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Family ties: maternal-offspring attachment and young adult nonmedical prescription opioid use

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Abstract

Background—Nonmedical prescription drug use is prevalent among young adults, yet little is known about modifiable determinants of use. We examined whether maternal-offspring attachment reported at mean age 21 was associated with nonmedical prescription opioid use at mean age 26, and investigated whether a history of depressive symptoms and substance use played a role in associations between maternal-offspring attachment and nonmedical prescription opioid use.

Methods—We used data from the Growing Up Today Study, a longitudinal cohort of United States adolescents followed into young adulthood. Maternal-offspring attachment was reported by young adults and their mothers, and defined as mutual low, mutual medium or high, and dissonant. Analyses were carried out in the full sample using generalized estimating equation models, and in

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Contributors: Bordelois had full access to all of the data in the study and conducted the statistical analyses. Cerdá and Koenen developed the study concept and design. Austin acquired the data. Bordelois, Cerdá, Koenen, Reisner, Roberts, Keyes and Martins contributed to the analysis and interpretation of the data. Cerdá and Bordelois drafted the manuscript. All authors provided a critical revision of the manuscript for important intellectual content and approved the final version of the manuscript.

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a sibling subsample, using conditional fixed effects models to control for stable aspects of the family environment.

Results—Analyses with the full sample and the sibling subsample both showed that mutual medium/high maternal-offspring attachment at age 21 was associated with lower odds of nonmedical prescription opioid use at age 26 (RR=0.74; 95% CI=0.57-0.97 in full sample). The association was partly mediated by mean age 23 offspring smoking, heavy episodic drinking, and illicit drug use.

Conclusions—Promoting reciprocal attachment in the maternal-offspring dyad should be investigated as a strategy to prevent nonmedical prescription opioid use by young adulthood. Even in young adulthood, programs that target both parents and offspring may have greater impact on offspring substance use than programs that target offspring alone.

Keywords

nonmedical prescription opioid use; maternal-child attachment; sibling fixed effects models; mediators

1. Introduction

Nonmedical use of prescription opioids, that is, use for recreational or self-treatment purposes without a prescription, or using more medication than prescribed by a physician, is an important and growing public health problem in high-income and low-middle-income countries (UNODC, 2011). In countries as diverse as Canada, Mexico, Costa Rica, and Australia, non-medical prescription opioids account for most of the use of opioids (UNODC, 2011). Little is known about modifiable determinants of use. Data from the United States provides some of the first insights into the epidemiology of non-medical prescription opioid use.

In the United States, an estimated 52 million people have used prescription opioids for nonmedical reasons at least once in their lifetime (Substance Abuse and Mental Health Services Administration (SAMHSA), 2011). Nonmedical prescription opioid use has increased dramatically since the early 1990s along with related mortality. While prescription opioids are a safe and effective treatment for pain when used as prescribed, unintentional overdose deaths due to nonmedical prescription opioid use quadrupled from 1999 to 2010 and by 2007 outnumbered those involving heroin and cocaine combined (National Institute on Drug Abuse, 2011). Women are particularly affected by this increase: deaths from prescription opioids increased more than 400% since 1999 for women, compared to 265% for men (CDC, 2013). In 2010, approximately 2.4 million Americans used prescription opioids nonmedically for the first time, or 6,600 people per day (SAMHSA, 2011).

Young adults (aged 18-25 years) are the age group at highest risk for nonmedical use of prescription opioids, with 5.9% reporting past-month nonmedical use in 2010 (SAMHSA, 2011). The young adult developmental period is characterized by rapid transitions into social contexts with more freedom, greater decision-making autonomy, and less exposure to external social controls than experienced during adolescence (Stone et al., 2012). Concomitant to this greater level of freedom is an increase in the prevalence of substance

use and abuse. Understanding factors associated with nonmedical prescription opioid use in young adulthood is critical to developing interventions to prevent use and related problems (i.e., opioid use disorders) both in the short-term and in later adulthood (Dowling et al., 2006; Martins et al., 2010).

