Child Maltreatment and Adult Cigarette Smoking: A Long-term Developmental Model

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Objective To examine: (a) child maltreatment’s association with young adult daily cigarette smoking, (b) variations in this association by gender, and (c) mediators of this association. Methods For all study participants (N = 1,125, 94% African American), data from multiple sources (e.g., child welfare records) were collected prospectively at child, adolescent, and young adult time points. Authors enlisted multivariate probit regression for objectives a and b versus exploratory and confirmatory mediation strategies for objective c. Results Maltreatment was significantly associated with daily cigarette smoking. Although not moderated by gender, this relation was fully mediated by adolescent indicators of family support/stability, social adjustment, and cognitive/school performance along with young adult indicators of educational attainment, life satisfaction, substance abuse, and criminality. Conclusions Maltreatment places low-income, minority children at risk for daily cigarette smoking and other deleterious young adult health outcomes. Recommended treatment targets include family support/stability, emotion regulation, social skills, and cognitive/academic functioning.

Key words behavioral health; child maltreatment; cigarette smoking; mediation.

Introduction

Recognition of the long-term health effects of child maltreatment is growing (Springer, Sheridan, Kuo, & Carnes, 2003). Research suggests that child maltreatment, i.e., child abuse and neglect (CAN), represents a developmental disruption whose ontogenic effects can cascade into health-related domains through alterations in neurobiological and behavioral functioning (Kim & Cicchetti, 2006). Impairments in later life such as heart disease, depression, and substance abuse can result (Briere & Scott, 2006; Felitti et al., 1998).

Although knowledge of the link between CAN and health has motivated collaboration across disciplines such as medicine, public health, psychology, and social work, CAN continues to receive insufficient attention in health care settings (Springer et al., 2003). Clinicians require greater insight into the sequelae of CAN and the relation between CAN and ensuing health-related outcomes in order to help ameliorate short- and long-term impacts. Pediatric psychologists are well-positioned to contribute to this effort through the delivery and coordination of tailored services (Bonner, Logue, & Kees, 2003).

In an attempt to inform such efforts, this study explores the effects of child maltreatment on young adult cigarette smoking. Mounting evidence suggests that young adult smoking is not only increasing but also foreshadows persistent, lifetime smoking habits (Lantz, 2003). In turn, long-term patterns of cigarette use represent the leading preventable cause of death in the U.S. (CDC, 2002). We therefore investigated the following research questions. First, is child maltreatment significantly associated with young adult daily cigarette smoking? Second, does the association between CAN and smoking vary by gender? Third, what adolescent and young adult measures help to mediate the potential maltreatment/smoking relation? Data originated from the Chicago Longitudinal Study (CLS), a prospective investigation of economically disadvantaged, predominantly African American (AA) participants born in 1980. Collection of official CAN data from birth through age 17 enabled the identification of maltreatment and
non-maltreatment groups within the study dataset. The CLS relies on these naturally emerging groups to test the long-term effects of CAN.

**Review of the Literature**

A limited number of investigations have uncovered a significant association between child maltreatment, or maltreatment-related events, and later cigarette smoking outcomes. For instance, relying on survey response data from a large patient sample, Felitti’s research group found a significant and graded relation between adverse childhood experiences (ACEs) and poor health outcomes such as general adult smoking and heavy adult smoking (Anda et al., 1999; Felitti et al., 1998). Self-reported ACEs included physical and sexual abuse along with family experiences akin to CAN, e.g., intimate partner violence.

Investigating the association between three major maltreatment subtypes (i.e., neglect, physical abuse, and sexual abuse) and current tobacco use with a sample over 200 women from a health care clinic, Rodgers et al. (2004) found that only sexual abuse demonstrated a statistically significant relation with tobacco use net of the other CAN subtypes. Jun et al. (2008), however, discovered that both physical abuse and sexual abuse, retrospectively reported, were associated with adolescent and young adult smoking in a sample of over 90,000 registered female nurses. Findings from the above studies should be interpreted cautiously as they rely on adult retrospective measures of and differential definitions of CAN.

