Poly-product drug use disparities in adolescents of lower socioeconomic status: Emerging trends in nicotine products, marijuana products, and prescription drugs

Mariel S. Bello[a], Rubin Khoddam[a], Matthew D. Stone[b], Junhan Cho[c], Yoewon Yoon[d], Jungeun Olivia Lee[d], Adam M. Leventhal[a,b,*]

[a] *University of Southern California, Department of Psychology, 3620 South McClintock Avenue, SGM 501, Los Angeles, CA, 90089, USA*
[b] *University of California, San Diego School of Medicine, Department of Family Medicine and Public Health, 9500 Gilman Drive, La Jolla, CA, 92093, USA*
[c] *University of Southern California Keck School of Medicine, Department of Preventive Medicine, 2001 North Soto Street, 3rd Floor, Los Angeles, CA, 90032-9045, USA*
[d] *University of Southern California, Suzanne Dworak-Peck School of Social Work, 669 W 34th St, Los Angeles, CA, 90089, USA*

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ABSTRACT

Greater diversification of nicotine products, marijuana products, and prescription drugs have contributed to increasing trends in adolescent poly-product use—concurrent use of 2 or more drugs—within these drug classes (e.g., nicotine use via e-cigarettes, hookah, cigars). Extant work suggests that poly-product drug use disparities may be disproportionately heightened among youth from lower socioeconomic status (SES) backgrounds, however, it is unknown whether indicators of objective SES or subjective SES differentially increase risk of poly-product use including these newly emerging drugs. This study examined associations of parental education and subjective social status (SSS: perceptions of social standing compared to society [societal SSS] or school [school SSS]) with poly-product use of nicotine products, marijuana products, and prescription drugs among adolescents ($N = 2218$). Lower parental education and school SSS were associated with increased odds of past or current single, dual, or multiple product use of nicotine, marijuana, and prescription drugs. Findings suggest that risk for poly-product use of emerging drugs are higher for adolescents who endorse lower perceived social standing relative to peers at school and who were from a lower parental SES background.

1. Introduction

Recent shifts in the tobacco landscape and the legalization of medical and recreational marijuana in the United States has resulted in a proliferation and availability of new and diverse forms of alternative nicotine products (e.g., e-cigarettes, cigars, hookah) and marijuana products (e.g., marijuana edibles, marijuana vaping, blunts) that are gaining popularity among youth (Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2016). Additionally, current prevalence estimates for adolescent use of prescription drugs for non-medical reasons have generally followed an increasing trend since 1976 (McCabe et al., 2017). With the increasing diversification in forms of nicotine, marijuana, and prescription drugs available, youth substance use increasingly takes a more complex form (Creamer, Perry, Harrell, & Diamond, 2015; Lee, Hebert, Nonnemaker, & Kim, 2015; Peters, Bae, Barrington-Trimis, Jarvis, & Leventhal, 2018). Particularly, the prevalence of poly-product drug use that involves these three classes of drugs—the concurrent utilization of two or more products within each of these drug classes—has substantially increased in youth (Arrazola et al., 2015; Harrell, Naqvi, Plunk, Ji, & Martins, 2017; Soneji, Sargent, & Tanski, 2014).

Extensive work has shown that the use of one nicotine product is associated with concurrent use of other nicotine products (Gilpin & Pierce, 2003; Nasim, Khader, Blank, Cobb, & Eissenberg, 2012; Schuster, Hertel, & Mermelstein, 2012). Epidemiological data from the 2017 National Youth Tobacco Surveys indicated that the use of multiple nicotine products is prevalent among youth, such that approximately 2 out of 100 middle school students (2.4%) and 9 out of 100 high school students (9.2%) reported current use of ≥ 2 nicotine products in the past 30 days (Wang et al., 2018). Although trend analyses demonstrate

significant nonlinear decreases in the overall prevalence of current use of ≥ 2 nicotine products among high school students (12.0%–9.2%) and middle school students (3.8%–2.4%) during 2011–2017 (Wang et al., 2018), youth poly-nicotine product use still warrants attention given that youth who use multiple nicotine products are at higher risk for developing nicotine dependence and may be more likely to continue using nicotine products throughout adulthood (USDHHS, 2000). Regarding marijuana use, a recent study found that 61.8% of youth who used marijuana were poly-product users of marijuana by ≥ 2 administration methods (consumption of marijuana via combustibles, edibles, or vaping) and 24.2% used all three products (Peters et al., 2018). In a sample of youth who reported prescription drug use for non-medical reasons, 19.7% reported using 2 different prescription drug classes and 8.9% reported using 3 or more different prescription drugs (Simoni-Wastila, Yang, & Lawler, 2008). The increasing prevalence is particularly concerning as there is growing evidence suggesting that adolescent poly-product drug use (vs. single product use) may be associated with more frequent use of multiple products (i.e., using more days in the past month; Demissie, Jones, Clayton, & King, 2017), increased engagement in other risky behaviors such as using alcohol and other illicit drugs (Demissie et al., 2017), and subsequent development of substance dependence (Cavazos-Rehg, Krauss, Spitznagel, Grucza, & Bierut, 2014) and other adverse mental health outcomes (Cho et al., 2018; Leventhal et al., 2016). Collectively considering that earlier onset of substance use can result in more severe long-term substance use problems, morbidity, and early mortality in adulthood (King & Chassin, 2007; Mathers, Toumbourou, Catalano, Williams, & Patton, 2006; Riggs, Chou, Li, & Pentz, 2007; Trenz et al., 2012), advancing our knowledge base on salient factors underlying problematic youth substance use, such as poly-product drug use, is critical to effectively reduce the public health burden triggered by youth substance use.

