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Adult Social Behavioral Effects of Heavy Adolescent Marijuana Use Among African Americans

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Abstract

The authors examined the effects of heavy adolescent marijuana use on employment, marriage, and family formation and tested both dropping out of high school and adult marijuana use as potential mediators of these associations among a community sample of African Americans followed longitudinally from age 6 to age 32–33. They used propensity score matching to reduce selection bias when estimating the effects of heavy adolescent marijuana use. Logistic regression results on the sample matched on sex, and early demographic and behavioral variables showed that adolescent marijuana use has adult social behavioral consequences: Use of marijuana 20 times or more during adolescence was associated with being unemployed and unmarried in young adulthood and having children outside of marriage for both males and females. Dropping out of high school and more frequent adult marijuana use seem to be important parts of the pathway from adolescent marijuana use to negative life outcomes.

Keywords

adolescent marijuana use; social behavioral functioning; longitudinal studies; long-term consequences

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Marijuana is the most common of all illicit substances used by adolescents. Findings from the Monitoring the Future Survey, a national annual survey of students, show that over 20% of high school seniors report current use, 34% report use in the past year, and almost half (45%) report lifetime use of marijuana (Johnston, O'Malley, Bachman, & Schulenberg, 2005). Although the literature consistently discusses the widespread nature of adolescent marijuana use and the risk factors associated with use, considerably less is known about the effects of adolescent marijuana use on later functioning (Brook, Adams, Balka, & Johnson, 2002; Newcomb, 1997), especially in minority populations (Beauvais & Oetting, 2002). Even though many of the concurrent effects that result from teenage drug use (e.g., memory and attention impairment, risky decision making, driving injuries and fatalities, delinquent

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activities, and estrangement from traditional institutions) have been supported empirically (see Hall & Solowij, 1998, for review), longer term consequences of adolescent drug use and the mechanisms explaining such effects are not well understood. Although most teenage marijuana use is time-limited and typically ends by one's mid-20s (Bachman, Wadsworth, O'Malley, Johnston, & Schulenberg, 1997), it is unclear if effects persist after use desists or even develop later in life. This information would be useful in developing drug prevention and intervention programs.

Because adolescence is an important time for the development of skills necessary to function as an adult in society, marijuana use, especially heavy use, may impede skill acquisition necessary for adequate performance of adult roles. Heavy marijuana use poses particular problems because of its association with drug abuse and dependence, and heavier use seems to be related to poorer outcomes (e.g., Fergusson & Horwood, 1997; Newcomb & Bentler, 1988).

Numerous explanations have been proposed to address findings suggesting long-term social behavioral consequences of early drug use; however, as stated by Newcomb (1997), these theories are "all in their beginning stages of development" (p. 72). Two promising theories are pseudomaturity (Newcomb & Bentler, 1988) and role incompatibility (Yamaguchi & Kandel, 1985). Though these explanations are vague regarding mechanisms and neither has been tested extensively, both suggest that early drug use interferes with the acquisition of psychosocial skills necessary to perform adequately in adult roles.

Pseudomaturity theory proposes that early drug use increases the risk of premature or out-of-sequence transitions to adult roles, and the younger the age at which adult transitional events are initiated, the more difficulty will be experienced because early transitions impede the acquisition of skills needed for proficiency in these roles (Newcomb & Bentler, 1988). For example, an adolescent who enters employment, marriage, or parenthood at a very young age is not likely to be prepared for the responsibilities that go along with these roles, and problematic outcomes may occur, such as economic disadvantage, job instability, or divorce.

Role incompatibility, in contrast, suggests that drug use leads to a lack of involvement, as well as difficulty with performance, in conventional adult roles. Thus, role incompatibility predicts a postponement of marriage, parenting, and employment among those who use drugs based on the notion that traditional roles (employee, husband/wife, parent) are incompatible with a lifestyle of drug use. This explanation has been applied more often in studies examining the impact of current drug use (e.g., Horowitz & White, 1991; Kandel & Yamaguchi, 1987). Although pseudomaturity and role incompatibility forecast contrasting outcomes, both explanations suggest difficulty with adult roles.

Premature transitions, delayed transitions, and general difficulty in adult roles as a result of early drug use have all been supported by a small number of cross-sectional and prospective studies. Specifically, early drug use has been associated with poor employment outcomes. For example, studies have found an association of early drug use with lower occupational expectations, unemployment, and job instability (Brook et al., 2002; Brook, Ritcher,

Whiteman, & Cohen, 1999; Fergusson & Horwood, 1997; Kandel, Davies, Karus, & Yamaguchi, 1986; Kandel & Yamaguchi, 1987; Newcomb & Bentler, 1985).

Studies have found that early drug use predicts both premature involvement in marriage (Newcomb & Bentler, 1985) and delayed involvement in marriage (White, Bates, & Labouvie, 1998) as well as marital and family difficulties, including higher levels of divorce and lower marital satisfaction (Horowitz & White, 1991; Kandel et al., 1986; Newcomb & Bentler, 1988). Researchers have found that adolescent drug use puts an individual at increased risk of early pregnancy (Krohn, Lizotte, & Perez, 1997; Newcomb & Bentler, 1985) and unintended premarital pregnancy (Brook et al., 2002; Halikas, Weller, Morse, & Hoffman, 1983; Kandel et al., 1986). Mensch and Kandel (1992) found that this increased risk of premarital pregnancy attributed to early drug use may be the result of an increase in the risk of early sexual experimentation.