Turning to adolescent-only studies, Moran, Vuchinich, and Hall (2004) surveyed over 2,000 Oregon high school students at one assessment point. Their results revealed that prior physical, sexual and emotional abuse were associated with significant risk of tobacco use. Chassin and associates (2005) reported that disengaged parenting styles, reported cross-sectionally by adolescent participants and defined as low behavioral control and low acceptance of a child, increased the likelihood of adolescent smoking initiation in a sample of 382 youths. Overcoming the limitations of retrospective survey designs and non-standardized definitions of child maltreatment, Kaplan and colleagues (1998) prospectively assessed the association between officially-determined child physical abuse and later cigarette smoking among an adolescent sample (N = 198). They found that physical abuse significantly predicted teen cigarette use; however, because analyses lacked (a) indicators of multiple CAN subtypes and (b) outcome measures of cigarette use extending into adulthood, results are tentative. Prospectively collected data that capture adult indicators of cigarette use while also integrating standardized measures of maltreatment, inclusive of neglect, could enrich our understanding of the CAN-smoking link.

Although there is reason to believe that early trauma such as CAN may affect the physical and behavioral health of males and females differentially (Olff, Langeland, Draijer, & Gersons, 2007), variation in the CAN/smoking association by gender has not been well studied. Acerno et al. (2000) discovered that childhood physical assault significantly predicted smoking in both males and females while sexual assault predicted smoking in females only. These preliminary findings suggest that CAN predicts smoking behavior among both males and females albeit possibly less robustly for males.

We are aware of only one study that has analyzed mediating processes from CAN to smoking (Edwards, Anda, Gu, Dube, & Felitti, 2007). In this investigation, the authors retrospectively explored depression as a mediator of the link between ACEs and high-risk cigarette smoking. Depression only modestly influenced the main-effect of interest. Given the dearth of published results in this research area, we turn to a theoretical orientation to help guide conceptualization of our mediation model.

As an integral theory explaining CAN effects, the ecological–transactional model of maltreatment (ETMM) depicts interactions between the individual and external forces as primary contributors to the sequelae of CAN (Lynch & Cicchetti, 1998). Within this framework, risk and protective factors from multiple ecological levels influence the development of intra-individual processes, such as emotion regulation. These dynamics may amplify or ameliorate CAN effects, which manifest most apparently when children attempt to master developmental tasks. Repeated failures across stage-salient tasks often evolve into harmful outcomes absent corrective environmental inputs. Cigarette smoking from this framework represents the culmination of maladaptive responses to developmental challenges.

The ETMM identifies a number of childhood domains that are crucial for development yet vulnerable to CAN effects. They include family support/stability, motivation/autonomy, socio-emotional adjustment, and cognitive functioning/school adjustment. Research conducted within this theoretical orientation has produced evidence to support postulated impacts of CAN on these domains (Kim & Cicchetti, 2004). Additionally, older adolescent and young adult areas of development potentially affected by maltreatment include the following: educational attainment, mental and behavioral health, and adult role adoption. Evidence exists, moreover, to validate hypothesized
impacts of CAN on these later outcomes (Briere & Scott, 2006); therefore, we evoke ETMM when considering a conceptual framework. This framework highlights domains through which CAN actualizes long-term smoking impacts.

Although linked to theory, we also considered mediator measures based on our review of empirically validated predictors of smoking. These predictors have also been implicated as maltreatment consequences, qualifying them as potential mediators of the CAN/smoking connection. For instance, measures of family support such as parental support and family stability appear to moderate smoking risk especially among AA youth. Ellickson, Orlando, Tucker, and Klein (2004) revealed that communication with parents helped attenuate smoking trends from adolescence to adulthood within an AA subsample. Family residential stability along with parental monitoring of teen children also appears to help prevent young adult AA smoking (Juon, Ensminger, Sydnor, 2002). Furthermore, child maltreatment adversely affects these predictors of cigarette smoking (Reynolds & Robertson, 2003).

