

Appendix
Substance Use Patterns Through Early Adulthood: Results for Youth With and Without Chronic Conditions
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Appendix 1. Panel Study of Income Dynamics Substance Use Questions

Substance	Child development supplement (CDS)	Transition into adulthood (TA) survey
Alcohol	<ul style="list-style-type: none"> • Have you had a drink of beer, wine, or liquor-not just a sip or a taste of someone else’s drink-more than 2 or 3 times in your life? • Do you ever drink beer, wine or liquor when you are not with your parents or other adults in your family? • Over the past 12 months, on how many days did you drink five or more drinks in a row? • Over the past 12 months, on how many days have you gotten drunk or “very, very high” on alcohol? • Think about the first time that you had a drink of beer, wine, or liquor when you were not with your parents or other adults in your family. How old were you then? 	<ul style="list-style-type: none"> • Do you ever drink any alcoholic beverages such as beer, wine, or liquor? • In the last year, on how many days have you had {“4” if female / “5” if male} or more drinks on one occasion?
Tobacco	<ul style="list-style-type: none"> • Have you ever tried cigarette smoking, even just 1 or 2 puffs? • Have you ever smoked cigarettes regularly, that is, at least 1 cigarette everyday for 30 days? • How old were you when you first started smoking cigarettes regularly (at least 1 cigarette everyday for 30 days)? 	<ul style="list-style-type: none"> • Do you smoke cigarettes? • Did you ever smoke cigarettes? • Do you smoke cigarettes regularly or just occasionally, for example, when you are at parties or in social situations? • How old were you when you first smoked cigarettes regularly? • How old were you when you last smoked cigarettes regularly?
Marijuana	<ul style="list-style-type: none"> • Have you ever tried marijuana? • During the past 30 days, how many times did you use marijuana? • How old were you when you tried marijuana, for the first time? 	<ul style="list-style-type: none"> • Have you have tried marijuana in your lifetime, even if it was just once? • Have you ever marijuana because a doctor told you to use them? • On how many occasions (if any) have you marijuana on your own – that is, without a doctor telling you to take them during the last 30 days? • How old were you when you tried marijuana for the first time?

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Appendix 2. Detailed Chronic Conditions Status

	Ever diagnosed	Lifetime use of substances			Heavier/regular/recent use any use		
		Alcohol	Tobacco	Marijuana	Alcohol	Tobacco	Marijuana
Any chronic condition	64.3%	71.7%	46.8%	49.8%	44.3%	76.9%	54.7%
Attention deficit/hyperactivity disorder	11.2%	68.4%	56.5%	55.3%	41.0%	82.9%	57.5%
Asthma	23.7%	72.4%	44.6%	48.3%	39.8%	77.6%	56.5%
Autism	0.7%	43.8%	28.4%	19.6%	61.4%	47.8%	93.9%
Birth defects	0.3%	63.7%	0.0%	30.2%	47.3%	--	0.0%
Breathing problems	0.3%	40.2%	53.5%	43.0%	0.0%	31.6%	67.0%
Cancer	1.0%	83.0%	54.8%	55.3%	35.3%	74.9%	47.0%
Chronic hypertension	5.1%	84.4%	58.3%	68.2%	53.1%	88.0%	42.7%
Diabetes	2.0%	74.9%	38.2%	52.1%	51.0%	94.6%	42.9%
Digestive problems	0.2%	19.3%	40.9%	30.3%	45.0%	100.0%	28.7%
Emotional/psychological issue	16.7%	79.1%	66.5%	65.4%	51.1%	87.4%	61.6%
Epilepsy	3.6%	81.0%	54.2%	61.2%	49.6%	76.8%	59.8%
Hearing impairment	3.6%	67.5%	48.5%	48.9%	49.9%	81.7%	50.1%
Heart conditions	1.8%	73.7%	47.2%	58.1%	45.3%	68.5%	60.5%
Kidney disease	0.4%	100.0%	35.3%	53.9%	23.8%	100.0%	71.9%