Socioeconomic disparities in adolescent substance use have been established across studies examining associations between objective indicators of socioeconomic status (SES), such as parental education, and single use of traditional forms of substances (e.g., cigarettes, marijuana, prescription painkillers; Andrabi, Khoddam, & Leventhal, 2017; Bachman, O'Malley, Johnston, Schulenberg, & Wallace, 2011; Chen, Matthews, & Boyce, 2002; Leventhal et al., 2015; Sung, Richter, Vaughan, Johnson, & Thom, 2005; Unger, Sun, & Johnson, 2007). Whether these socioeconomic disparities found in prior work extend to poly-product drug use of nicotine, marijuana, or prescription drugs has not been well-studied. To date, there are only two studies that have examined objective SES and adolescent poly-product use. One longitudinal study that utilized the Family Affluence Scale as a measure of objective SES found that adolescents of lower SES was associated with a greater likelihood of being an ever poly-nicotine product user and current user of 2 or more nicotine products relative to adolescents with higher SES (Simon et al., 2017). Another recent longitudinal study reported inverse associations of parental education with increased odds of single or dual marijuana product use (Peters et al., 2018). Although no existing study to our knowledge has focused on poly-prescription drug use in U.S. youth, findings drawn from adult literature suggests that older adults with lower educational attainment had a higher probability of using three or more prescription drugs relative to those with greater education levels (Haider, Johnell, Weitoft, Thorslund, & Fastbom, 2009). Given that prior theoretical models propose that adolescents of lower parental SES backgrounds may be at increased risk of substance use as a consequence of being disproportionately exposed to a range of family-related stressors (e.g., parental psychological distress as a result of job instability or family substance use; Conger & Donnellan, 2007; Masten et al., 1988; Wilens et al., 2002), substance-related advertisements (Barbeau, Leavy-Sperounis, & Balbach, 2004), and tobacco and/or marijuana retail outlets (Henriksen et al., 2008; Shi, Meseck, & Jankowska, 2016) within their disadvantaged environment, it is imperative to explore associations of objective SES with poly-product use in light of newly emerging drugs which are becoming increasingly popular among adolescents in the U.S.

In contrast to studies focusing on "objective" SES status measures (Pampel, Krueger, & Denney, 2010), discussion about the influence of subjective social status (SSS) on adolescent substance use, let alone poly-product use, is relatively absent (Quon & McGrath, 2014). Whereas objective socioeconomic status assesses a person's place within a hierarchy in a given society using established markers, such as education, occupation, and income (Braveman et al., 2005), SSS aims to capture a person's own subjective perception of their social standing. SSS is typically assessed by asking adolescents where they would see themselves on a picture of a ladder representing a hierarchy within their country's society or within their school (Goodman et al., 2001). Unique utility and advantage of SSS has been argued in the context of youth health (Goodman et al., 2001; Quon & McGrath, 2014). While objective SES measures may be useful for determining individual differences among younger children, they may decrease in relevance for adolescents who gain more independence and establish their own schema to understand and interpret a societal hierarchy (Hanson & Chen, 2007a; West & Sweeting, 2004). Further, an adolescent's perceptions of their social standing relative to others within their school community (school SSS) may be a particularly important SES factor contributing to adolescent poly-product drug use, given that adolescents spend more time with their peers in school (Goodman et al., 2001; Hanson & Chen, 2007a; West & Sweeting, 2004). Taken together, it is feasible that adolescents' subjective social status, particularly school SSS, may function as an important SES factor for youth poly-product use. No identified studies have evaluated these possibilities.

Although existing work has not yet investigated the impact of SSS on adolescent poly-product use, there is suggestive evidence supporting that SSS is indeed associated with specific type of products, but findings are yet inconclusive. On one hand, few U.S.-based studies have demonstrated that students with lower school SSS were at increased risk for cigarette smoking initiation and current smoking in contrast to students with higher school SSS (Finkelstein, Kubzansky, & Goodman, 2006; Wilkinson et al., 2009; Wilkinson, Shete, Spitz, & Swann, 2011). On the other hand, prior research with a sample of socioeconomically disadvantaged youth from Mexico found that societal SSS—an adolescent's perceptions about their social standing relative to others in Mexican society—and school SSS were differentially related to substance use, such that youth with higher levels of school SSS were more likely to be current smokers and drinkers (vs. lower school SSS), while youth with lower societal SSS reported current smoking and drinking (vs. those with greater societal SSS; Ritterman et al., 2009). To date, there are no published studies that have investigated and compared relations of objective SES and SSS with poly-product drug use of new, emerging nicotine products, marijuana products, and prescription drugs among U.S. adolescents aged 16 years old, leaving the importance of two dimensions of SES in shaping youth substance use of newly emerging and rapidly increasing substances unidentified.