Indicators of adolescent social and emotional adjustment also have been identified as robust contributors to adolescent or adult smoking behavior. Delinquency, for instance, has emerged as a risk factor for adolescent and early adult smoking for both AAs and White Americans (White, Violette, Metzger, Soutzhammer-Loeber, 2007). Further, peer factors contribute significantly to smoking initiation and maintenance. Brook, Pahl, and Ning (2006), for instance, affirmed peer relationships as a significant determinant of smoking trajectories within a sample of minority youth. Griffin, Scheier, Botvin, and Diaz (2001) validated the protective effects of self-control and self-regulation, indicators of emotional adjustment, on adolescent tobacco use. CAN’s effects on these indicators of socio-emotional adjustment (i.e., delinquency, social competence, and emotional adjustment) are well-documented (Widom, 2000).

In addition, cognitive functioning and school adjustment, culminating in educational attainment, represent potent social determinants of adult health behavior such as cigarette smoking (CDC, 2007). For instance, academic achievement in middle and high school has been shown to impart significant preventive effects on later smoking behavior (Hu, Lin, & Keeler, 1998). Moreover, numerous studies have revealed that finishing high school and/or attending college is associated with a decreased likelihood of smoking (Hu, Davies, & Kendel, 2006). These findings have been replicated in AA samples (Kogan, Luo, Brody, & Murry, 2007). Published research has also shown that CAN impairs school performance and contributes to low educational attainment including high school dropout (Widom, 2000).

Mental health indicators such as depression have also been linked to cigarette smoking (Degenhardt & Hall, 2001). Most empirical work in this area has been conducted with White samples, but recent studies have been completed with AA participants. Prospectively collected data from a sample of over 600 AA youth, for example, indicated that depression significantly predicted early adult cigarette use (Repetto, Caldwell, & Zimmerman, 2005). Moreover, child maltreatment has been established as a predictor of adolescent and adult depression (Brown, Cohen, Johnson, & Smailes, 1999) reinforcing the potential role of depression as a mechanism linking CAN to smoking.

Positive indicators of mental health have, conversely, been associated with lower smoking risk. Studies evince life satisfaction as a protective factor against smoking outcomes (Piko, Luxczynska, Gibbons, & Telkozul, 2005). Additionally, child maltreatment can undermine adult well-being, as measured by life satisfaction (Silverman, Reinherz, & Giaconia, 1996). Taken together, these findings recommend well-being or life satisfaction as a possible protective mechanism of the CAN/smoking nexus.

Behavioral health indicators such as substance use or abuse (not including cigarette use) have also been identified as predictors of cigarette smoking. For instance, adolescents who use drugs harder than cigarettes tend to report significantly higher rates of cigarette use compared to non-drug using youth (Okoli, Richardson, Ratner, & Johnson, 2008). Additionally, increased smoking rates have been detected in those that use drugs (non-cigarette) prior to adopting cigarette use as adults (Patton, Coffey, Carlin, Sawyer & Lynskey, 2005). Substance use or abuse is also an established consequence of CAN (Widom, Marmorstein, Raskin-White, 2006) suggesting it qualifies as a viable study mediator.

Last, Pratt, and Cullen (2000) identify adult crime as a correlate of adult cigarette use. Theorists posit that antisocial or self-destructive behaviors such as crime and cigarette smoking tend to cluster, as they share common underlying dynamics such as conventional role rejection and self-regulatory skills deficits. Given the apparent link between CAN and adult crime (English, Widom, & Brandford, 2002), criminality represents another potential pathway through which maltreatment leads to adult smoking.