There is speculation that much of the association of adolescent marijuana use with poor adult adjustment is the result of other factors that predispose an individual to use marijuana in the first place. According to problem behavior theory (Jessor & Jessor, 1977), deviant behaviors co-occur because adolescents who hold nonconforming attitudes and values tend to transition into a variety of adult roles that are deviant. This approach suggests that adulthood effects are a result of selective recruitment into adolescent marijuana use of nonconforming individuals, not that marijuana use has an independent effect on later behavior. Supporting this explanation is that numerous individual and family risk factors have been shown to be related to early drug use and poor adult functioning, including childhood problem behavior—such as aggression and poor achievement—low family socioeconomic status, and family history of drug use (e.g., Block, Block, & Keyes, 1988; Brier, 1995; Brook & Newcomb, 1995; Brook, Whiteman, Cohen, & Tanaka, 1992; Donovan & Jessor, 1985; Ensminger & Juon, 1998; Ensminger & Slusarcick, 1992; Fleming, Kellam, & Brown, 1982; Jessor & Jessor, 1978; Kellam, Brown, Rubin, & Ensminger, 1983; Masse & Tremblay, 1997; Mechanic & Hansell, 1987; Newcomb & Bentler, 1988).

Although early drug use and adult problems share early risk factors, studies have shown that effects persist after controlling for these risk factors. For example, Fergusson and Horwood (1997) found that after controlling on a wide range of predisposing factors, including gender, family socioeconomic status, IQ, and childhood conduct disorders, a direct association remained between early marijuana use and poorer educational attainment and unemployment. They concluded that a common cause model only partly explained the linkages between marijuana and later adjustment. However, few other previous studies have adequately addressed confounding to exclude the possibility that the association of early marijuana use with later outcomes is a result of predisposing factors.

It has been suggested that educational attainment may be one mechanism through which early marijuana use is associated with poor adult outcomes (Fergusson & Horwood, 1997; Johnson & Kaplan, 1990), though it has not been tested extensively. Frequent marijuana use during adolescence has been found to be associated with dropping out of high school (Bray, Zarkin, Ringwalt, & Qi, 2000; Ellickson, Bui, Bell, & McGuigan, 1998; Ensminger,

Lamkin, & Jacobson, 1996; Fergusson & Horwood, 1997; Fergusson, Horwood, & Beautrais, 2003; Krohn, Lizotte, & Perez, 1997; Mensch & Kandel, 1988; Yamada, Kendix, & Yamada, 1996), fewer years of schooling (Fergusson & Horwood, 1997), and failure to enter university or obtain a university degree (Fergusson et al., 2003); it has also been found to be associated with having lower educational expectations, being suspended or expelled from school, and being "high" at school (Brook et al., 2002). Because adequate education is needed for successful functioning in a variety of adult roles, especially employment, and studies have shown that early marijuana use may lead to poor education (see Lynskey & Hall, 2000, for a review), early marijuana use's association with later poor outcomes may be an indirect one through education.

It has also been suggested that much of the association between early drug use and adulthood problems is the result of continued drug use (Newcomb & Bentler, 1988). One of the most reliable findings of the long-term consequences of early marijuana use is later drug use (Ensminger, Juon, & Fothergill, 2002; Kandel et al., 1986; Merline, O'Malley, Schulenberg, Bachman, & Johnson, 2004; Newcomb & Bentler, 1988; Stein, Newcomb, & Bentler, 1987; White, Bates, & Labouvie, 1998). Various research studies have estimated that typically more than half of adolescents who use illicit drugs continue use throughout their 20s (Substance Abuse and Mental Health Services Administration, 2005). However, few empirical investigations on the consequences of early use have taken later use into consideration.

There is mounting evidence that gender plays such an important role in drug use. In fact, men and women have different risk factors, opportunities to use, and rates of use (Ensminger, Brown, & Kellam, 1982; Kellam, Ensminger, & Simon, 1980; Lex, 1991; Van Etten & Anthony, 1999). Men and women also experience different social issues when it comes to drug use. For example, though drug use in general is stigmatized, women who use drugs encounter more social disapproval than men (Blume, 1986). In a review of the literature, Brady and Randall (1999) concluded that drugs are more likely to affect a man's job or career path, whereas women are more likely to experience family problems, as evidenced by, for example, higher rates of divorce in substance-using women than men (Lex, 1991). Thus selection and the consequences of early drug use may vary for males and females.

In this longitudinal, prospective study, we addressed gaps in the literature concerning the young adulthood experiences of men and women who used marijuana significantly as adolescents. We examined marijuana use because it is the most widely used illicit drug. Social behavioral consequences examined include employment, marriage, and parenting. In addition to comprising the key areas of functioning for young adults (Erikson, 1959, 1963; Havighurst, 1952; Neugarten, 1968), success in employment and family relations have been linked to better long-term health (e.g., Aseltine, 1996; Dawson, 1991; DeLeire & Kalil, 2002; Gove, 1973; House, Landis, & Umberson, 1988; Marmot & Theorell, 1988; Williams, 1990). Specific research questions were as follows: (a) Does heavy adolescent marijuana use (20 times or more) influence later marriage, parenting, and employment, taking into account early characteristics that independently predict these roles? (b) Are these associations accounted for by the relationship between adolescent marijuana use and high school

graduation? (c) Are these associations accounted for by the relationship between adolescent marijuana use and marijuana use that continues into adulthood? and (d) Are consequences different for males and females?