This cross-sectional study of 11th grade high school students in Los Angeles, CA expands upon the literature by comparing associations of parental education and SSS with past or current single, dual, or multiple product use of nicotine products (cigarettes, hookah, cigars, e-cigarettes), marijuana products (marijuana, marijuana edibles, marijuana vaping, blunts), and prescription drugs (stimulants, painkillers). Specifically, we focus on these three classes of substances, as they represent types of substances with rapid evolvement in delivery methods and exponential increase in popularity among youth. Consistent with prior work, we hypothesized that lower parental education would be associated with a greater likelihood of lifetime or current single, dual, or poly-product use of nicotine products, marijuana products, or prescription drugs. Considering a lack of consensus regarding the direction in association between SSS and poly-product drug use, we do not put forth hypotheses regarding how SSS dimensions may differ with regards to the measures of poly-product drug use among adolescents.

2. Methods

2.1. Participants and procedures

The present study utilized cross-sectional data from a longitudinal study of mental health and substance use among adolescents enrolled in 10 public high schools in the greater Los Angeles, CA, USA metropolitan area. All students who were not enrolled in English as a Second Language Programs or special education courses (i.e., students with learning disabilities) were eligible to partake in the study ($N = 4100$). Among the 4100 students who were eligible, 3874 (94.5%) provided active written or verbal assent, and 3396 (82.8%) provided active written or verbal parental consent. Each participating school was selected based on its adequate representation of diverse demographic characteristics; the percent of students eligible for free lunch within each school (i.e., student's parental income $\leq$ 185% of the national poverty level) on average across the ten schools was 31.1% ($SD = 19.7$, range: 8.0%–68.2%). Paper-and-pencil surveys were distributed once every 6 months beginning at the start of 9th grade (Wave 1; Fall Semester, 2013; $N = 3383$) through the start of 11th grade (Wave 5; Fall Semester, 2015; $N = 3235$). Students were informed that their responses would be confidential and not shared with their teachers, parents, or school staff. Each participating school was compensated $2500 for their general activity fund; students were not individually compensated, but were given small incentives (e.g., pens, keychains). The study is approved by the University of Southern California Institutional Review Board.

2.2. Measures

2.2.1. Parental education

Highest level of parental education was assessed only at 9th grade (Wave 1) using ordinal forced choice item for each parent (1 = *8th grade or less*, 2 = *Some high school*, 3 = *High school graduate*, 4 = *Some college*, 5 = *College graduate*, 6 = *Advanced degree*). Based on prior work (Andrabi et al., 2017; Lee et al., 2017; Leventhal et al., 2015), we utilized the highest education level across the two parents in our analyses; if data is available for only one parent, that parent's score was used. Extensive research examining associations between SES and adolescent substance use have utilized parental education as the key objective marker for adolescent SES (Andrabi et al., 2017; Bachman et al., 2011; Finkelstein et al., 2006; Lee et al., 2017; Leventhal et al., 2015; Unger et al., 2007).

2.2.2. MacArthur Scale of Subjective Social Status (SSS)

Societal and school SSS was assessed at 11th grade (Wave 5) via the adolescent version of the MacArthur Scale of Subjective Social Status (Adler, John, & Catherine, 2007; Goodman et al., 2001). The 10-rung ladder image that assessed societal SSS is an ordinal forced choice item that included the following instructions: "Imagine that this ladder pictures how American society is set up. Now think about your family. Please tell us where you think your family would be on this ladder." The top rung was labeled "the best off people in America—they have the most money, the highest amount of schooling, and the jobs that bring the most respect" and the bottom rung represented "the worst-off people in America—they have the least money, little or no education, no jobs or jobs that no one wants or respect."

The 10-rung ladder image that assessed school SSS is an ordinal forced choice item that included the following instructions: "Now assume that the ladder is a way of picturing all the students in your school. Where would you place yourself on this ladder?" The top rung represented "the people in your school with the most respect, the highest grades, and the highest standing" while the bottom rung was labeled as "the people who no one respects, no one wants to hang around with, and have the worst grades." The MacArthur Scale has been shown to be a reliable and valid measure of subjective perceptions

of social status among adolescents (Goodman et al., 2001; Singh-Manoux, Marmot, & Adler, 2005).

2.2.3. Lifetime & current specific product use & poly-product use

Each specific drug was assessed at 11th grade via standard validated items used in epidemiologic surveys of adolescents (Eaton et al., 2010; Johnston et al., 2016). For past use, students were asked whether they had ever used any of the following 10 products for recreational purposes or to get "high": cigarettes, e-cigarettes, cigars, hookah water pipe, marijuana, marijuana edibles, marijuana vaping, blunts, prescription painkillers, and prescription stimulant pills. These responses were coded as binary outcomes (0 = *No*, 1 = *Yes*) for past use of each specific drug. Current use (i.e., frequency of recreational use in the past 30 days) was assessed for each specific product and coded as a binary outcome (0 days = *No*, 1–30 days = *Yes*).