When answering research question one, we expected that child maltreatment would significantly predict our primary outcome, daily adult smoking, consistent with the research cited above. For question two, we anticipated
the overall CAN/smoking relation to be significant across genders. Finally, for question three, we posited that our explanatory model would fully mediate the main effect of interest but did not formulate hypotheses for specific pathways given the exploratory nature of our initial mediator tests.

This current investigation contributes uniquely to the study of maltreatment health effects in three major ways. First, whereas many investigations in this area have relied on retrospective measures of maltreatment or maltreatment subtypes, we utilized prospectively collected data from official maltreatment records and included all major CAN subtypes in our measure. Although administrative maltreatment data have limitations that include underestimation of overall CAN rates and differential rates of reporting across racial/ethnic groups, they facilitate comparison of maltreatment measures between studies and avert recall bias inherent in retrospective self-reports.

Second, our study sample consists primarily of low-income, urban-dwelling, AA participants (94%), isolating the relations of interest within a relatively homogeneous sample at risk for child maltreatment and for smoking consequences. According to Sedlak and Broadhurst (1996), AA children are overrepresented in official CAN figures due to poverty and surveillance bias. Further, while self-report surveys indicate that AA youth initiate smoking in adolescence at lower rates compared to Whites (Fergus, Zimmerman, & Caldwell, 2005), evidence suggests that AA teens tend to under-report smoking behavior (Bauman & Ennett, 1994) and that AA adults report smoking rates equal to or exceeding those of Whites (Caraballo, Yee, Gfroerer, & Mirza, 2008). Moreover, consequences of regular cigarette smoking disproportionately affect AAs given disparities in metabolizing processes and menthol cigarette usage (Gardner, 2004).

Third, evidence indicates that CAN is a significant predictor of cigarette smoking in the CLS sample (Mersky, Topitzes, & Reynolds, in press). This current study advances the previous in three ways: (a) we introduce a control for parental substance abuse; (b) we assess subgroup effects for gender; and (c) we expand analyses to include a test of mediation which represents the first examination of a comprehensive mediator model explaining the CAN/adult smoking link.

The original sample included all children who enrolled in the Chicago Child-Parent Center (CPC) preschool program in either 1983 or 1984 (n = 989) and completed a CPC kindergarten program in 1986. A matched comparison group consisted of children who did not attend a CPC program but did attend a non-CPC public kindergarten program in 1985–1986 (n = 550). The CPC program is a high quality early childhood intervention that provides educational and family-support services to children residing in high-poverty neighborhoods. In this current study, we examine the impacts of child maltreatment while controlling for CPC program participation.

As discussed above, maltreatment and nonmaltreatment groups emerged in the dataset after the CLS reviewed official child maltreatment records in 1998 when study participants averaged 18 years of age. CAN histories were verified for 1,411 of the original 1,539 CLS participants via triangulation of child protective service and court records for children who resided in Chicago after age 10 (Reynolds & Robertson, 2003). The current study sample (n = 1,125) represents all CLS participants who completed an age 22–24 self-report adult survey and responded to a cigarette smoking item. We were able to validate official maltreatment status for 1,062 of these 1,125 participants. The remaining study sample members (n = 63) are included in the non-maltreatment group (n = 992) because they indicated that they did not receive child welfare services from ages 0–17 when responding to an item in the aforementioned adult survey.

Table I presents descriptive statistics for study measures along with unadjusted comparisons of the study sample (n = 1,125) and attrition sample (n = 414) on most covariate or background measures. Compared to the study sample, the attrition sample has a significantly lower proportion of females, African Americans, and CPC preschool participants. There were no significant group differences on a measure of cumulative risk. We addressed the apparent sample differences methodologically in two ways. First, we statistically controlled for all of these measures in multivariate analyses. Second, we employed a propensity scoring procedure to construct a variable predicting each sample members’ probability for study inclusion and entered this measure into secondary regression models to test for the effects of differential attrition.