In this study, we examined later social behavioral consequences of adolescent marijuana use in a longitudinal cohort of low-income African American individuals, thus advancing the field in a number of important ways. We followed individuals prospectively to ages 32–33, whereas most studies follow individuals only to their mid-20s; thus, we were able to assess adult functioning at a development period when the majority of adolescent marijuana users have discontinued use. We focused on African Americans, who are disproportionately affected by drug disorders (Wallace, 1999), because little is known about long-term outcomes of adolescent drug use for this population.

A major advantage is that we used propensity scores to better compare the outcomes for heavy users and infrequent/nonusers, who are likely to differ dramatically in their background and behaviors as well as in their marijuana use. Propensity scores capture all of the potentially confounding variation in the covariates, enabling us to match on one score instead of many variables. Standard regression adjustment for the differences in background covariates rely heavily on the model assumptions and extrapolation. To avoid that model dependence, we matched on socioeconomic, family, and behavioral covariates that have been found to be related to both early drug use and adult functioning, selecting groups of heavy users and infrequent/nonusers who looked similar on the set of background covariates. In that sense, we replicated the distribution of covariates that would be expected if heavy marijuana use were randomly assigned to a group of individuals. This method produces inferences that are substantially more robust and less sensitive to modeling assumptions than regression on unmatched samples because standard regression analyses ignore that treatment group and control group members may not overlap enough on background variables to allow for meaningful comparison (Rosenbaum & Rubin, 1984; Tan, in press). Finally, in this study we tested potential mechanisms along the path from adolescent drug use to social behavioral outcomes and considered gender differences in long-term consequences.

Method

Woodlawn Study and Population

Data came from the Woodlawn Study, a prospective study of African American youths in Chicago. This research and intervention program were based on a partnership of the University of Chicago, the City of Chicago Board of Health, and the Woodlawn Mental Health Center Board (Kellam, Branch, Agrawal, & Ensminger, 1975). The epidemiologically defined population has been followed longitudinally beginning in 1966–1967 when all first graders in the nine public schools and three parochial schools in Chicago's Woodlawn neighborhood were recruited in the project ($N = 1,242$). Only 13 families declined participation. We then followed up the cohort in adolescence (age 15–16), early adulthood (age 32–33), and mid-life (age 42–43). We used data from the first three assessments in the present study because the purpose of the study was to determine young adult outcomes.

During first grade, we gathered information through in-person interviews with each child's mother or female guardian and teacher on the children's social adaptation, academic performance, behavior, social relationships, and family background. The adolescent assessment occurred in 1975–1976. Only mothers and adolescents who remained in the Chicago area were reassessed. Of those teens whose mothers were interviewed ($n = 939$), 75% were assessed ($n = 705$). Of the rest, 9.5% declined participation, 5% agreed but were never interviewed because of funding restrictions, 2.2% were residing in institutions, 1.5% had left the Chicago area, and 6.7% could not be located. Through group administered questionnaires, adolescents provided information about drug use, school performance, and peer and family relationships, among other things. Questionnaires were administered on audio tape to control for reading differences, and the assessments were run by African American college students.

In 1992–1993, we attempted to locate and interview all 1,242 original participants regardless of the location of their residence; 1,038 (84%) were successfully located. Of these, 952 (92%) were reinterviewed, 39 (4%) refused to participate, 43 (4%) were deceased, and 3 (<1%) were too incapacitated to participate (Ensminger, Anthony, & McCord, 1997). The Young Adult Interview consisted of 598 primary questions as well as numerous subsets of questions. Interview topics included household composition, health, social relationships, criminal involvement, marital and family relationships, education and employment, neighborhood, racial attitudes and experiences, drug use, and psychological health. Seventy-eight percent of respondents completed the interview in person, whereas 22% completed the interview over the telephone.

In 1966–1967 when the study began, Woodlawn was the 5th poorest of the 76 community areas that make up Chicago. Woodlawn had high rates of unemployment, poverty, and welfare. It was characterized by both abandoned buildings and overcrowding. Over 95% of Woodlawn residents were African American. Despite high rates of poverty in Woodlawn, there was economic diversity in the community, with some blocks having high rates of employment and home ownership as well as median education. The Woodlawn Study population was also diverse on a number of indicators collected throughout the study. According to the young adult follow-up interviews, by age 32–33, cohort members were diverse in socioeconomic status. Almost 80% had finished high school, and 16% of respondents were college graduates. Approximately 64% were currently employed. About a third reported a household income of less than $10,000, whereas about 10% reported an income above $50,000. Although 84% of those who were interviewed lived in the Chicago area, only 9% were living in Woodlawn; 10% were living in suburban areas of Chicago.

Attrition and Missing Data

For this study, we restricted our analyses to the subsample who were assessed during adolescence ($N = 705$). Of these individuals, 598 (85%) completed the young adult assessment. We arrived at a final sample size of 530 for matching by removing 3 individuals who reported teen parenting and 20 individuals who dropped out of school during the same year as marijuana use initiation (in order to ensure marijuana use preceded the outcome of interest) and 45 individuals because of failure to provide information on one or more control

variables or an adult outcome (i.e., 26 individuals did not provide income information, 9 did not provide mother's history of drug use, and 10 were missing one of the outcome variables).