Two sets of poly-product drug use outcomes within each drug class were computed: (a) the total number of nicotine products (cigarettes, hookah, cigars, and e-cigarettes; range 0–4), marijuana products (marijuana, marijuana edibles, marijuana vaping, and blunts; range 0–4), or prescription drugs (stimulants, painkillers; range 0–2) a participant had ever used in their lifetime (past use) and; (b) the total number of nicotine products (range 0–4), marijuana products (range 0–4), or prescription drugs (range 0–2) a participant had used currently (past 30 days). Nicotine and marijuana poly-use outcomes were then collapsed into four categories (0 = *No use*; 1 = *Single-product use*, 2 = *Dual-product use*, or 3+ = *Poly-product use*) due to the small stratum specific cell sizes of participants endorsing the use of all 4 nicotine products or all 4 marijuana products in both lifetime or past 30 days outcomes. Adolescents who reported that they used one product within each drug class were categorized as "single-product" users. Adolescents who reported that they used two products within each drug class were considered as "dual-product" users and those who reported using 3+ products within each drug class were "multiple product" users.

2.2.4. Covariates

Covariates included age, gender, and 7 dummy variables representing each of seven racial/ethnic groups (American Indian or Alaskan Native, Asian, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander, Multiracial, Other, with White as the reference group). These demographic factors have been shown to be associated with substance use and SES variables and therefore may confound key associations (Andrabi et al., 2017; Bachman et al., 2011; Lee et al., 2017; Leventhal et al., 2015).

2.3. Analytic approach

Descriptive statistics for parental education, SSS, substance use outcomes, and covariates were calculated and intercorrelations were also examined among SES measures (see Tables 1–3). Polytomous (multinomial) logistic regression models were then conducted to test associations of each SES or SSS variable with the following nominal outcomes: 1) the number of nicotine products used (0, 1, 2, or 3 + products); 2) the number of marijuana products used (0, 1, 2, or 3 + products); and 3) the number of prescription drugs used (0, 1, or 2 prescription drugs). Separate models were tested for lifetime (past use) and current (past 30-day use) designations relative to never use, with school-level random effects and one observation per respondent. Univariable SES and SSS models controlled for demographic characteristics (age, gender, and ethnicity) and school (as a random effect) and are reported in the online supplement. Multivariable models simultaneously included all SES and SSS variables after controlling for demographics and the random effect of school (see Table 4).

Odds ratios (ORs) and 95% confidence intervals (CI) are reported. To compare the resulting ORs directly, all SES and SSS measures were standardized (z-scored) and reverse scored to facilitate ease of interpretation, such that ORs greater than 1 indicated increasing odds of

Table 1
Sample Characteristics among 11th grade adolescents.

Sociodemographic Variables	Overall Sample (N = 2218)	Substance Use[c]	
		Lifetime Users (N = 1403)	Never Users (N = 786)
Age,[b] *M (SD)*	16.49 (0.40)	16.51 (0.41)	16.45 (0.39)
Gender,[a] *n (%)*			
Female	1209 (54.6%)	781 (55.8%)	413 (52.6%)
Male	1005 (45.4%)	619 (44.2%)	372 (47.4%)
Race/Ethnicity,[a] *n (%)*			
American Indian or Alaskan Native	17 (0.8%)	12 (0.9%)	5 (0.6%)
Asian	393 (18.0%)	167 (12.1%)	222 (28.6%)
Black or African American	103 (4.7%)	65 (4.7%)	38 (4.9%)
Hispanic or Latino	962 (44.0%)	693 (50.1%)	253 (32.6%)
Native Hawaiian or Pacific Islander	81 (3.7%)	57 (4.1%)	24 (3.1%)
White	381 (17.4%)	237 (17.1%)	141 (18.1%)
Multiracial	124 (5.7%)	70 (5.1%)	51 (6.6%)
Other	126 (5.8%)	82 (5.9%)	43 (5.5%)
Parental Education,[a] *n (%)*			
8th grade or less	86 (3.9%)	59 (4.2%)	25 (3.2%)
Some high school	197 (8.9%)	151 (10.8%)	45 (5.7%)
High school graduate	340 (15.3%)	239 (17.0%)	98 (12.5%)
Some college	428 (19.3%)	296 (21.1%)	122 (15.5%)
College graduate	723 (32.6%)	425 (30.3%)	291 (37.0%)
Advanced degree	444 (20.0%)	233 (16.6%)	205 (26.1%)
Skewness	-.61	–	–
Kurtosis	-.49	–	–
Subjective Social Status (SSS)[b]			
Societal SSS, *M (SD)*	5.99 (1.66)	5.94 (1.69)	6.09 (1.61)
1st Quartile (1–5), *n (%)*	825 (37.2%)	544 (38.8%)	270 (34.4%)
2nd Quartile (6), *n (%)*	556 (25.1%)	354 (25.2%)	194 (24.7%)
3rd Quartile (7–10), *n (%)*	837 (37.7%)	505 (36.0%)	322 (41.0%)
Skewness	.02	–	–
Kurtosis	.01	–	–
School SSS, *M (SD)*	6.81 (1.81)	6.70 (1.85)	7.02 (1.73)
1st Quartile (1–6), *n (%)*	915 (41.3%)	616 (43.9%)	283 (36.0%)
2nd Quartile (7), *n (%)*	456 (20.6%)	297 (21.2%)	153 (19.5%)
3rd Quartile (8–10), *n (%)*	847 (38.2%)	490 (34.9%)	350 (44.5%)
Skewness	.49	–	–
Kurtosis	.23	–	–

