents post-hoc tests. Across both studies, patterns were similar if trajectories were created from single substance use variables, rather than the composite variable (data not shown, but available from the authors upon request).

DISCUSSION

Across two samples of African American adolescents, one half to two thirds showed increasingly unhealthy lifestyles during the transition to adulthood, either engaging in substance use (smoking, drinking, drug use) or gaining weight. Both paths were equally likely (27% in each group in SHAPE and 18%−23% in Add Health). A small minority (approximately 10%) started with high levels of both and displayed increasing substance use and weight gain into adulthood. These statistics suggest that both substance use and obesity are common, potentially serious health concerns among African Americans transitioning to adulthood.

Why would this transition be accompanied by a rise in substance use and obesity? This period can be challenging for many lower-income, minority youth, as they struggle to find stable employment while entering adulthood. Such challenges may increase stress and negative mood,[4] which have been associated with drug use and compulsive eating.[7,45] Obesity trajectories may also be driven by sedentary behaviors. An alternative interpretation from life history theory suggests that the contexts in which low-income minority youth live create "desperate environments" that encourage fast-life strategies. These strategies include eating fatty, high-calorie foods even when not hungry (to deal with food insecurity); and impulsively engaging in risky behaviors (e.g., substance use), given a focus on the present.[46]

Though this study did not assess drug addiction per se, researchers have proposed that drug addiction and obesity share underlying mechanisms related to how the brain responds to rewards and compulsive consumption behaviors.[9,10] Both involve behavioral sensitization, whereby repeated exposure to a substance produces a greater response to, and wanting of, that stimulus over time.[47] Sensitization is driven by the dopaminergic system,[48,49] which modulates responses to rewards, motivation to seek rewards, and conditioned learning, all processes dysregulated in drug addiction and overeating of high-sugar/high-fat foods.[8,10] These systems can also be dysregulated in response to chronic stress.[50,51] Thus, the stressors associated with transitioning to adulthood for many African Americans may trigger compulsive but stress-relieving behaviors that, if sustained, could lead to addiction and obesity.

Table 4. Sex Differences in Substance Use and Obesity Trajectory Groups

	Trajectory groups				
Variables	**Low substance use/low obesity**	**Low substance use/high obesity**	**High substance use/low obesity**	**High substance use/high obesity**	***F***
SHAPE sample, *n*	183	139	137	57	
Sex (female), *n* (%)	111 (60.7)[a]	101 (72.7)[b]	37 (27.0)[c]	32 (56.1)[a]	**23.424*****
Add Health sample, *n*	497	179	228	88	
Sex (female), *n* (%)	330 (66.4)[a]	141 (78.8)[b]	82 (36.0)[c]	48 (54.5)[d]	**33.239*****

Note: Analyses in SHAPE controlled for intervention status and analyses in Add Health sample controlled for sample weight. Boldface indicates statistical significance (***$p<0.001$).
[a,b,c,d]Percentages with different superscripts are significantly different from each other based on post-hoc LSD comparisons ($p<0.05$).
Add Health, National Longitudinal Study of Adolescent Health; LSD, least significant difference; SHAPE, Strong African American Families Healthy Adult Project.

What determines whether someone will go down the substance use versus weight gain pathway? One idea is sex. Males are more likely to turn to substances, whereas females are more likely to turn to overeating and may have more sedentary behaviors. These differences may reflect sex norms about culturally sanctioned ways of coping with stress. Future studies are needed that investigate drug use and obesity concomitantly to better understand shared underlying origins.

In terms of antecedents, the present study focused on self-control, but future research could expand to consider other psychosocial factors. For example, research has identified school bonds and parent supervision as protective against substance use in adolescence/adulthood.[30,52] Personality factors, such as low self-esteem, are also associated with substance use trajectories.[53] And childhood adversities, such as maltreatment, are associated with risks of obesity.[54]

In addition, although the percentage was small (approximately 10%), there may be a syndemic nature to the problems of substance use and obesity,[55] and future research should investigate predictors of the group at risk for both.

Trajectories also had implications for health. High substance use trajectories were associated with internalizing and externalizing problems in adulthood. High obesity trajectories were associated with diabetes, MetS, low-grade inflammation, and higher blood pressure in adulthood. Substance use trajectories did not relate to physical health outcomes, and obesity trajectories did not relate to mental health problems. These findings suggest that stemming the rise of substance use and obesity during the transition to adulthood is important not only in its own right, but also for the prevention of mental and physical health problems later in adulthood.

Across the two cohorts, 36%−50% of African American adolescents showed little substance use or weight gain over time. These resilient youth were the ones whose teachers rated them as having high self-control in early adolescence (SHAPE) or who had higher grades in high school (Add Health). When confronting stressors of inequality, lower self-control may make youth more vulnerable to unhealthy coping behaviors.[7]

Limitations

Strengths of this study include the replication of findings across two large samples of African Americans, and the longitudinal component of both studies. The two studies differed in that SHAPE focused on rural, Southern, working poor families, whereas Add Health drew from a nationally representative sample. Although this makes Study 2 not an exact replication of Study 1, Study 2 does increase the generalizability of findings. A strength of Study 1 was that self-control was measured by teacher report (rather than self-report), eliminating biases because of self-presentation desires. Limitations include having no direct measure of diet, and inferring overeating from obesity trajectories. Trajectories reflected a health behavior (substance use) and a health outcome (obesity), rather than both being health behaviors. BMI is limited in its ability to account for muscle mass and changes in body fat with age.[56] Substance use was based on self-report, which could lead to underreporting. In Add Health, dichotomous variables were used for substance use because of low levels of these behaviors. Dichotomous variables may have introduced error into measurements, and findings should be tested for replicability in other samples with higher frequencies of substance use. In addition, the relevance of individual substance use trajectories to outcomes was obscured by the composite substance use variable. This approach served the study's goal of contrasting obesity and substance use trajectories; however, more targeted research is needed for those interested in trajectories related to a specific substance. Grades were used as a proxy for self-

control in Add Health. Follow-ups were done only until ages 25−29 years, and additional youth may develop mental and physical health problems as they progress through adulthood. In addition, the final timepoint of the trajectories was concurrent with the adult mental and physical health assessments. This was necessitated by constraints in the number of timepoints available for analyses in Study 2; however, future study designs that allow for mental and physical health to be separated in time from trajectories of obesity and substance use would be useful. Finally, although it was a strength to focus on African Americans, it is not known whether these findings generalize to other racial/ethnic groups.

CONCLUSIONS

Across two samples, one half to two thirds of African American adolescents transitioning to adulthood exhibited increasingly unhealthy lifestyles, either in the form of substance use or weight gain. Increasing trajectories of substance use were associated with worse mental health in adulthood, whereas increasing trajectories of obesity related to worse physical health in adulthood. These findings highlight the importance of recognizing this transition period as a vulnerable one, and of developing programs to help curb risky behaviors during this period. Youth who showed neither drug use nor weight gain had higher self-control earlier in adolescence. Despite seeming like two different behaviors, substance use and obesity may in fact represent two sides of the same coin for many youth. The same prevention efforts may help stem the rise in multiple mental and physical health problems among African American youth.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2018.07.004.

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