We conducted analyses to determine bias in those who were and were not interviewed in 1975–1976 (Fleming et al., 1982; Kellam et al., 1983). Attrition bias analyses showed that mothers who were not interviewed were younger and were more likely to have started child rearing in adolescence, to have been more mobile before and during the child's first-grade year, and to have their children in parochial schools in first grade. Mothers who were interviewed were not different from those who were not on psychological well-being, early family income, welfare status, or family structure in the home. We found no differences in early social adaptational status or psychological well-being of children reinterviewed in 1975–1976 and those who were not.

We made additional comparisons between the mothers who completed the 1975–1976 interview along with their adolescent ($N = 704$) and the mothers who completed the interview and their adolescent did not ($N = 235$; Kellam et al., 1983). We found no differences on mothers' reports of adolescents' self-esteem, psychological well-being, cognitive achievement, school attachment, social contact, delinquency, and alcohol and drug use or on family structure or income. Mothers whose adolescent we did not interview, though, reported their child to be less mature and more anger prone. Comparisons made between interviewed young adults who provided the adolescent interview ($n = 599$) and those who did not ($n = 353$) showed no differences were found on key variables such as marital status, employment, depression, or living in a high-poverty tract. We assumed the missing data to be missing at random, which means that the probability of missingness is only dependent on observed values, not unobserved ones (Allison, 2001; Schafer & Graham, 2002).

Measures

Table 1 presents the means, standard deviations, and coding for all study variables. We show these statistics for the full sample ($N = 530$). Included are the independent or treatment variable, matching variables, outcome variables, and mediators.

Independent or treatment variable—The independent or treatment variable is use of marijuana 20 times or more during adolescence. We assessed adolescent marijuana use by asking adolescents to indicate on a 6-point scale the number of times they had used marijuana in their lifetime. Frequency categories ranged from never to more than 40 times. We collapsed categories to create a binary variable of heavy use (20 or more times) versus experimental or nonuse. Although the majority of adolescents in the original sample had used marijuana at some level (60%), using 20 times as a threshold to divide the sample into heavy or regular users and experimenter or nonusers allowed us to make a conservative comparison between those who had used marijuana a significant number of times and those who had used less frequently or not at all. There is little consensus in the literature on what constitutes frequent or heavy use, and various cutpoints have been used. For example, Fergusson and Horwood used 10 times or more to distinguish heavy users from others, and

Milich and colleagues used 40 or more times as the cutpoint (Milich et al., 2000). Previously published work on the Woodlawn Study (Ensminger et al., 1982) classified 20 or more times as "heavy use."

Matching variables—To reduce confounding, we included 10 background covariates in the propensity score model used in the matching process. We included these variables because they may influence selection into being a heavy marijuana user during adolescence, and they may affect the outcome variables of interest. As recommended when conducting propensity score analysis, these variables need to occur pretreatment (i.e., before marijuana use begins) or be fixed variables (e.g., sex), as it is inappropriate to match on variables that may have been affected by the treatment. The background covariates included were sex, a family background variable (i.e., mother's drug use), three measures of family socioeconomic status in first grade (family income, poverty status, and mother's education), and five behavioral characteristics assessed by first-grade teachers.

We assessed mother's history of drug use during the 1975–1976 interview. Mothers self-reported their lifetime use of illicit substances (i.e., marijuana, cocaine, heroin, hallucinogens, inhalants, stimulants, amphetamines, sedatives, tranquilizers). Any amount of any illicit substance by mothers during their lifetime was coded as having a history of drug use. We measured mother's education at the first assessment (1966–1967) by asking each mother the number of years of schooling she had completed. Responses ranged from 0 to 18 years. We measured family income by asking mothers during the first assessment their total household income before taxes for the previous year. We calculated poverty status using U.S. Census Bureau estimates for the poverty threshold for 1966 based on household income, size, and age of members. We created a binary variable from mothers' reports in first grade representing less than 100% of the poverty threshold or above the poverty threshold.

We measured early school achievement with a single item on the Teacher's Observation of Classroom Adaptation (TOCA; see Kellam et al., 1975, for reliability and validity establishment), in which teachers rated each first-grade student's achievement. We also measured aggression, shyness, immaturity, and inattention by single items on the TOCA.

Outcome variables—We determined current employment by asking respondents during the young adult assessment a single question about their work status the previous week. We coded those with temporary absences from employment (e.g., vacation, illness) as employed. We assessed current marital status by a single item reported during the young adult assessment, in which we asked the respondent his or her current marital status. We created a teen parenthood variable out of a single item reported during the young adult assessment, in which we asked the respondent his or her age at the time of the birth of his or her first child. We based the parenting outside marriage variable on the respondent's age at first marriage and age at the time of birth of first child reported at the young adult assessment.

Mediators—We based the dropping out of high school mediator on self-reports from the young adult assessment and school records provided by the Chicago Board of Education. The adult marijuana use mediator was a self-report of the frequency of use of marijuana in

the past year on a 9-point scale. Responses ranged from no use within the past year to daily use. We collected it at the young adult assessment. When considered as an outcome, we reduced adult marijuana use to a binary variable of use or no use in the previous year.