Note. N = 2189–2218 due to missing data for specific covariates. SSS = MacArthur Scale of Subjective Social Status (range 1–10).
[a] Wave 1 data from 9th grade students collected in Fall 2013.
[b] Wave 5 data from 11th grade students collected in Fall 2015.
[c] Substance Use defined as endorsement of lifetime use of any substance at Wave 5. 1st Quartile = 25th percentile; 2nd Quartile = 50th percentile (Median); 3rd Quartile = 75th percentile.

poly-product use with lower levels of parental education or lower perceived positions within the social hierarchy. Significance was set to 0.05 (two-tailed) and raw p-values for the polytomous logistic regression models were considered statistically significant after correction for multiple testing using the Benjamini-Hochberg method to control for the false discovery rate (Benjamini & Hochberg, 1995). All analyses were conducted using IBM SPSS Version 24 (IBM, 2016).

Sensitivity analysis utilizing five multiply imputed datasets with the missing at random assumption for sociodemographic data were conducted to handle missing covariate data (*n* = 105), which did not appreciably change results. Additional sensitivity analyses are summarized below and detailed in the online supplement Table 2. Supplementary analyses then retested the univariable and multivariable models for each specific substance use outcome (i.e., cigarettes, hookah, cigars, e-cigarettes, marijuana, marijuana edibles, marijuana vaping, blunts, and prescription drugs) using polytomous logistic regression and are reported in the online supplement (see online supplement Tables 3 and 4).

3. Results

3.1. Participant accrual analyses and sample characteristics

To address the primary aims of the study, we focused only on students who had completed all key objective and subjective SES measures. Some students did not complete all the survey items within the time allotted, were absent on one of the assessment days, or elected to not complete the measures at 11th grade (*n* = 135). Participants who did not provide data on parental education at baseline (9th grade; *n* = 100) or those who selected the response "Don't know" for both parents' education level at baseline (9th grade; *n* = 365) were not included in the sample (N = 2796). Furthermore, those who did not have complete data for both measures of SSS at 11th grade (*n* = 578) were excluded from the sample, leaving us with a final analytic sample of N = 2218 students (see Supplementary Fig. 1 for detailed study accrual flow chart). Some groups of students excluded from the primary analysis were significantly older and had different gender and race/ethnicity compositions (see online supplement Table 2).

Descriptive statistics for sociodemographic characteristics, poly-product use, and specific product use outcomes are reported in Tables 1 and 2. Approximately 72% of students reported having parents who have completed either some college, graduated college, or having obtained an advanced degree, and the *M (SD)* for societal SSS and school SSS were 5.99 (1.66) and 6.81 (1.81), respectively (Table 1).

Intercorrelations among study variables are illustrated in Table 3. Male gender was associated with greater school SSS (*r* = 0.04, *p* < .05). Additionally, there were modest intercorrelations between SES variables (*rs* = 0.09-0.28, *ps* < .0001).

Table 2
Prevalence of Poly-Product Use and Specific Product Use Outcomes among 11th grade Adolescents.

Substance, n (%)	Past Use	Current Use
Poly-Products		
Nicotine Products		
Never Use	1238 (56.6%)	–
Use of 1 Nicotine Product	334 (15.3%)	117 (5.4%)
Use of 2 Nicotine Products	257 (11.8%)	50 (2.3%)
Use of 3+ Nicotine Products	163 (7.5%)	27 (1.2%)
Marijuana		
Never Use	1418 (64.9%)	–
Use of 1 Marijuana Product	141 (6.5%)	73 (3.3%)
Use of 2 Marijuana Products	144 (6.6%)	79 (3.6%)
Use of 3+ Marijuana Products	211 (9.7%)	120 (5.5%)
Prescription Drugs		
Never Use	1811 (83.0%)	–
Use of 1 Prescription Drug	204 (9.3%)	47 (2.2%)
Use of 2 Prescription Drugs	92 (4.2%)	29 (1.3%)
Specific Products		
Cigarettes	234 (10.7%)	83 (3.8%)
Hookah	529 (24.2%)	74 (3.4%)
Cigars	226 (10.4%)	34 (1.6%)
E-Cigarettes	671 (30.8%)	120 (5.5%)
Marijuana	450 (20.7%)	247 (11.3%)
Marijuana Edibles	364 (16.7%)	145 (6.6%)
Marijuana Vaping	214 (9.8%)	80 (3.7%)
Blunts	348 (16.0%)	166 (7.6%)
Prescription Stimulants	145 (6.7%)	43 (2.0%)
Prescription Painkillers	265 (12.2%)	62 (2.8%)

Note. N = 2176–2188 due to missing data for specific substance use outcomes at Wave 5.

Table 3
Intercorrelations between study variables.

Measures	Intercorrelations (r)				
	1.	2.	3.	4.	5.
1. Age	–				
2. Gender	.07**	–			
3. Parental Education	-.04	.01	–		
4. Societal SSS	.02	.03	.23†	–	
5. School SSS	.04	.04*	.09†	.28†	–

Note: N = 2218; Correlations among continuous variables are Pearson correlation coefficients. Correlations between continuous and dichotomous variables are point-biserial correlation coefficients. Gender (Female = 0, Male = 1). SSS = MacArthur Scale of Subjective Social Status (range 1–10). *p < .05, **p < .01, ***p < .001, †p < .0001.