**Methods**

**Sample and Data**

The CLS is a panel study of 1,539 economically disadvantaged, minority participants that chronicles the development of its members from school entry to adulthood.
the CLS administered a face-to-face, self-report survey to nearly 75% \((n = 1,142)\) of its original sample. The survey consisted of over 100 items representing multiple domains of functioning. Several measures in this current study derived from the adult survey, including tobacco smoking.

**Outcome Measure**

**Daily Tobacco Smoking**

We drew our measure of daily tobacco smoking from one CLS adult survey item. Respondents were asked if they have ever smoked tobacco, and if yes, how often do they currently do so. Response categories included once or more per day (20.1% of sample), almost everyday (8.4%), a few times per week (4.3%), a few times per month (2.8%), less than once per month (2.3%), not currently but have in the past (9.3%), and never (52.8%). We treated all individuals who endorsed smoking once or more per day as daily smokers and assigned them a code of 1. All other cases were coded 0. We dichotomized the primary outcome measure at this cut point because previous findings indicated that the health risks accompanying occasional tobacco use are considerable yet less extensive than risks associated with daily smoking (Luoto, Uutela, & Puska, 2000). We did, however, test the robustness of the main effect relation of interest with two alternative dichotomous smoking outcomes. For the first measure, all respondents who endorsed smoking tobacco a few times per week or more (32.8%) were coded 1 versus 0 for all others. For the second measure, we differentiated current smokers regardless of frequency (37.9%) from current nonsmokers.

**Mediator Measures**

Two blocks of mediator measures, each consisting of five variables, comprised our explanatory model. The first block covers adolescence (ages 11–17), and the second encompasses late adolescent/young adult ages (16–22). Each first block mediator lacked valid data on select cases due to differential attrition across assessment time points. Using an expectation-maximization (EM) algorithm (Schafer, 1997), we estimated missing values with a multiple imputation strategy in LISREL. This strategy generates simulated values for missing observations. It draws on known

### Table I. Descriptive Statistics for Primary Study Variables and Descriptive Attrition Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Study sample</th>
<th>Original sample</th>
<th>Study sample</th>
<th>Attrition sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean/Rate (SD)</td>
<td>N = 1,125</td>
<td>N = 1,539</td>
<td>N = 1,125</td>
<td>N = 414</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>0–1</td>
<td>0.50 (0.50)</td>
<td>0.55 (0.50)</td>
<td>0.38 (0.49)</td>
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</tr>
<tr>
<td>Race</td>
<td>0–1</td>
<td>0.93 (0.26)</td>
<td>0.94 (0.23)</td>
<td>0.90 (0.31)</td>
<td></td>
</tr>
<tr>
<td>Parental substance abuse, ages 0–5</td>
<td>0–1</td>
<td>–</td>
<td>0.04 (0.20)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Risk index, ages 0–3</td>
<td>0–7</td>
<td>3.58 (1.69)</td>
<td>3.54 (1.70)</td>
<td>3.70 (1.64)</td>
<td></td>
</tr>
<tr>
<td>CPC preschool participation</td>
<td>0–1</td>
<td>0.64 (0.48)</td>
<td>0.66 (0.47)</td>
<td>0.60 (0.49)</td>
<td></td>
</tr>
<tr>
<td><strong>Explanatory variables</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Indicated maltreatment, ages 0–17</td>
<td>0–1</td>
<td>0.14 (0.35)</td>
<td>0.12 (0.32)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Indicated neglect, ages 0–17</td>
<td>0–1</td>
<td>0.09 (0.28)</td>
<td>0.08 (0.27)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Indicated physical abuse, ages 0–17</td>
<td>0–1</td>
<td>0.03 (0.17)</td>
<td>0.03 (0.16)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Indicated sexual abuse, ages</td>
<td>0–1</td>
<td>0.02 (0.12)</td>
<td>0.02 (0.12)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Parent involvement in school, grades 4–6</td>
<td>1–5</td>
<td>2.50 (0.96)</td>
<td>2.57 (0.97)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>School mobility, grades 4–8</td>
<td>0–4</td>
<td>0.95 (0.95)</td>
<td>0.90 (0.92)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Juvenile delinquency</td>
<td>0–1</td>
<td>0.21 (0.41)</td>
<td>0.19 (0.40)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Socio-emotional skills, grades 6–7</td>
<td>10–50</td>
<td>30.99 (6.90)</td>
<td>31.42 (7.07)</td>
<td>31.42 (7.07)</td>
<td></td>
</tr>
<tr>
<td>Reading achievement, grade 8</td>
<td>79–212</td>
<td>144.83 (20.97)</td>
<td>146.00 (21.24)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Highest grade completed, by age 22</td>
<td>7–16</td>
<td>11.84 (1.56)</td>
<td>12.02 (1.60)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Depression, ages 22–24</td>
<td>0–25</td>
<td>–</td>
<td>3.67 (5.60)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Life satisfaction, ages 22–24</td>
<td>1–5</td>
<td>–</td>
<td>3.03 (1.17)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Substance abuse, ages 16–22</td>
<td>0–1</td>
<td>–</td>
<td>0.09 (0.28)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Adult arrest conviction, ages 18–21</td>
<td>0–1</td>
<td>0.20 (0.40)</td>
<td>0.19 (0.39)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td><strong>Outcome variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily tobacco smoking, ages 22–24</td>
<td>0–1</td>
<td>–</td>
<td>0.20 (0.40)</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant group mean differences \((p < .05)\) between study sample and attrition sample at the bivariate level.