Analysis Plan

We separated the analysis into two steps, as recommended by Ho, Imai, King, and Stuart (2005a). First, we selected well-matched groups of heavy users and infrequent/nonusers using propensity score-matching methods. This step did not involve the outcome values at all. Once we obtained matches, we ran a parametric outcome analysis on the matched samples. We conducted propensity score matching using the MatchIt program (Ho, Imai, King, & Stuart, 2005b), a component of the R statistical package (R Development Core Team, 2005), in order to attempt to equate the heavy marijuana users (treatment group) with those who used marijuana less frequently or not at all (control group) on background covariates. The goal of this approach was to preprocess the data before the parametric analysis in order to reduce the association between treatment (e.g., heavy marijuana use) and covariates without introducing bias and inefficiency. Propensity score methods assume ignorability, which means that after conditioning on covariates, there are no other differences between heavy marijuana users and infrequent/nonusers. In other words, all confounding is taken into account, and there is no hidden bias.

With propensity score matching, first we estimated the probability of being treated (being a heavy marijuana user) for each respondent using logistic regression. This propensity score is a numerical summary of all the covariates for each individual. After we estimated propensity scores, we used the matching method of one-to-one nearest neighbor matching to match males with males and females with females. Nearest neighbor matching is a very common form of matching in which the best overall control match for each individual in the treatment group is selected (Rosenbaum & Rubin, 1983). Matching was done using a distance measure defined by the propensity score, estimated using a binomial generalized linear model with a logit link function (Venables & Ripley, 2002). The MatchIt program chose matches for each treatment unit one at a time. For each treatment unit, the MatchIt program selected the control unit that was not yet matched but was closest to the treatment unit on the distance measure. Control units not chosen as a match for any treatment unit were discarded from the data set, resulting in a substantial reduction in sample size and thus a potential loss of power, although the improved balance in the covariate distributions may decrease the variance of the estimated effect. The resulting matched data set thus consisted of the 137 regular marijuana users and their 137 matched controls, with equal numbers of males and females. We excluded 256 individuals.

To ensure that matching resulted in matched treatment and control groups with similar covariate distributions, as would be expected in a randomized experiment, we compared the covariate distributions in each group using graphical displays (quantile-quantile plots and jitter plots) as well as numerical summaries. One such numerical summary examined was the *standardized bias*, defined as the difference in means of the covariate in the treated and control groups, divided by the treated group's standard deviation. We examined the standardized bias for all covariates, their squares, and every two-way interaction of

covariates. Less than a quarter of a standard deviation difference in means across groups (a standardized bias of less than 0.25) indicates good matches, with smaller standardized biases being even better (Ho et al., 2005a).

After matching, we used Stata 9 to perform regression analyses on the matched subsample. We used logistic regression to assess the effect of heavy adolescent marijuana use on employment status, marital status, teen parenting, premarital parenting, dropping out of school, and adult marijuana use. We ran the logistic regression analyses separately for males and females for each outcome. We calculated robust standard errors (Huber, 1967). We report marginal effects (Liao, 1994), which indicate how much the probability of the outcome changes comparing the treatment group with the control group. For continuous variables, the marginal effect represents the change in the probability of the outcome for a change of one unit of the predictor.

In each step, we regressed the outcome against the respondent's report of frequent marijuana use. In the first step, we included frequent marijuana use during adolescence as a predictor of the outcomes. Step 2a tested the association of frequent marijuana use with the later outcomes controlling for dropping out of high school to determine if the relationship of adolescent marijuana use with later outcomes could be accounted for by the association of adolescent marijuana use and dropping out of high school. For Step 2b, we adjusted for adult marijuana use. We did not include teen parenting and dropping out of high school as outcomes in Step 2b because the adult marijuana use would have occurred after the teenage parenting and the completion of high school education.

Results

Table 2 shows the background characteristics of the sample before and after matching. After matching, there were no longer significant differences on any of the covariates between the heavy users and matched controls. As can be seen in Table 2, those excluded from the analysis were more likely to be female, to have had higher family income during childhood, and to be less aggressive as rated by their first-grade teacher. Therefore, had these better functioning individuals been left in the analysis, we would have overestimated consequences, as these individuals were not comparable to the cases and were functioning better in young adulthood. Preliminary regression analyses on the full sample (not presented) showed this to be the case. Further illustrating that the treatment group and matched controls were similar on background characteristics, we found the standardized biases for each covariate, as well as the interaction between covariates and the square of each covariate, to be less than 0.15 after matching. Before matching, heavy marijuana users were significantly more likely to be male and more likely to be rated as aggressive and inattentive by first-grade teachers.

Table 3 presents the marginal effect of various social behavioral outcomes associated with frequent adolescent marijuana use for males and females (Step 1). After matching on early predictors of adult outcomes (SES, childhood behavior, mother's drug use), heavy adolescent marijuana use was negatively associated with being employed at age 32–33 for males ($-.185$, $p = .009$) and marginally associated for females ($-.178$, $p = .077$). Heavy

adolescent marijuana was negatively associated with being married for males (−.130, $p =$ .047) and females (−.222, $p = .019$) compared with experimental or nonusers. It was also associated with parenting outside of marriage for both males (.163, $p = .025$) and females (.289, $p = .004$). Heavy marijuana use during adolescence was not associated with teen parenthood for either males (.087, $p = .150$) or females (.156, $p = .102$).

Heavy adolescent marijuana use was also associated with both mediators of interest for both males and females (see Table 3). Regression analyses on the matched sample showed that frequent adolescent marijuana use was associated with an increased risk of dropping out of school (.207, $p = .004$, for males; .200, $p = .030$, for females) compared with receiving a high school diploma or GED as well as with an increased risk of continuing to use marijuana into adulthood (.261, $p < .001$, for males; .222, $p = .004$, for females).