3.2. Associations of parental education and SSS with poly-product use

Multivariable models demonstrated significant inverse associations of parental education and school SSS with increased odds of within-drug class single, dual, or multiple product use of nicotine products, marijuana products, and prescription drugs within one's lifetime and within the past 30 days (ORs: 0.80 [95% CI: 0.72–0.88] to 1.71 [95% CI: 1.24–2.35]; see Table 4). These results can be interpreted as, per the example that, each 1 SD unit decrease reported on the school SSS ladder was significantly associated with 68% (95% CI: 1.15–2.43) increased odds of being a current multiple nicotine product user (vs. never user). Univariable models showed a similar pattern of association (online supplement Table 1).

Specifically, we found that lower parental education was associated with increased odds of being a past or current single or dual product user of nicotine products (ORs: 1.44 [95% CI: 1.19–1.75] to 1.71 [95% CI: 1.24–2.35]) and dual or multiple product user of marijuana products relative to never use (ORs: 1.36 [95% CI: 1.08–1.72] to 1.43 [95%

CI: 1.14–1.79]), while lower school SSS was associated with greater odds of current single or multiple nicotine product use (ORs: 1.23 [95% CI: 1.07–1.41] to 1.68 [95% CI: 1.15–2.43]) and past or current single or dual prescription drug use (vs. never use; ORs: 1.35 [95% CI: 1.17–1.54] to 1.42 [95% CI: 1.10–3.73]). The effect sizes of these associations were of small to medium magnitude (Cohen's ds = 0.11-0.30). In contrast, lower societal SSS was related to reduced odds of current use of a single marijuana product (OR: 0.80 [95% CI: 0.72–0.88]), with a small effect size (Cohen's $d = -0.12$).

3.3. Associations of parental education and SSS with specific product use

Univariable models are shown in the online supplement Table 3. Multivariable models that simultaneously included all SES variables as regressors after adjusting for covariates and school effects demonstrated inverse associations of parental education with greater likelihood of past e-cigarettes, marijuana edibles, and blunts use (vs. never use; ORs: 1.30 [95% CI: 1.12–1.51] to 1.46 [95% CI: 1.16–1.83]; see online supplement Table 4). Relative to never users, lower school SSS was associated with being a past or current user of cigars, e-cigarettes, prescription stimulants, and prescription painkillers (ORs: 1.11 [95% CI: 1.03–1.20] to 2.03 [95% CI: 1.57–2.62]). No significant associations were found for societal SSS and use of specific products and effect sizes for significant associations were of small to medium magnitude (Cohen's ds = 0.06–0.39).

4. Discussion

Our study is the first to provide evidence of differential relations between objective SES (parental education) and subjective social status with poly-product use of new and diverse forms of nicotine products, marijuana products, and prescription drugs in a large, socioeconomically diverse sample of 11th grade adolescents. Consistent with previous adolescent research focusing on objective SES (Peters et al., 2018; Simon et al., 2017), we found that lower parental education was associated with greater probability of being a lifetime or current single, dual, or multiple product user of nicotine or marijuana products compared to those with higher parental education. However, our results demonstrating that lower school SSS was associated with increased odds of poly-nicotine product and prescription drug use, illustrates that both measures of SES capture overall risks for poly-product use of nicotine products but also differentially associate with specific types of substances. This suggests that risks for using newly emerging nicotine products among adolescents may be strongly driven by SES disparities, but associations of parental education with marijuana use and school SSS with prescription drug use may potentially be influenced by different mechanisms. These findings add to a scarce knowledge base of sociodemographic variables underlying youth poly-product use and provides critical insights into understanding the impact of objective and subjective SES markers on poly-product-related disparities affecting youth who are socioeconomically disadvantaged.

There are some plausible theoretical interpretations for why objective SES such as parental education may be associated with youth poly-product use of nicotine and marijuana products. The family stress model proposes that financial difficulties may have adverse effects on parents' emotions, behaviors, and relationships with their children, which in turn could negatively influence their parenting strategies (Conger & Donnellan, 2007; Conger et al., 2002). Thus, parents of lower education levels and less prestigious jobs may have greater job instability and psychological stress, which may result in greater stress among their children (Conger & Donnellan, 2007; Masten et al., 1988). This may increase the likelihood of their children using nicotine products as a way to cope with elevated levels of stress (Scales, Monahan, Rhodes, Roskos-Ewoldsen, & Johnson-Turbes, 2009). Furthermore, children from lower parental SES backgrounds are more likely to reside with parents struggling with substance use disorders relative to children

Table 4
Multivariable models for association of parental education & subjective social status with poly-product use outcomes.