We focus on a potentially key determinant of young adult prescription opioid use: maternal-offspring attachment in late adolescence/young adulthood. A parent-offspring relationship characterized by secure attachment has been associated with healthy development and reduced drug use (Brook et al., 1990). Different aspects of the parent-offspring relationship, including parental assertiveness and involvement, parental affection and offspring-centeredness, and offspring's identification with parents' values, have been inversely correlated with drug use (Brook et al., 1990; King and Chassin, 2004; Locke and Newcomb, 2004; Maggs et al., 1997; Morojele and Brook, 2001; Stone et al., 2012). In the case of nonmedical prescription opioid use, however, the evidence is less clear. Harrell and Broman (2009) did not find an association between mid-adolescent reports of satisfaction and closeness of the maternal relationship and any type of young adult nonmedical prescription drug use in Add Health, a nationally representative US sample of young adults (Harrell and Broman, 2009). However, contrary to expectations, maternal warmth was associated with higher risk of nonmedical prescription drug use among Hispanic respondents, specifically (Harrell and Broman, 2009). Collins and colleagues did not detect an association between offspring reports of parental monitoring and any nonmedical prescription drug use in a sample of Appalachian children and adolescents (Collins et al., 2011). To our knowledge, no prior national study has examined the association between the quality of reciprocal maternal-offspring attachment, measured from the perspectives of both the mother and the offspring, and nonmedical prescription opioid use.

In addition to being understudied, research on the relation between maternal-offspring attachment and nonmedical prescription opioid use faces at least two important challenges. The first involves confounding. Maternal-offspring attachment occurs along with a broader constellation of social and behavioral factors that also influence offspring substance use. This poses a challenge to assessing the causal effect of maternal-offspring attachment. Family-level characteristics that are potentially confounding factors include family socioeconomic status and family violence, as well as maternal characteristics including marital status, personality attributes, nonmedical prescription opioid use, and psychiatric history (D'Onofrio et al., 2012; Kendler et al., 2013). While some investigators have measured some of these factors in studies of maternal-offspring attachment and other types of substance use, determining whether or not there is a causal effect of maternal-offspring attachment may require accounting for all of them simultaneously as well as other unmeasured and unknown confounders.

A second important challenge involves understanding the mechanisms in the offspring that connect maternal-offspring attachment to nonmedical prescription opioid use. Comorbid offspring psychiatric symptoms and other substance use may constitute central mechanisms in the pathway linking maternal-offspring attachment to offspring nonmedical prescription opioid use. Low maternal-offspring attachment in adolescence increases the risk for offspring depression, which contributes to nonmedical prescription opioid use as a way to

self-medicate depressive symptoms (Khantzian, 1997; Martins et al., 2012). At the same time, early alcohol use, cigarette smoking, and illicit drug use among offspring with low maternal-offspring attachment may serve as a gateway to acquiring and experimenting with prescription opioids (Brook et al., 1990). Previous research suggests that depression and other substance use precede incident prescription opioid use, but the role that they play in the relationship between maternal-offspring attachment and nonmedical prescription opioid use is unknown (McCabe et al., 2005, 2008; McCabe and Teter, 2007; Pletcher et al., 2006).

In the current study, we conducted an analysis of maternal-offspring attachment in relation to offspring nonmedical prescription opioid use in the context of a prospective cohort study in which multiple offspring per family were enrolled. The power of this design comes from sibships in which there was variability in maternal-offspring attachment and nonmedical prescription opioid use, but similarity in the shared familial environment (Lahey and D'Onofrio, 2010). Hence, differences in nonmedical prescription opioid use between exposed and unexposed siblings could not be attributed to shared aspects of the familial environment, ranging from some shared inherited genetic susceptibility and family history of nonmedical prescription opioid use to shared environmental factors. This design consists of a comparison of siblings matched on family background, in which estimates of nonmedical prescription opioid use risk are conditioned on family-specific intercepts.

This study had two aims: (1) to examine the association between maternal-offspring attachment in late adolescence/young adulthood and nonmedical prescription opioid use in young adulthood; and (2) to evaluate whether offspring depressive symptoms and substance use (i.e., heavy episodic drinking, cigarette smoking, marijuana, and other illicit substance use) reported following maternal-offspring attachment and prior to nonmedical prescription opioid use explain the association between maternal-offspring attachment and nonmedical prescription opioid use in young adulthood. Analyses were conducted in the full sample as well as in a sibling subsample.

2. Methods

2.1 Study sample

The Growing Up Today Study (GUTS) is an ongoing cohort study enrolled in 1996 with offspring of women participating in the Nurses' Health Study II (NHS II). NHS II is a prospective cohort of female nurses. The study, begun in 1989, recruited 116,430 nurses aged 25-44 nationwide and has since followed them biennially. Nurses with offspring of ages 9-14 (N=34,174) were requested permission to recruit their offspring into GUTS. A baseline questionnaire was mailed to the nurses who granted consent (54%). Of their children, 9,039 girls (68%) and 7,843 boys (58%) returned the baseline questionnaire and were enrolled. Since baseline, GUTS participants have completed 11 questionnaires, initially on an annual basis and every two years since 2001. Participants who missed a questionnaire were retained in subsequent waves. A detailed description of the GUTS cohort is available (Field et al., 1999)

This analysis was conducted among all GUTS participants who responded to 2010 questions about past-year nonmedical prescription opioid use (hereafter referred to as “full sample,

n=7,746") and in a subsample consisting of the sibling pairs in which at least one of the siblings reported past-year nonmedical prescription opioid use on at least one occasion (number of young adults = 290, number of families=139), hereafter referred to as the "sibling subsample." This study was approved by the Brigham and Women's Hospital Institutional Review Board. Study participants provided informed consent prior to participating in the study.