Also shown in Table 3 is the association of adolescent marijuana use with employment status, marital status, and parenting outside of marriage, adjusting for dropping out of high school, for males and females (Step 2a). The association of the frequent adolescent marijuana use with employment status remained for males (−.148, $p = .044$). The association of the frequent adolescent marijuana use with marital status (−.100, $p = .136$) was no longer statistically significant for males once dropping out of high school was considered, suggesting mediation. The association of frequent adolescent marijuana use with parenting outside of marriage became marginally significant for males (.127, $p = .094$), suggesting partial mediation. The marginal association of the frequent adolescent marijuana use with employment status disappeared for females (−.122, $p = .258$). The association of the frequent adolescent marijuana use with marital status (−.202, $p = .038$) and parenting outside of marriage (.249, $p = .018$) remained for females even when dropping out of high school was considered. Heavy marijuana use during adolescence continued to be highly associated with adult marijuana use for both males (.250, $p < .001$) and females (.205, $p = .009$).

Table 3 also shows the association of the significant (or marginally significant) outcomes from Step 1 with heavy adolescent marijuana use, adjusting for the frequency of adult marijuana use (Step 2b). Adjusting for adult marijuana use, heavy adolescent marijuana use continued to be associated with employment for males (−.159, $p = .030$), but it was no longer associated with employment for females (−.112, $p = .309$). It was only marginally associated with being married for males (−.115, $p = .090$) and females (−.183, $p = .059$), suggesting partial mediation. It was no longer associated with parenting outside of marriage for males (.109, $p = .156$); it remained statistically significant for females (.244, $p = .020$).

Discussion

In this article, we examined the social behavioral effects of early involvement with marijuana (use 20 or more times prior to age 17) for males and females. After matching on earlier risk factors, this level of adolescent marijuana use predicted a variety of difficulties, including dropping out of high school, being unemployed, being unmarried, parenting outside of marriage, and using marijuana in one's 30s. Results suggest that effects of early, heavy marijuana use continue to be seen as much as 15 years after initiation of use in key areas of functioning for young adults (e.g., family formation and employment).

Heavy use was defined in this study as using marijuana 20 times or more before age 17. Although there is not a gold standard that represents what constitutes frequent, heavy, or regular use, we believe that 20 times represents a significant involvement with marijuana. We recognize that individuals in this so-called heavy group are not homogeneous regarding their use of marijuana. Had we been able to further break down these high levels of use (e.g., daily use vs. weekly use), as well as abuse and/or dependence, we may have found even more severe consequences. Previous analyses of the Woodlawn data have shown that the results are not sensitive to slight tweaking of the frequency category (see Green, 2004).

As described earlier, multiple explanations have been offered for the association of early marijuana use with poor social behavioral outcomes. One is that the association is spurious because adolescent marijuana use shares risk factors with these outcomes. We tested this by using propensity scores to match heavy users with similar controls. This statistical method for drawing causal inference reduced bias and allowed for our sample to more closely resemble a sample in which individuals had been randomized to heavy marijuana use or control. We matched on individual and family factors that may predispose an individual to both marijuana use and poor outcomes, including socioeconomic status, maternal drug use, and teacher's rating of classroom academic and behavioral problems during childhood. Despite a reduction in sample size, we still found significant relationships between adolescent marijuana use and later roles. Thus, we did not find much support for only a shared risk factor perspective.

A second explanation, termed *pseudomaturity*, posits that a lifestyle of drug use during adolescence will lead to both premature and out-of-sequence involvement and performance problems in the roles of adulthood, such as that of spouse, parent, or worker. Our education result and one of our parenting findings are more in line with this perspective. We found early marijuana use to be related to prematurely leaving school but not early parenting. Early marijuana use was associated with parenting outside of marriage.

We also found evidence of difficulty or lack of involvement with some adult roles, as demonstrated by current unemployment and lack of marriage at age 32–33 among those who used marijuana frequently during adolescence. These findings are consistent with role incompatibility perspective. Thus, whereas pseudomaturity and role incompatibility suggest opposite effects of early drug use, we found that the domain of the effect (i.e., education, marriage, employment) was what mattered when applying these explanations.

Multiple mechanisms linking early marijuana use with later social effects have been suggested, including educational attainment and adult drug use. More frequent marijuana use in adulthood somewhat accounted for these findings as some investigators have speculated (e.g., Newcomb & Bentler, 1988). Adult marijuana use either partially or fully mediated the association between adolescent marijuana use and marital status for males and females, between adolescent marijuana use and employment status for females, and between adolescent marijuana use and having a child outside of marriage for males. These findings suggest that at least some of the detrimental effects of adolescent marijuana use are due to the likelihood that drug use continues into adulthood. Approximately 25% of those in this population who used marijuana as adolescents were still using marijuana in their 30s. These

individuals were also more likely to be using cocaine and heroin as young adults and to have a drug arrest, all of which affect employability.

To some extent, consequences found can be attributed to the relationship of early marijuana use with dropping out of high school, a more proximate effect. It is this association that accounts for some of the marital, parenting, and employment status findings. We found, as others have found, that early drug use is related to poor educational attainment (e.g., Brook et al., 2002; Hill, White, Chung, Hawkins, & Catalano, 2000; Johnson & Kaplan, 1990; Kandel & Yamaguchi, 1987; Krohn, Lizotte, & Perez, 1997; Mensch & Kandel, 1988; Yamada, Kendix, & Yamada, 1996). Our matching procedure helped ensure that the relationship of marijuana use and school drop out was not confounded by other earlier characteristics related to both. The link of adolescent drug use with lack of marriage for males and unemployment for females may be a direct result of the low earning potential of those who do not graduate high school. Employment opportunities are limited for those without advanced education (perhaps more so for women), and men with little education may be less desirable marital partners perhaps because of their poor earning potential. Thus, future research on marital and employment difficulties as a result of drug use should consider education as a pathway and further explore gender differences.