Poly-Product Use Outcome	Parental Education		Societal SSS		School SSS	
	Past Use	Current Use	Past Use	Current Use	Past Use	Current Use
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Nicotine Products						
Never Use	REF	REF	REF	REF	REF	REF
Use of 1 Nicotine Product	**1.44 (1.19, 1.75)†**	**1.68 (1.23, 2.30)†**	0.92 (0.81, 1.03)	0.93 (0.81, 1.07)	1.06 (0.86, 1.31)	**1.23 (1.07, 1.41)†**
Use of 2 Nicotine Products	1.15 (0.99, 1.34)	**1.71 (1.24, 2.35)†**	1.05 (0.89, 1.25)	0.94 (0.75, 1.19)	1.09 (1.01, 1.18)	1.21 (0.91, 1.61)
Use of 3+ Nicotine Products	1.49 (1.08, 2.07)	0.77 (0.30, 1.94)	0.87 (0.76, 1.00)	1.00 (0.54, 1.87)	1.16 (1.01, 1.33)	**1.68 (1.15, 2.43)†**
Marijuana Products						
Never Use	REF	REF	REF	REF	REF	REF
Use of 1 Marijuana Product	1.13 (0.90, 1.44)	1.30 (0.90, 1.87)	1.08 (0.94, 1.24)	**0.80 (0.72, 0.88)†**	1.03 (0.82, 1.28)	1.17 (0.92, 1.49)
Use of 2 Marijuana Products	1.24 (0.95, 1.63)	**1.36 (1.08, 1.72)†**	1.06 (0.87, 1.29)	0.96 (0.77, 1.19)	1.11 (0.93, 1.32)	1.16 (0.91, 1.49)
Use of 3+ Marijuana Products	**1.43 (1.14, 1.79)†**	1.10 (0.71, 1.70)	1.01 (0.89, 1.15)	0.97 (0.80, 1.18)	1.07 (0.99, 1.15)	1.24 (1.02, 1.52)
Prescription Drugs						
Never Use	REF	REF	REF	REF	REF	REF
Use of 1 Prescription Drug	0.91 (0.66, 1.25)	0.98 (0.57, 1.66)	0.96 (0.78, 1.19)	1.01 (0.70, 1.44)	**1.35 (1.17, 1.54)†**	**1.42 (1.10, 3.73)†**
Use of 2 Prescription Drugs	1.26 (0.88, 1.80)	1.12 (0.66, 1.89)	1.00 (0.83, 1.22)	0.84 (0.44, 1.63)	1.05 (0.82, 1.36)	**1.39 (1.09, 1.78)†**

Note: N = 2218; SSS = MacArthur Scale of Subjective Social Status (range 1–10). Past Use = Lifetime product use. Current Use = Past 30 days product use. Nicotine Products = Cigarettes, Hookah, Cigars, and E-Cigarettes. Marijuana = Marijuana, Marijuana Edibles, Marijuana Vaping, and Blunts. Prescription Drugs = Prescription Stimulants and Painkillers. Multivariable models simultaneously included all SES variables after adjusting for age, gender, ethnicity, and school effects. SES and SSS variables were reverse scored for primary analyses to facilitate ease of interpretation, such that ORs greater than 1 indicated increasing odds of poly-product use with lower parental education or a lower position in the social hierarchy. †Statistically significant after Benjamini-Hochberg correction for false discovery rate.

with higher parental SES (Wilens et al., 2002), which may consequently elevate their risk of developing substance use disorders via increased exposure to parental substance use (Biederman Faraone, Monuteaux, & Feighner, 2000). Additionally, lower SES adolescents may have less access to substance-free, healthy, and enjoyable activities due to neighborhood deprivation (e.g., residing in communities with fewer recreational outlets such as parks) or financial restrictions (e.g., parents with lower levels of education may not have enough financial resources to afford extracurricular activities), which may increase risk for poly-product use. Prior work has shown that the effects of parental education on adolescent substance use may be mediated by involvement in extracurricular activities, such that diminished access to and engagement in substance-free, enjoyable activities may be an underlying mechanism linking lower parental education with greater adolescent substance use risk across multiple substances (i.e., cigarettes, marijuana; Andrabi et al., 2017; Leventhal et al., 2015). Finally, youth from socially disadvantaged backgrounds often live in economically disadvantaged neighborhoods where tobacco-related advertisements (Barbeau et al., 2004) and the density of tobacco retail outlets (Henriksen et al., 2008) are disproportionately concentrated. Examining such possible mechanisms underlying the link between objective SES and adolescent poly-product use might be a fruitful future direction.

Consistent with a prior study (i.e., parental education; Finkelstein et al., 2006), upon further examination of inverse associations between lower school SSS and adolescent specific product use in our supplementary analyses, we found that lower school SSS was particularly associated with increased odds of current cigars, e-cigarettes, and prescription painkiller use and past e-cigarettes, prescription stimulants, and prescription painkiller use. These findings illuminate that distinct dimensions of SES may be associated with specific classes of substances, such that objective SES (parental education) may be sensitive to risk for newly emerging nicotine and marijuana products while school SSS may capture risks for using nicotine products and prescription drugs. Some reasons for why school SSS may be substance specific are perhaps due to lower school SSS adolescents (vs. higher school SSS peers) being more motivated to initiate and then experiment with several drugs because of presumed social benefits of substance use as a tool to make adolescents look "cool" and thus increase their popularity and peer social standing (Wilkinson et al., 2009). Some research supporting this