2.2 Study Measures

Table 1 shows timing of assessment of the variables used in the analyses. To summarize, to establish a temporal order, confounders were measured before assessment of the exposure of interest (maternal-offspring attachment), while potential mediators were assessed between assessments of the exposure and outcome and were operationalized to reflect status in the year following exposure assessment. Hence, maternal-level confounders were measured in 2001 and 2003, offspring-level confounders were assessed in 2003; offspring and maternal reports of the exposure were assessed in 2005 and 2006 respectively; offspring reports of potential mediators (i.e., offspring substance use) were assessed in 2007; and offspring reports of the outcome (past year nonmedical prescription opioid use) were assessed in 2010.

2.2.1 Offspring reports of the outcome, 2010—The main outcome of this study was frequency of past-year use of prescription opioids without a doctor's prescription. In the 2010 GUTS questionnaire, respondents who answered yes to the question: "Have you ever used any pain killers (e.g., Percocet, Percodan, Oxycontin, Oxycodone, codeine, morphine) without a doctor's prescription?" were asked to indicate frequency of use in the prior 12 months. The answer options included: Not in past year, 1 time, 2-5 times, 6-10 times, 11-15 times, 16+ times. Participants who endorsed the "Not in past year" option in the questionnaire and those who indicated that they have never used painkillers were classified as non-past-year users.

2.2.2 Exposure: Maternal and offspring reports of maternal-offspring attachment, 2005-2006—Youth/young adults (GUTS, 2005) and mothers (NHS II, 2006) were asked to complete an identical 9-question scale questionnaire that assessed the quality of their relationship. Mothers completed separate scales for each offspring they had in the study. The scale was developed for research in adolescents and has been shown to correlate highly with other more complex measures of quality of relationships (Dittus and Jaccard, 2000; Jaccard and Dittus, 2000; Jaccard et al., 1996). The scale had high internal consistency reliability in the sample of mothers and offspring (Cronbach's $\alpha = 0.94$ for mothers and $\alpha = 0.94$ for offspring). The mother and offspring reports (Spearman's r=0.43; p <0.001) and the sibling reports (Spearman's r=0.19; p=0.02) were significantly correlated with each other.

Young adults and mothers rated their dissatisfaction regarding aspects of the relationship including affection, emotional support, conflict resolution, respect, and communication in a 5-point scale with higher score indicating more dissatisfaction. For each young adult and mother's report an overall attachment score was computed as the sum of the answers to the

nine items. Medium-high attachment was defined as the bottom 75% of the score distributions. Low attachment was defined as the top 25%. The maternal and offspring scores were then combined to create a 4-level attachment variable: (1) mutual medium-high (medium-high young adult – medium-high mother attachment ratings); (2) medium-high young adult – low mother attachment ratings, (3) low young adult – medium-high mother attachment ratings and (4) mutual low (low young adult-low mother attachment ratings).

2.2.3 Mediators, 2007—Mediators were offspring characteristics considered to potentially be in the pathway between maternal-offspring attachment and offspring non-medical use of prescription drugs. All mediators were assessed in GUTS 2007 and were operationalized to indicate presence/absence of the mediator in the year following exposure assessment.

Depressive symptoms in the past week were assessed with the 10-item Center for Epidemiological Studies Depression scale (CESD-10; Kohout et al., 1993). The items covered depressed mood, guilt, worthlessness, helplessness, psychomotor retardation, and appetite and sleep disturbances experienced on the past week. The overall score was dichotomized, as recommended, with a score of 11 or higher indicating mild or severe depressive symptomatology (Andresen et al., 1994).

We defined heavy episodic use of alcohol as drinking five or more alcoholic beverages over a few hours on more than five occasions in the past year for males and drinking four or more alcoholic beverages in this same time frame for females.

Smoking was defined as (1) never, (2) past (participant has a history of smoking but has not smoked in past year), and (3) current (smoking within past year).

We created a binary variable to reflect past year use of marijuana and another binary variable -“other illicit drugs”- to reflect past year use of cocaine, LSD, heroin, GHB, ecstasy, crystal methamphetamine, or other amphetamines.