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Learning disability	10.4%	68.1%	54.3%	53.8%	47.9%	83.1%	52.1%
Migraines	1.1%	84.9%	58.7%	56.3%	33.7%	86.8%	47.7%
Orthopedic impairments	9.2%	75.6%	38.8%	39.9%	40.2%	76.6%	58.7%
Sickle cell anemia	0.1%	76.3%	51.0%	40.8%	21.6%	100.0%	72.6%
Skin disease	0.4%	60.1%	17.0%	30.3%	20.0%	100.0%	10.7%
Speech impairment	10.4%	62.3%	45.8%	45.4%	44.1%	79.8%	58.0%
Visual impairment	7.9%	64.9%	41.1%	31.7%	27.1%	68.9%	47.1%
Other (not specified)	18.0%	77.4%	57.0%	63.2%	47.8%	84.2%	57.3%
No chronic condition	35.7%	63.7%	39.7%	44.1%	38.0%	66.0%	41.4%

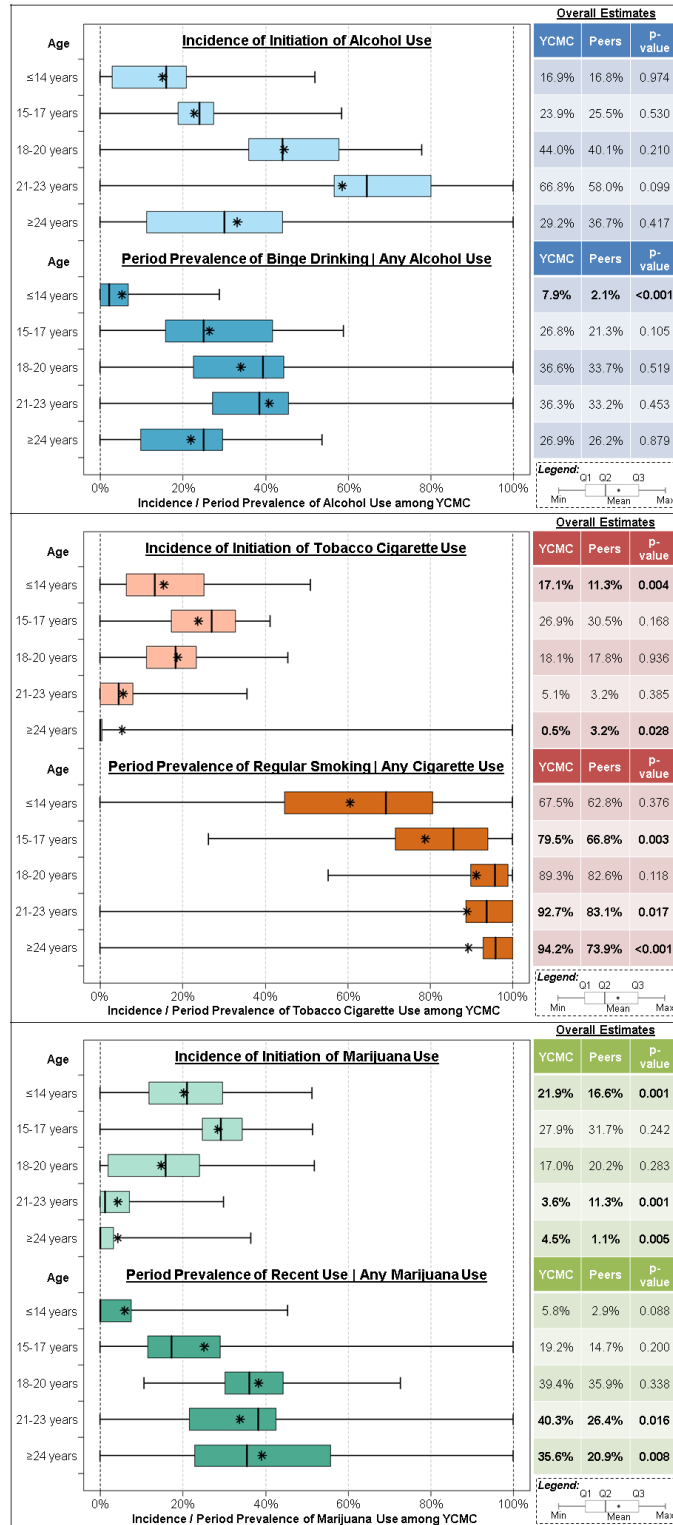
^a 'Ever diagnosed' describes the prevalence of each diagnoses among the entire sample (column percent). The remaining columns describe the prevalence of substance use among those diagnosed with each condition (row percent).