*Group differences were not analyzed due to substantial missing data for cases in the attrition sample.
associations between the measure in question and alternative study variables through examination of covariance matrices, variable means, and sample subsets with no missing data (du Toit & du Toit, 2001). For all first block mediators, we utilized this imputation strategy, and the number of missing observations for which values were imputed for each measure is identified below.

**First Block Mediators**
Our first block of mediators included two family support/stability mediators: *parent involvement in school* and *school mobility*. The former averages annual teacher ratings of parent involvement from grades 4 to 6. Across these 3 years, teachers provided responses to one survey item per year, *parent participates in school activities*, ranging from 1 (poor or no involvement) to 5 (excellent or much involvement). When aggregated, the scores produced an alpha reliability coefficient of .60. For the final measure, values were imputed for cases with no valid data (*n = 199*) with the EM algorithm. This measure has been well-described in previous CLS studies (Barnard, 2004) and demonstrates good properties of construct, convergent and divergent validity within the CLS dataset. A second family support/stability mediator, *school mobility*, indexed the number of school moves from grades 4 to 8 for each study member. The CLS obtained these data via grade-by-grade analyses of school system records. Missing values were imputed for 99 cases.

Two measures of socio-emotional adjustment were entered into the first mediator block: *juvenile delinquency* by age 17 and *socio-emotional skills* in grades 6–7. Our dichotomous measure of delinquency derived from official reports to the juvenile court in Cook County, Illinois along with Milwaukee and Dane counties in Wisconsin. For participants whose official delinquency status could not be confirmed (*n = 66*), we relied on adult survey, self-report responses to an item denoting age of first arrest. We created the second socio-emotional adjustment measure from two subscales of the Teacher–Child Rating Scale (T-CRS)—frustration tolerance and peer social skills—reflecting teachers’ assessments of how well students demonstrated social and emotional competence at school, from one (not at all) to five (very well). T-CRS reports have been shown to be valid indicators of adolescent adjustment (Perkins & Hightower, 2002). Frustration tolerance consisted of five items connoting emotional equilibrium and interpersonal tolerance while peer social skills, also developed from five items, captures friendliness, sociability and peer popularity. To arrive at a single measure, for each grade we summed the items from both subscales. The 10-items for grades 6 and 7 produced α-reliability coefficients of .94 and .93, respectively. We averaged scores from these 10-items across the two grades while relying on scores for either if only one existed. We imputed missing data (29.1%) utilizing the EM algorithm.