2.2.4 Confounders—Confounders, listed below, were maternal and young adult characteristics commonly associated with either maternal-offspring attachment or offspring non-medical use of prescription drugs. Each confounder was measured using the most detailed assessment available that was conducted prior to, and closest in time to, the assessment of maternal-offspring attachment.

2.2.4.1 Maternal characteristics: NHS II, 2001-2003: We used the 2001 questionnaire to assess maternal depressive symptoms with the 5-item Mental Health Index (MHI-5) overall test score (Rumpf et al., 2001) and to measure household income (categorized in this study as 1=<50,000, 2=50,000-74,999, 3=75,000-99,000, 4>99,000). We used the 2003 questionnaire to assess maternal smoking, categorized as Ever/Never smoking.

2.2.4.2 Young adult characteristics (GUTS baseline and 2003): Young adult depressive symptoms were assessed in 2003 using 6 items of the previously validated McKnight Risk Factor Survey (MRFS) (Shisslak et al., 1999). We computed mean scores for respondents who answered at least four of the questions. Young adult's prior heavy episodic use of

alcohol assessed in 2003 was defined as drinking 5 (for males) or 4 (for females) or more alcoholic beverages over a few hours on more than five occasions in the past year. Smoking was defined as (1) never, (2) past (participant has a history of smoking but has not smoked in past year), and (3) current (smoking within past year). Past-year use of marijuana was categorized as yes/no. Other characteristics were baseline young adult's age (continuous), sex (male/female), and race/ethnicity (white/non-white).

Missing covariate information was assumed to be at random and was imputed using the R Mi package (Su, 2011)

2.3 Statistical analysis

2.3.1 Analysis in the full sample—We examined the relationship between maternal-offspring attachment and offspring's frequency of past year nonmedical prescription opioid use. We modeled the relative rate of past year nonmedical prescription opioid use using generalized estimating equations with a Poisson distribution, while accounting for familial correlation of data (Lipsitz et al., 1991). The first model controlled for socio-demographic confounders (Model 1: offspring's age, race/ethnicity, sex and family income); we then added pre-exposure maternal and offspring mental health history as potential confounders (Model 2: maternal depressive symptoms and smoking status, and offspring's history of depressive symptoms, heavy episodic alcohol use, smoking, and marijuana use). In sequential models we separately added potential mediators, assessed between the exposure and the outcome: offspring past week depressive symptomatology (Model 3a), past-year smoking and use of alcohol (Model 3b), past-year marijuana use (Model 3c), and past-year use of other illicit drugs (Model 3d). A final model adjusted for all potential mediators (Model 3e).

2.3.2 Analysis in siblings subsample—We used a matched, or fixed effects, (Allison, 2005) sibling analysis to examine the relationship between maternal-offspring attachment and frequency of past-year nonmedical prescription opioid use in the sibling subsample. This analysis assumes that effects of maternal variables are similar in siblings (Rutter et al., 2001). The matched analyses among siblings were conducted by using Poisson regression with dummy variables for all families (less one) with correction for overdispersion. Only potential confounders that differed among siblings were included in the sibling fixed-effects models, as observed and unobserved confounders that were shared among siblings (e.g., maternal characteristics) were accounted for by the sibling design. In these models, we adjusted for pre-exposure offspring history of depressive symptomatology, smoking, heavy episodic drinking, marijuana use, age, sex, and race/ethnicity. Only families in which at least one of the siblings reported some past-year use of prescription opioids were kept in the analytic sample (Number of participants=290, number of families=139). In subsequent and separate models we further adjusted for potential mediators: post-exposure offspring depressive symptomatology, smoking and heavy episodic drinking, and use of illicit drugs. All analyses were conducted in SAS 9.3 (2002).

2.3.3 Sensitivity analyses in sibling subsample—Our analysis relied on offspring and maternal reports of maternal-offspring attachment and examined the role they played in

the risk for nonmedical prescription opioid use. This reliance on offspring-specific reports of maternal-offspring attachment could lead to confounding, as offspring-specific factors could lead siblings to perceive the same objective maternal relationship differently (and thus to have different probabilities of being classified as having concordant maternal-offspring attachment) and could also contribute to between-sibling differences in the risk of young adult nonmedical prescription opioid use. We conducted a sensitivity analysis using only one rater across siblings (the mother) to examine this possibility. We estimated the relationship between maternal reports of maternal-offspring attachment and the risk of nonmedical prescription opioid use.