^b Data are from the Panel Study of Income Dynamics, Child Development and Transition to Adulthood Supplements (2002-2011).

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Appendix 3. Distribution of Substance Use Initiation and Period Prevalence Estimates among Youth with Chronic Medical Conditions (YCMC).



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Legend: Box plots show the unadjusted incidence and period prevalence of alcohol, tobacco, and marijuana use by age and chronic condition status. Panels show the distribution (minimum, Q1-25th percentile, Q2-median, mean, Q3-75th percentile, and maximum) of unadjusted point estimates for incidence of substance use initiation and period prevalence of heavier/regular/recent use across each of the 22 specific disease categories and by age. The inset tables describe the overall incidence of initiation (% who initiated in each period among non-users in the previous period) and period prevalence (% with heavier/regular/recent use among those who reported any use during that period) and p-values for the comparison between all youth with chronic medical conditions (YCMC) and their healthy peers.

Technical Appendix

Detailed Methods

Data Source and Sample

Data are from the Panel Study of Income Dynamics (PSID), a nationally representative, longitudinal household survey. In 1997, children from birth to age 12 years residing in PSID families (3,563 children from 2,394 families) were recruited into the Child Development Supplement (CDS); repeat waves of the CDS were administered in 2002-2003 and 2007-2008. CDS participants who graduated or dropped out of high school and were aged ≥ 18 years were interviewed for the Transition into Adulthood (TA) survey in 2005, 2007, 2009 and 2011.

Respondents were eligible for this study if they were (1) interviewed in the initial 1997 CDS wave, (2) subsequently interviewed in at least one CDS or TA survey between the ages of 12 and 26 years, and (3) did not have missing information for any of the primary study measures (N=2,719). Note that questions about substance use were only asked **after** the 1997 CDS for those youth who were at least 12 years of age at survey administration. Of the 3,563 children included in the 1997 CDS, 314 (8.8%) did not have any follow-up assessments (and were thus excluded from our cohort) and an additional 402 (11.3%) only completed follow-up assessment(s) prior to turning age 12 and thus were not asked any of the substance use questions; 125 youth (3.5%) were further excluded because of missing information or because they had ever received a diagnosis of an intellectual disability. Of the 2,719 respondents in our final sample, participants completed an average of 3.3 additional assessments after the 1997 CDS

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administration (median=2.9), with 2,155 (79.3%) having at least 1 follow-up ≥ 18 years of age and 1,457 (53.6%) having at least 1 follow-up ≥ 21 years of age.

As data were already collected and de-identified, this study was considered exempted from IRB approval.

Measures

Respondents were asked about their experience with alcohol, tobacco, and marijuana; as question content and phrasing varied between the CDS and TA, efforts were made to reconcile responses across questions to construct similar measures for both surveys (Appendix 1 lists verbatim wording of questions in the two surveys). For each substance, measures of lifetime use and heavy/regular/recent use were assessed.

Lifetime use of alcohol was defined by reports of ever drinking beer, wine or liquor when not with their parents or other adults in their family in the CDS or ever drinking beer, wine or liquor in the TA. "Heavy use" of alcohol was characterized by report of binge drinking, specifically reporting monthly frequency of drinking four (for women)/five (for men) or more drinks in one occasion (CDS or TA), or being "very drunk" in the CDS.

Lifetime use of tobacco cigarettes was defined by the report of ever trying cigarettes in either the CDS or TA. "Regular use" of tobacco cigarettes was characterized by report of smoking at least one cigarette every day for 30 days.