We included reading achievement as an indicator of cognitive functioning/school adjustment in the first block. This measure reflected *grade 8 reading comprehension* scores on the Iowa Test of Basic Skills, a widely used instrument with sound properties of reliability and validity (Hieronymus, Lindquist, & Hoover, 1980). Of the 1,125 study sample members, CLS had valid data for 1,013. For 77 of the 112 missing cases, we imputed values using 6th and 7th grade ITBS reading scores. High correlations of scores across grade levels and a missing value estimation formula consistent with the scoring structure of the test enabled this strategy. For the remaining 35 cases with no relevant data we imputed values using the EM algorithm.

**Second Block Mediators**
A measure of *highest grade completed by age 22* indicated educational attainment and represented one of five measures in the second mediator block. We obtained data for this measure from administrative high school records along with information from a higher education consortium for all but 12 participants for whom educational status was culled from adult survey responses.

Two indicators of adult mental health created from adult survey data were modeled in the second block of mediators. These measures indicated current experience of *depression* and *life satisfaction*. Because these variables were measured contemporaneously with the outcome, their inclusion in the model tested correlational versus predictive relations to daily tobacco smoking.

To create a measure of *depression*, we summed results from five items appearing in a modified version of the Derogatis Brief Symptom Inventory subscale (Derogatis, Rickels, & Rock, 1976). Each item assessed the frequency with which respondents encounter depression-related symptoms within the past month, 0 (not at all) to 5 (almost every day). The items included feeling depressed, hopeless, lonely, life isn’t worth living, and very sad. Cronbach’s α-reliability coefficient for these 5-items was .84.

Respondents also provided ratings of current and personal *life satisfaction* on a 5-point Likert scale ranging from (1) poor to (5) excellent. Within the CLS dataset, this measure correlates significantly and positively with indicators of optimism, educational attainment, and employment/earnings while exhibiting significant negative correlations with adult crime, high school dropout and unemployment.
A dichotomous measure of any substance abuse in early adulthood represents an additional adult mediator. This measure derived from participant responses to two adult survey items: (1) have you had any substance abuse problems from ages 16 to 22 and (2) have you received any substance abuse services from ages 18 to 22. Participants endorsing at least one of these items were coded 1 on this measure.

We included a dichotomous measure of any arrest conviction as our final second block mediator, an indicator of conventional adult role rejection. Criminal histories were ascertained from county, state, and federal administrative records supplemented with self reports from the adult survey. Participants with an age of first adult arrest conviction from ages 18–21 were coded 1 on this mediator measure.

Explanatory Measure
Indicated Child Maltreatment
Child maltreatment records were aggregated from two sources: petitions to Cook County Juvenile Court and Cook County referrals to the Illinois Department of Child Services (DCFS). We combined the court and DCFS data to create a dichotomous explanatory variable denoting one or more indicated maltreatment reports prior to age 18 (Reynolds & Robertson, 2003). Participants were coded 1 (n = 133) if they had an indicated report in at least one of the two data sources. Although our records did not include cases of documented emotional abuse, the remaining major maltreatment subtypes were represented in our sample: neglect (e.g., lack of supervision and lack of health care), physical abuse, and sexual abuse.

Covariates
Prior evidence suggested that CPC preschool participation was associated with an array of favorable outcomes, including lower rates of both child maltreatment and adult cigarette smoking (Reynolds & Robertson, 2003; Topitzes, Godes, Mersky, Ceglarak, & Reynolds, 2009). Therefore, this examination incorporated a dichotomous measure of CPC preschool participation as an exogenous covariate. We also controlled for gender (female = 1, male = 0) and race/ethnicity (AA = 1, Hispanic non-White = 0). All data for these measures derived from official Chicago Public School records.