3. Results

Characteristics of the full 2010 GUTS sample and of the sibling sub-sample used in our analyses are shown in Table 2. The 2010 prevalence of past-year nonmedical prescription opioid use was 7%. Young adult respondents were aged 18-26 (mean age 21) years old when offspring attachment was measured, 19-26 (mean age 22) when maternal attachment was measured, and 23-30 (mean age 26) years old when we measured past-year nonmedical prescription opioid use. Of the 7,646 GUTS participants who responded to the 2010 question on past-year nonmedical prescription opioid use (full-sample), 290 (3.8%) were included in our sibling analysis, as they each had a sibling in the study and, within each of those families, at least one sibling had reported past-year use of nonmedical opioids in 2010. Due to this inclusion criteria, 51.38% of the sibling sample had used prescription opioids in the past year.

3.1 Analysis in the full sample

Adjusting for sex, race/ethnicity, and age, the frequency of past-year nonmedical prescription opioid use among young adults with mutual medium-high maternal-offspring attachment was half that of young adults who had mutual low maternal-offspring attachment (Risk ratio (RR)=0.50, 95% Confidence Interval (CI)=0.38-0.65) (Table 3). Further adjustment for maternal history of depressive symptoms and smoking and offspring's history of depressive symptoms, smoking, heavy episodic use of alcohol, and marijuana use, all assessed prior to assessment of attachment, slightly reduced the association between mutual medium/high attachment and nonmedical prescription opioid use (RR=0.74, 95% CI=0.57-0.97). We next tested whether offspring's depressive symptoms and other types of substance use, measured after assessment of attachment, mediated the relationship between attachment and nonmedical prescription opioid use. The beta coefficient for the main effect was attenuated by 10%, 18%, 7%, and 16% upon adjustment for depressive symptoms (Model 3a), heavy episodic use of alcohol and smoking (Model 3b), marijuana (Model 3c), and other illicit drug use (Model 3d), respectively. In a final model that included all potential mediators the beta coefficient was attenuated by 39% (Model 3e).

3.2 Analysis in siblings subsample

Adjusting for sex, race/ethnicity, and age, the frequency of past-year nonmedical prescription opioid use among young adults with mutual medium-high maternal-offspring attachment was a quarter of that of their siblings who had mutual low maternal-offspring

attachment (RR=0.22, 95% CI =0.09-0.54) (Model 1; Table 4). After further adjustment for young adult's pre-exposure history of depressive symptoms, smoking, heavy episodic drinking, and use of marijuana, the association between mutual medium-high attachment and nonmedical prescription opioid use remained unchanged (RR=0.29, 95% CI=0.12-0.74). In subsequent models that tested whether offspring's post-exposure depressive symptoms and other types of substance use mediated the relationship, smoking and heavy episodic use of alcohol (Model 3b), and other illicit drug use (Model 3d) attenuated the beta coefficient of the main effect by 21% and 18 % respectively. In a final model that included all potential mediators the beta coefficient was attenuated by 28% (Model 3e). Sensitivity analyses in the sibling subsample using only maternal reports on maternal-offspring attachment (Table 5), found comparable results to the main sibling analysis.

4. Discussion

Maternal-offspring attachment in late adolescence/young adulthood was associated with lower risk for offspring nonmedical prescription opioid use in young adulthood. The consistent findings in the full sample and the siblings fixed-effects analysis of prevalent nonmedical prescription opioid use indicate that the association is likely not due to family-level sources of confounding shared between siblings. Our findings fit within a broader body of work on substance use, which found that close and supportive relationships characterized by secure parent-offspring attachment were protective against substance use (Fang et al., 2010; King and Chassin, 2004; Maggs et al., 1997; Morojele and Brook, 2001; Stone et al., 2012). Interventions aimed at promoting mother-child attachment in early childhood have been effective in preventing long-term adverse health outcomes in the offspring (Geeraert et al., 2004; Olds, 2006; Olds et al., 2007); this study highlights the persistent influence that promoting secure maternal-child attachment can have on nonmedical prescription opioid use even in young adulthood.

A key strength of this study is the use of both maternal and offspring reports of maternal-offspring attachment. Through this dyadic approach, we found that concordance in maternal-offspring attachment (i.e., medium-high attachment reported by both the mother and the offspring) distinguished nonmedical prescription opioid use from non-use. Cases of discordant attachment (i.e., medium-high maternally-perceived attachment but low offspring-perceived attachment, or low maternally-perceived attachment but medium-high offspring-perceived attachment), did not have significantly different levels of risk of nonmedical prescription opioid use from individuals with concordant low offspring-mother perceptions of attachment. With the use of a dyadic measure, we could conclude that what mattered was reciprocal attachment between the mother and offspring, rather than just the offspring's perception of attachment. The lack of consistent findings in previous studies that examined the association between maternal warmth (Harrell and Broman, 2009) or parental monitoring (Collins et al., 2011) and nonmedical prescription opioid use may be partly due to the reliance on offspring reports of the maternal-offspring relationship that obscure the distinctions between reciprocal high quality relationships and unidirectional perceptions of such relationships.