assertion has shown that youth often learn to experiment with prescription drugs by observing a family member or other members of their social network (Leukefeld, Walker, Havens, Leedham, & Tolbert, 2007) and daily prescription drug use among adult drug users was significantly associated with greater social capital within their social network of drug users (Jonas, Young, Oser, Leukefeld, & Havens, 2012). In addition, given that the school-level SSS captures various dimensions of an adolescent's social status (i.e., academic standing, popularity, and respect from others), adolescents with higher school-level SSS may have higher academic performance and academic aspirations, be involved in more substance-free, extracurricular activities that may be highly regarded by their peers, or generate greater peer popularity, which have all been shown to be protective against substance use (Alexander, Piazza, Mekos, & Valente, 2001; Andrabi et al., 2017; Leventhal et al., 2015). Moreover, it is plausible that associations of greater school SSS with reduced risks of poly-product and specific product use may be reflective of social norms for substance use within school. Research suggests that, in schools with a lower smoking prevalence, youth with higher levels of popularity and social ranking within their school had a reduced likelihood of current smoking relative to their peers with lower popularity, whereas in schools with a higher smoking prevalence, youth with higher popularity (vs. youth with lower popularity) had a greater likelihood of current smoking (Alexander et al., 2001). These results suggest that associations of popularity status and ranking with youth substance use may be influenced by social norms within school, such that for schools with lower smoking prevalence, non-smoking may be normative behavior that is linked to social prestige and vice versa for schools with higher smoking prevalence (Alexander et al., 2001). Considering that parental SES is relatively stable over time and not particularly malleable, future efforts that examine whether changes in school SSS via prevention and individual-level intervention strategies, such as personalized normative feedback (Lewis & Neighbors, 2006), may be beneficial in reducing adolescent drug use by addressing lower school-level SSS adolescents' beliefs about social norms regarding substance use.

Our results also showed that elevated societal SSS was associated with current single marijuana product use. Given that the societal SSS ladder was designed to be more representative of traditional SES (such as parental education), it is unclear why this result was not consistent

with the inverse associations found between parental education and marijuana product use, although this finding may be reflective of some research suggesting that higher SES teens may also be at risk for marijuana use due to having increased access to financial resources and spending money (vs. teens of lower SES; Hanson & Chen, 2007b; Luthar & Latendresse, 2005). Future longitudinal work should continue to explore the differential effects of objective SES and SSS dimensions on adolescent poly-product drug use outcomes to further clarify which distinct SES markers may be more strongly associated with poly-product use across the lifespan.

The current study is subject to several limitations. First, the cross-sectional design of the current analysis precluded causal inferences. Future prospective studies should examine these associations utilizing longitudinal data to determine the effects of SSS on adolescent poly-product use over time or determine whether associations between SSS dimensions and adolescent poly-product drug use may be bidirectional in nature. Second, parental education and SSS variables were evaluated at different time points (9th grade and 11th grade respectively), which may have impacted our patterns of results. Third, the study sample is a regional community sample, possibly limiting the generalizability of study findings. Fourth, relative to youth in this report, those excluded from the primary analytic sample due to cohort attrition prior to the Fall 2015 survey or other sources of missing data (see online supplement Table 2) were slightly older, males, and certain racial/ethnic minorities based on data collected at 9th grade and 11th grade. Thus, our results may underestimate poly-product use, specific product use, or SES-related disparities. Fifth, we did not assess sexual orientation in the sample, which may have contributed to the poly-product drug use disparities observed in the study, given that prior work denotes that sexual and gender minority youth are at increased risk of drug use and other drug-related problems relative to heterosexual peers (Marshal et al., 2008). Sixth, we did not test associations of SES and SSS with lifetime or current poly-drug use across nicotine products, marijuana products, and prescription drugs (e.g., use of any nicotine product + any marijuana product or use of all three products [nicotine products + marijuana products + prescription drugs] given the small number of participants who endorsed using multiple products across substances in our sample, thus, future work utilizing larger samples of adolescents should investigate whether SES or SSS differentially increases risk of poly-drug use across drug classes. Lastly, data from this ongoing study utilized self-report measures to assess SES and substance use. Hence, additional work should consider using alternate methods to assess these variables (e.g., biomarkers of substance exposures or clinical interviews).

5. Conclusions

The current study provides initial evidence for unique and complex associations of objective SES and SSS dimensions with adolescent poly-product use within three classes of substances (nicotine products, marijuana products, and prescription drugs). The current study suggests that the assessment of an adolescent's school SSS in addition to objective SES, may provide unique insights into SES disparities in poly-product use which is an important but yet overlooked form of youth substance use in the relevant literature. Results of this study may inform public education, prevention, and intervention efforts to address poly-product use of new and emerging products among youth who are from lower parental SES backgrounds or who report lower perceived social standing relative to peers at school. Additionally, our findings may provide implications for tobacco and/or marijuana regulatory policies or other policy-making efforts that aim to prevent poly-product use and increase mass media prevention campaigns in order to reduce exposure to alternative nicotine products, marijuana products, and prescription drugs in vulnerable youth groups, which may aid in the reduction of poly-product drug use disparities among socioeconomically disadvantaged adolescent populations.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2018.11.014.

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