Although we considered dropping out of school to be a proximate effect of early, heavy marijuana use, it is important to note that there are other potential mechanisms that we did not test. For example, we did not test cognitive impairments as an even closer mechanism that leads to this effect. Others have found that heavy marijuana use may lead to lasting cognitive impairments (see Solowij, 1998), which can have a cascading effect on education and later social roles, including developing relationships and obtaining and maintaining employment. In order to examine this question, it would be important to have measures of cognitive functioning before and after the marijuana use occurs and to have precise measures of the amount and timing of marijuana use. A second potential mechanism that may be highly informative is delinquent behavior or criminal involvement that may result from heavy marijuana use, as the association between drugs and crime has long been recognized (e.g., Brook, Whiteman, Finch, & Cohen, 1996; Loeber, 1988). Neither mechanism tested accounted for the association of heavy adolescent marijuana use with young adult unemployment for males and having a child outside of marriage for females. Future research should consider other mechanisms.

We found only slight differences in consequences of early marijuana use for males and females. Because so many aspects of the drug process vary by gender, we had expected there may be different effects for males and females. Although fewer girls used marijuana during adolescence and girls used it less heavily than boys, if girls used marijuana as heavily as boys, they seemed to experience similar education, employment, and marriage effects, though the magnitude of effects varied by gender. Along these same lines, Anthony and colleagues found that given the same exposure opportunity, girls and boys use drugs at the same rate (Van Etten & Anthony, 1999), and once using drugs, girls and boys transition to dependence at similar rates (Anthony, Warner, & Kessler, 1994). Thus, gender appears to be more important as a risk factor for use and level of use than it is an effect modifier of the

consequences of use. Gender differences in mediation should be explored in future work on the consequences of adolescent marijuana use.

The study's limitations should be considered when interpreting the findings. First, as is the case with any longitudinal study, attrition is a concern. The adolescent assessment was limited to those who remained in the Chicago area. Even though rates of attrition are fairly low for the young adult assessment compared with other longitudinal studies that take place over a significant period of time, and analyses were conducted to ensure that those who did not participate in any subsequent round of data collection did not differ significantly on earlier variables of importance to the study's aims, biases as a result of attrition should be considered when interpreting results. Furthermore, when considering conclusions about the effect of marijuana use, it is important to note that adolescents who were using marijuana heavily were also more likely to be using cocaine, to be using alcohol more regularly, and to be smoking cigarettes. Thus, effects that we attributed to heavy marijuana use may represent a broader array of substance use as well as abuse and dependence. As an extension of the current analysis, future study could use a propensity score matching approach similar to that done by Foster (2003) to examine the role of various combination of substances on consequences.

Finally, because early marijuana use shares risk factors with a variety of poor social consequences, our ability to match on these risk factors is key in drawing conclusions about the effect of early marijuana use on adult functioning beyond what can be accounted for by shared risk factors. Although we were able to adequately match on a number of early risk factors, we were not able to consider factors not assessed in this study or assessed concurrently with marijuana use. For example, we were unable to match on IQ, unconventional attitudes, deviant peer affiliations, poor parental monitoring, or family conflict, which may have led to marijuana use and increased the likelihood of the adverse outcomes. Even though we accounted for individual and family factors that have been shown to confound this relationship, we may not have included all necessary constructs. This limitation is a significant one, and thus results should be interpreted judiciously.

These concerns aside, this study contributes to the understanding of the long-term psychosocial consequences of adolescent marijuana use for urban African Americans. This study followed individuals until age 32 or 33, whereas most other drug consequence studies have not examined individuals beyond their mid-20s, the time when most drug users desist their use. These results broaden previous findings by showing that the effects of early marijuana use extend into adulthood. Our methods involving matching helped to ensure that the effects we found were due to drug use, not confounded with other characteristics that may go along with drug use. Whereas previous researchers have suggested that the impact of adolescent drug use may take longer to materialize than they were able to study (e.g., Newcomb & Bentler, 1988), this study is one of the first to provide evidence of what effects are still evident 15 or more years after the initial assessment of drug use. Some argue that by adulthood, effects of early experimentation with marijuana may diminish; however, the results of this study show this is not the case.

As much of the research on consequences of adolescent drug use is in White populations, this study provides evidence regarding the generalizability of those results to African Americans. Our results suggest that consequences for an urban African American population are similar to those in non-minority populations. Although it has been suggested that the consequences of drug use generally are characterized as more serious in African Americans (Beauvais & Oetting, 2002), this study provides specific evidence of what consequences may be expected.

The findings of the study highlight the importance of preventing or delaying early marijuana use, especially heavy use, and preventing the escalation of use. Although marijuana use is sometimes considered a normative part of development, this study provides evidence that early marijuana use (by age 15–16) at significant amounts has important long-term social behavioral effects. These consequences remained even after matching on early childhood factors that may lead to drug use.