Maternal-offspring attachment may influence nonmedical prescription opioid use through a variety of pathways, including by communicating parental disapproval of nonmedical prescription opioid use and other types of drugs (Collins et al., 2011; Sung et al., 2005) and by preventing diversion of drugs from family members' prescribed medications (Ford and Lacerenza, 2011). We tested one pathway connecting maternal-offspring attachment to nonmedical prescription opioid use: depressive symptoms and engagement in alcohol, tobacco or illicit drug use. We found that the association between maternal-child attachment and nonmedical prescription opioid use was partly mediated by intervening levels of smoking, heavy alcohol use, and other types of illicit drug use. Multiple studies have found an overlap between nonmedical prescription opioid use and other drug use behaviors, including cigarette smoking, heavy drinking, marijuana use, and other illicit drug use (Bardhi et al., 2007; Blanco et al., 2007; Boyd et al., 2004, 2009; Catalano et al., 2011; McCabe et al., 2009, 2007, 2006, 2008). Nonmedical prescription opioid use may be another type of drug used by youth engaged in polydrug use. Low maternal-child attachment may contribute to earlier initiation of alcohol, tobacco, and illegal drugs, which may lead youth to find out where and how to access prescription drugs, thus placing them at greater risk for nonmedical prescription opioid use (Viana et al., 2012).

Our findings should be considered with the following limitations. First, we were unable to examine the association between maternal-offspring attachment and incident nonmedical prescription opioid use due to statistical power considerations in the sibling subsample. Future studies will have to determine whether maternal-offspring attachment is associated with incident nonmedical prescription opioid use. However, the availability of prospective data on confounders, exposures, and mediators allowed us to establish a temporal order in these measures and to assess whether changes in substance use and depressive symptoms pre- vs. post-measurement of attachment explained the association between maternal-offspring attachment and nonmedical prescription opioid use. Second, our sample was predominantly White; findings may not apply to other populations. Third, the sibling analysis imposed important restrictions on the analytic sample; unmeasured offspring-level confounders such as temperament could have contributed to the between-sibling discordance in nonmedical prescription opioid use and in attachment. Fourth, we did not measure maternal-offspring attachment in childhood; the effect of maternal-offspring attachment on non-medical prescription opioid use may be stronger in childhood and early adolescence. Fifth, we were unable to distinguish nonmedical use of opioids for recreational versus self-treatment purposes; future studies need to examine the specific impact of maternal-offspring attachment on each type of nonmedical prescription opioid use. Sixth, while parents may protect offspring against engagement in nonmedical use of prescription opioids, they may also be a source of diverted prescription opioids—the moderate effect of maternal-offspring attachment on nonmedical prescription opioid use may be due to this dual role played by families in the case of prescription opioids.

Reciprocal attachment between mother and offspring is associated with lower risk of nonmedical prescription opioid use in young adults. The findings suggest that family substance use prevention interventions may need to work with families as a unit in order to have an impact on nonmedical prescription opioid use. Further, parenting programs that work with young parents to improve psychosocial and developmental outcomes in parents

and children may be a promising strategy to prevent offspring nonmedical prescription opioid use by promoting a closer parent-offspring relationship (Barlow et al., 2011; Scharfe, 2011).

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Table 1

Timing of offspring (Growing Up Today Study) and maternal (Nurses Health Study-II) assessments used in the study, 2001-2010

Year	2001	2003	2005	2006	2007	2010
*GUTS participants' mean ages in years (Interquartile range)	16.8 (15.4-18.2)	19.3 (17.9-20.7)	21.01 (19.8-22.5)	21.7** (20-23)	23.2 (21.8-24.5)	25.7 (24.4-27.1)
Measures						
Confounders						
Offspring reports (GUTS)						
Offspring depression		X				
Offspring smoking, alcohol use, marijuana use		X				
Maternal reports (NHS II)						
Depression, family income	X					
Smoking		X				
Exposures: Maternal-offspring attachment						
Maternal reports (NHS-II)						
Closeness to offspring			X			
Offspring reports (GUTS)						
Closeness to mother			X			
Mediators						
Offspring reports (GUTS)						
Offspring smoking, alcohol, marijuana, and other illicit drugs				X		
Outcome						
Offspring reports (GUTS)						
Offspring past year nonmedical prescription opioid use					X	

*Age at assessment is estimated as mean age at questionnaire return

**Date of return of the 2006 questionnaire is not available. Hence, age of GUTS participants at return of the questionnaire was approximated by subtracting the year of birth from 2006

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Table 2

Characteristics of study participants (Growing Up Today Study) and their mothers (Nurses Health Study-II) in the full sample (N=7,646) and the sibling sub-sample (N=290).