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Lifetime use of marijuana was defined by reports of ever trying marijuana in either the CDS or TA. “Recent use” of marijuana was characterized by report of any past month marijuana use without the consent of a doctor (note that the TA distinguished between use with and without the consent of a doctor while all reported past month use in the CDS was assumed to be without the consent of a doctor because respondents were under the age of 18 years).

Substance use summary variables for incidence and prevalence were constructed separately for each survey administration (2002, 2005, 2007, 2009, 2011); while each individual could be observed up to five times between 2002 and 2011, respondents completed an average of 3.3 additional assessments after the 1997 CDS administration. Substance use summary variables for incidence and prevalence presented in Figure 1, Table 2, and Appendix 3 were constructed separately for five age periods: (1) pre-adolescence (≤ 14 years); (2) adolescence (15-17 years); (3) transition (18-20 years); (4) early adulthood (21-23 years); and (5) adulthood (≥ 24 years). If an individual was observed twice in one age range, all available data was used, prioritizing the report of substance use in that period, if any (e.g., if a respondent was observed at age 15 and reported no alcohol use and again at age 17 and reported any alcohol use, they would be counted as reporting alcohol use during adolescence; alternatively, if a respondent was observed at age 15 and reported binge drinking and again at age 17 but did not report binge drinking at that time, they would be counted as engaging in binge drinking during adolescence).

Earliest reported age or use or age at survey administration for first report of use (when reported age of initiation was missing) was used to determine incidence of lifetime use. Of the respondents who reported using each substance, 69.0%, 31.1%, and 0.3% had missing

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information on age of initiation for alcohol, tobacco, and marijuana, respectively, thus age at first report of initiation was used as a proxy. For prospective incidence estimates in Table 2 and Appendix 3, the denominator decreases over time, as respondents were only eligible to be included in a period incidence if they did not report use in a prior period. Individuals were censored after the last survey that they completed. Period prevalence of heavier use was constructed from point-in-time reports of substance use behavior; estimates for period prevalence were thus conditional on lifetime use. If respondents were interviewed outside of an age range but reported initiating the behavior before or during an earlier age range, they would also be counted in the earlier period prevalence (e.g., if an individual was not observed between the ages of 15-17 but reported initiating smoking at age 16, then they were counted for the prevalence estimate for ages 15-17); if respondents were interviewed outside of an age range but reported never using a substance at that point, they would also be counted for that period prevalence (e.g., if an individual was not observed between the ages of 15-17 but reported initiating smoking at age 18 or never having smoked when they responded to the survey at age 18, then they were counted in the denominator for the prevalence estimate for ages 15-17).

Chronic conditions were conceptualized as those requiring regular, lifelong medical management with onset in childhood, and identified by report of ever being told by a doctor or other health professional that they had: attention deficit/hyperactivity disorder; asthma; autism; birth defects; breathing problems; cancer; chronic hypertension (reported two or more times); diabetes; digestive problems; emotional or psychological problems; epilepsy; heart conditions; kidney disease; learning disability or developmental delays; migraines; orthopedic conditions; sickle cell anemia; skin disease; hearing, speech, or visual impairments; and other conditions. The PSID

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provided parents (in the CDS) and individuals (in the TA) with a list of pre-specified condition and the following prompt: *Has a doctor or other health professional ever told you that you have or had...* After respondents are asked about specific conditions (e.g., asthma), the PSID asks: *Is there any other serious, chronic condition that a doctor or other health professional ever told you that you have or had?* Respondents could provide a verbatim response when asked to specify what the “other serious, chronic condition” was. The PSID further classified these verbatim responses (e.g., responses on the TA could be classified as: ‘Seizures,’ ‘Bone disorder/arthritis/scoliosis,’ ‘Kidney disease,’ ‘Coronary problem,’ ‘Anemia,’ ‘Allergies,’ or ‘Other.’ When possible, these verbatim responses were aligned with other reported conditions (e.g., report of ‘Other-Seizures’ was collapsed with report of epilepsy, report of ‘Other-Bone disorder/ arthritis/ scoliosis’ was collapsed with report of orthopedic impairments); thus the remaining ‘Other condition’ category only included other serious, chronic conditions that were not otherwise specified.