Results of this study indicate that intervention and prevention programs should encompass a broad scope because early marijuana use appears to relate to later outcomes, and later outcomes share risk factors with early marijuana use. The association of early marijuana use with school dropout provides evidence that programs addressing each risk separately may benefit from addressing the other risks simultaneously. The findings also suggest high school graduation as a potential target for drug intervention programs attempting to mediate the long-term effects of early marijuana use. That is, intervention programs that increase the likelihood of high school graduation may also mitigate some of the results of early marijuana use on later social roles. Similarly, programs that focus on preventing or reducing teen substance use may increase the likelihood of high school graduation, diminish adult drug use, and have benefits with regard to the transition to adult roles. Therefore, it seems necessary that those who design school dropout programs and drug prevention programs consider including the other outcome as a goal of the program as well as consider the vast literature on risk factors for other outcomes during program design.

Acknowledgments

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Table 1

Means and Standard Deviations for Study Variables (N = 530)

Variable	M	SD
Independent/treatment variable		
Heavy adolescent marijuana use (0 = *use less than 20 times or no use*, 1 = *use 20 times or more*)	0.258	0.438
Matching variable		
Gender (0 = *female*, 1 = *male*)	0.470	0.500
Mother's history of drug use (0 = *no illicit drug use*, 1 = *illicit drug use*)	0.030	0.171
Mother's years of schooling	10.606	2.298
Family income for 1965–1966 (1 = *under $2,000*, 10 = *$10,000 or more*)	4.902	2.749
Below poverty threshold (0 = *above the poverty threshold*, 1 = *below the poverty threshold*)	0.491	0.500
First-grade classroom adaptation (0 = *adapting*, 3 = *severely maladapting*)		
Teacher rating of underachievement	0.596	0.922
Teacher rating of aggression	0.474	0.861
Teacher rating of shyness	0.457	0.820
Teacher rating of immaturity	0.562	0.921
Teacher rating of inattention	0.532	0.934
Outcome variable		
Employed at age 32–33 (0 = *unemployed*, 1 = *employed*)	0.647	0.478
Married at age 32–33 (0 = *unmarried*, 1 = *married*)	0.292	0.455
Teen parent (0 = *not a teen parent*, 1 = *teen parent*)	0.266	0.442
Parenting outside of marriage (0 = *no parenting outside of marriage*, 1 = *parenting outside of marriage*)	0.538	0.499
Mediator		
High school dropout (0 = *diploma/GED*, 1 = *high school drop out*)	0.175	0.381
Adult marijuana use at age 32–33 (0 = *no use*, 1 = *past year use*)	0.194	0.396

Note. GED = general equivalency diploma.

Table 2

Comparison of Study Participants Before and After Matching on Matching Variables

Matching variable	Heavy users[a,b] (*n* = 137)	Full controls[a] (*n* = 393)	Matched controls[b] (*n* = 137)	Discarded controls (*n* = 256)
% male	67.2	39.9	67.2	25.4
% of mothers with a history of drug use	0.0	4.1	0.0	6.3
Mean mother's years of schooling	10.53	10.63	10.64	10.63
Mean family income	4.66	4.99	4.77	5.10
% below poverty threshold	54.7	47.1	52.6	44.1
Mean teacher's rating of underachievement	0.61	0.59	0.57	0.60
Mean teacher's rating of aggression	0.66	0.41	0.60	0.30
Mean teacher's rating of shyness	0.50	0.44	0.45	0.44
Mean teacher's rating of immaturity	0.61	0.55	0.56	0.54
Mean teacher's rating of inattention	0.67	0.48	0.59	0.43

Note. There were no significant differences on any covariates between heavy users and matched controls.

[a]Part of the original sample (*N* = 530).

[b]Part of the matched sample (*N* = 274).

Table 3

Marginal Effects of Heavy Adolescent Marijuana Use on Adult Outcomes for Males (n = 184) and Females (n = 90)

Outcome variable and mediator	Step 1: Marginal effect			Step 2a: Marginal effect adjusting for dropping out of high school			Step 2b: Marginal effect adjusting for the frequency of adult marijuana use		
	Effect	95% CI	p	Effect	95% CI	p	Effect	95% CI	p
Males									
Effect of heavy marijuana use on									
Being employed at age 32–33	−.185	−.323, −.047	.009	−.148	−.292, −.004	.044	−.159	−.303, −.155	.030
Being married at age 32–33	−.130	−.259, −.002	.047	−.100	−.231, .032	.136	−.115	−.248, .018	.090
Being a teen parent	.087	−.016, .205	.150						
Parenting outside of marriage	.163	.021, .306	.025	.127	−.022, .276	.094	.109	−.042, .261	.156
Mediators									
Dropping out of high school	.207	.066, .347	.004						
Using marijuana as an adult	.261	.138, .384	.001	.250	.124, .375	.001			
Females									
Effect of heavy marijuana use on									
Being employed at age 32–33	−.178	−.375, .019	.077	−.122	−.333, .090	.258	−.112	−.328, .103	.309
Being married at age 32–33	−.222	−.410, −.037	.019	−.202	−.392, −.011	.038	−.183	−.374, −.007	.059
Being a teen parent	.156	−.031, .342	.102						
Parenting outside of marriage	.289	.093, .485	.004	.249	.042, .456	.018	.244	.038, .450	.020
Mediators									
Dropping out of high school	.200	.019, .380	.030						
Using marijuana as an adult	.222	.071, .373	.004	.205	.051, .359	.009			

Note. CI = confidence interval.