Variables	Full 2010 sample[1]	2010 Sibling sub-sample
Participants, total	N=7,646	N=290
Age in years in 2010, mean (SD)[2]	25.75 ± 1.61	25.83 ± 1.69
Maternal covariates, NHS II 2001, 2003		
Depressive symptoms in 2001, mean score (SD)	75.00 (14.78)	73.01 (15.19)
Family income in 2001 (%)		
<50,000	771 (10.08)	23 (7.93)
50,000-74,999	1418 (18.55)	43 (14.83)
75,000-99,000	2766 (36.18)	73 (25.17)
99,000+	2691 (35.19)	151 (52.07)
Smoking, ever, 2003 (%)	384 (5.02)	16 (5.52)
Offspring covariates, GUTS		
Sex, male (%)	2530 (33.09)	113 (38.97)
Race/ethnicity (%)		
White	7117 (93.08)	269 (92.76)
Non-white	529 (6.92)	21 (7.24)
Depressive symptoms, 2003, mean score (SD)	1.32 ± 0.59	1.45 ± 0.62
Heavy episodic use of alcohol, 2003 (%)	3331 (43.57)	179 (61.72)
Smoking, 2003 (%)		
Never	6433 (84.14)	199 (68.62)
Past	89 (1.16)	9 (3.10)
Current	1124 (14.70)	82 (28.28)
Marijuana, 2003 (%)	2281 (29.83)	156 (53.79)
Maternal-offspring attachment, NHS II 2006, GUTS 2005 (%)		
Mutual mid-high maternal and offspring attachment	4631 (60.57)	153 (52.76)
Mid-high maternal and low offspring attachment	924 (12.08)	41 (14.14)
Low maternal and mid-high offspring attachment	1029 (13.46)	43 (14.83)
Mutual low maternal and offspring attachment	1062 (13.89)	53 (18.28)

Variables	Full 2010 sample[1]	2010 Sibling sub-sample
Offspring mediators, GUTS 2007		
Depressive symptoms (%)	1924(25.16)	96 (33.10)
Smoking (%)		
Never	5838 (76.35)	157 (54.14)
Past	332 (4.34)	21 (7.24)
Current	1476(19.30)	112 (38.62)
Heavy episodic use of alcohol (%)	4670 (61.08)	230 (79.31)
Marijuana (%)	2207 (28.86)	152 (52.41)
Other illicit drugs (%)	777 (10.16)	67 (23.10)
Outcome, GUTS 2010		
Young adult frequency of past-year nonmedical prescription opioid use (%)		
Did not use	7103 (92.9)	141 (48.62)
Once	138 (1.80)	39 (13.45)
2-5 times	236 (3.09)	58 (20)
6-10 times	76 (0.99)	22(7.59)
11-15 times	25 (0.33)	5 (1.72)
16+ times	68 (0.89)	25 (8.62)
Number of offspring per family		
1 child	5,550	-
2 children	945	127
3 children	66	12
4 children	2	-

[1] The full 2010 sample, as defined for our analysis, included GUTS participants who answered 2010 question about past-year nonmedical prescription opioid use

[2] SD = standard deviation

Table 3

Generalized estimating equations models of the association between maternal-offspring attachment and young adult frequency of past year non-medical prescription drug use in the full sample, Growing Up Today Study, N=7,646[1]

Variables	Model 1 RR (95% CI)	Model 2[2] RR (95% CI)	Model 3a[2,3] RR (95% CI)	Model 3b[2,3] RR (95% CI)	Model 3c[2,3] RR (95% CI)	Model 3d[2,3] RR (95% CI)	Model 3e[2,3] RR (95% CI)
Maternal-offspring attachment							
Mutual low				Reference			
Med-high youth/Low mom	0.77 (0.55-1.07)	0.96 (0.70-1.33)	0.98 (0.71-1.35)	1.00 (0.72-1.39)	0.97 (0.70-1.34)	1.05 (0.76-1.43)	1.09 (0.79-1.50)
Low youth/Med-highmom	0.93 (0.67-1.30)	1.04 (0.76-1.43)	1.07 (0.79-1.46)	1.06 (0.78-1.46)	1.03 (0.76-1.41)	1.05 (0.77-1.45)	1.09 (0.80-1.48)
Mutual mid-high	0.50 (0.38-0.65)	0.74 (0.57-0.97)	0.77 (0.59-0.99)	0.79 (0.61-1.02)	0.76 (0.59-0.99)	0.78 (0.60-1.02)	0.83 (0.64-1.09)
Depression symptoms			1.65 (1.33-2.05)				1.52 (1.23-1.88)
Heavy use of alcohol				1.68 (1.23-2.29)			1.36 (0.98-1.89)
Smoking							
Never				Reference			Reference
Not in past-year				2.49 (1.66-3.73)			1.99 (1.32-2.99)
Past-year				2.79 (2.03-3.85)			1.96 (1.41-2.71)
Marijuana					2.80 (2.15-3.63)		1.79 (1.34-2.39)
Other illicit drugs						3.25 (2.57-4.10)	2.27 (1.79-2.89)