Youth who did not report any of the aforementioned chronic conditions or reported only acute or episodic conditions (e.g., allergies, jaundice, tonsillitis) were considered to have no chronic conditions. Youth with a reported diagnosis of intellectual disability were excluded.

Age at diagnosis was reported for most conditions but age at first report of each condition was used as a proxy when these data were missing. Youth with onset of a chronic condition after reported initiation of a substance were counted as not having the condition until they were diagnosed. In sensitivity analyses, we removed these youth from the sample and reran the models; findings from the restricted and unrestricted sample were consistent.

Note that the prevalence of inheritable chronic conditions in the CDS sample may be inflated as the CDS allowed the inclusion of up to two children from eligible families. Moreover, there is a higher degree of familial relationships (e.g., cousins) within the PSID sampling frame than would otherwise be expected. Specifically, many household heads in 1997 were previously children in families interviewed as part of the original 1968 PSID sample.

Sociodemographic and health factors. Data on child sociodemographic factors included: age in 1997 (continuous), sex (male, female), and race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic Asian, non-Hispanic other). Several indicators of childhood socioeconomic status were constructed, including: (1) whether the mother participated in the Special Supplemental Nutrition Program for Women, Infants, and Children or Aid to Families with Dependent Children programs during pregnancy (participated vs not); (2) whether or not both parents were present in the household in 1997 (two vs single parent household); and (3) the highest educational attainment for either parent (less than high school degree/GED, high school degree or GED, some college or vocational school, and college graduate or beyond). Psychological distress was assessed at each interview using the Kessler 6 (range 0-24, higher scores indicate greater distress).

Statistical Analysis

Analyses were conducted using survey procedures from SAS version 9.3. Statistical significance was considered at $p < 0.05$. The SEs were corrected due to clustering within strata and the primary sampling unit, and CDS sampling weights were used to account for both attrition and the unequal household selection probabilities from the original PSID sampling frame. See

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<http://psidonline.isr.umich.edu/data/weights/Long-weights-doc.pdf> and

<http://psidonline.isr.umich.edu/CDS/weightsdoc.pdf> for additional details on analytic weight construction and PSID sampling strategy.

Summary statistics were generated to describe sample characteristics; chi-square and Kruskal-Wallis tests were used to determine significant differences in sociodemographic characteristics between youth with and without any chronic conditions, and to assess differences in substance use behaviors for youth with and without any chronic conditions. Multivariate generalized linear mixed models with a binomial distribution were used to model lifetime and heavier use of substances; sex (binary), race/ethnicity (categorical), Special Supplemental Nutrition Program for Women, Infants, and Children or Aid to Families with Dependent Children participation during pregnancy (binary), parent marital status at baseline (binary) and parental educational attainment (categorical) were treated as time-invariant covariates while chronic condition status (binary), psychological distress (continuous) and age (continuous) were treated as time-varying covariates. As the risk of substance use was not assumed to be constant through adolescence and young adulthood, natural cubic splines (with evenly spaced quintile knots) were utilized to model age; models also included an interaction between the spline for age and a time-varying indicator of chronic condition status to allow the effect of chronic condition status to vary non-linearly across age. Likelihood ratio tests were performed to evaluate the inclusion of spline terms and their interactions with chronic condition status; these test revealed that for all outcomes the trajectory of substance use behaviors across age was significantly different for YCMC compared to their healthy peers. Average marginal predicted probabilities of substance use were calculated by age and chronic condition status and used to construct Figure 2. Each substance and use

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outcome was modeled separately for a total of six models: any alcohol use, binge drinking, any tobacco use, regular smoking, any marijuana use, and recent marijuana use. Models for heavier use of substances were conditional on reported lifetime use.