[1] All models are adjusted for age, sex, race/ethnicity, and family income and account for family clustering of data.

[2] Models 2 - 3e are further adjusted for maternal and offspring history of depression, maternal smoking and offspring previous heavy episodic use of alcohol, smoking,and use of marijuana

[3] Models 3a – 3e are adjusted for mediators assessed in the offspring during follow up

Table 4

Fixed-effects models of the association between maternal-offspring attachment and young adult frequency of past year non-medical prescription drug use in the sibling sub-sample, Growing Up Today Study (N=290) [1]

Variables	Model 1	Model 2[2]	Model 3a[2,3]	Model 3b[2,3]	Model 3c[2,3]	Model 3d[2,3]	Model 3e[2,3]
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Maternal-offspring attachment							
Mutual low				Reference			
Med-high youth/Low mom	0.35 (0.12-1.02)	0.49 (0.16-1.55)	0.47 (0.15-1.49)	0.56 (0.17-1.83)	0.47 (0.14-1.55)	0.63 (0.20-2.02)	0.60 (0.17-2.06)
Low youth/Med-high mom	0.79 (0.29-2.14)	0.82 (0.29-2.34)	0.82 (0.30-2.27)	0.88 (0.31-2.50)	0.80 (0.26-2.47)	0.90 (0.31-2.61)	0.89 (0.28-2.84)
Mutual mid-high	0.22 (0.09-0.54)	0.29 (0.12-0.74)	0.29 (0.12-0.74)	0.38 (0.14-0.99)	0.30 (0.12-0.76)	0.36 (0.14-0.92)	0.41 (0.15-1.14)
Depression symptoms			1.64 (0.79-3.40)				1.64 0.69-3.91
Heavy use of alcohol				1.81 (0.67-4.90)			1.88 (0.70-5.01)
Smoking							
Never				Ref			Ref
Not in past-year				4.27 (1.07-17.02)			2.52 (0.56-11.27)
Past-year				2.65 (0.89-7.93)			1.65 (0.52-5.24)
Marijuana					2.36 (1.09-5.09)		1.99 (0.91-4.35)
Other illicit drugs						3.13 (1.35-7.26)	2.02 (0.80-5.13)

[1] All models are adjusted for age, sex, race/ethnicity

[2] Models 2 - 3e are further adjusted for offspring history of depression, previous heavy episodic use of alcohol, smoking, and use of marijuana

[3] Models 3a – 3e adjust for mediators assessed in the offspring during follow up

Table 5

Fixed-effects models of the association between maternal reported attachment to the offspring and young adult nonmedical prescription opioid use in the sibling sub-sample, Growing Up Today Study (N=290)[1]

Variables	Model 1	Model 2[2]	Model 3a[3]	Model 3b[4]	Model 3c[5]	Model 3d[6]	Model 3e[7]
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Maternal attachment							
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mid-high	0.28 (0.13-0.61)	0.37 (0.16-0.85)	0.37 (0.16-0.83)	0.46 (0.19-1.10)	0.38 (0.16-0.88)	0.45 (0.19-1.03)	0.49 (0.20-1.20)

[1] All models are adjusted for age, sex, and race/ethnicity

[2] Model 2 is further adjusted for offspring history of depression, heavy episodic use of alcohol, smoking, and use of marijuana

[3] Model 3a: Model 2 + offspring depressive symptoms during follow-up

[4] Model 3b: Model 2 + offspring smoking and heavy episodic use of alcohol during follow up

[5] Model 3c: Model 2 + offspring use of marijuana during follow up

[6] Model 3d: Model 2 + offspring use of cocaine and LSD during follow up

[7] Model 3e: Model 2 + offspring's depressive symptoms, smoking and heavy episodic use of alcohol, depressive symptoms, use of marijuana, and other illicit drugsduring follow up