We included a cumulative risk index as a study covariate, comprised of the following individual items measured at or near the child’s birth: (a) neighborhood poverty (≥40% residents below poverty level, 1980 Census), (b) single-parent household, (c) mother ever a teen parent, (d) mother did not complete high school, (e) four or more children living in family household, (f) family receipt of Aid to Families with Dependent Children (AFDC), and (g) mother not employed full or part-time. A code of 1 indicated high-risk status on each item (see Reynolds, 2000, for description of data sources). Our analysis models also included a dichotomous, retrospective self-report measure of parental substance abuse originating from the adult survey and reflecting participants’ early childhood family environment, ages 0–5.

Analysis Strategy
Question 1
We employed a multivariate probit regression strategy to analyze the association between CAN and daily tobacco smoking controlling for study covariates. Additionally, we tested relations between maltreatment and the study’s two alternative smoking outcomes. Probit regression uses a maximum likelihood estimator that generates reliable coefficients with large samples (Horowitz & Savin, 2001). We transformed parameter estimates associated with each predictor into marginal effect coefficients indicating the percentage-point change in the outcome corresponding to a one-unit change in the predictor.

Question 2
To explore gender differences vis-a-vis the CAN/smoking relation, we introduced a maltreatment/gender interaction term into the study’s main-effect probit model.

Question 3
We undertook two successively more stringent exploratory mediation strategies to address question 3. First, we conducted bivariate, Kendall’s Tau rank double correlations to examine unadjusted relations between each proposed mediator and both the explanatory and outcome measures. In a second more stringent test of association, each proposed mediator was entered into the study’s main-effect model, in a simple one-step hierarchical regression. Results were reviewed for adjusted significant associations between the mediator and the smoking outcome along with attenuation of the original main-effect relation. Based on predetermined conventional criteria, a number of potential mediators were dropped from analysis at different stages of this two-step exploratory process, including indicators of adolescent motivation and autonomy. Variable paring via theory-driven approaches is an “adaptive” means of specifying mediator models and enhancing causal inference (MacKinnon, 2008).

To further specify and confirm our mediator model, we employed structural equation modeling (SEM) with LISREL software (Joreskog & Sorbom, 1996). A set of
equations in this block recursive approach, one for each intervening variable, was estimated simultaneously by maximum likelihood (ML). Completely standardized regression coefficients articulated the direct and indirect paths of effect. We represented latent variables with single indicators, and included estimates of variable measurement errors to increase the accuracy of results. Path estimates were based on a polychoric covariance matrix generated from a PRELIS processor utilizing pairwise-present cases. We relied on a test statistic of 2.50 to convey statistical significance (α-level of ~.01). Daily cigarette smoking is somewhat uncommon in our sample, yet the 20% rate is close to the level recommended for reasonably robust standard errors (Stevens, 1990). We report three indicators of model fit assessment: the root mean square error of approximation (RMSEA), standardized room mean square residual (SRMR), and adjusted goodness-of-fit index (AGFI). Measures within mediator block 1 were allowed to covary as were measures within mediator block 2. These operations were informed by theory and planned a priori.

Results

Question 1

Results from the multivariate probit analysis revealed that indicated maltreatment, ages 0–17, significantly predicted adult daily tobacco smoking (p = .006). Marginal effect estimates indicated that CAN was associated with a 58.3% increase in the likelihood of daily smoking (18.0% vs. 28.5%) and with a substantially higher rate relative to population estimates for AA adults (19.8%; CDC, 2007). Within this multivariate context, indicated maltreatment was also significantly related (p = .033) to an alternative smoking measure indexing respondents who smoked a few times per week or more. Maltreatment was only marginally associated (p = .088) with the outcome indicating any current smoking. Entering the variable representing propensity for study sample inclusion did not alter results of these main effect analyses.

Question 2

The CAN/gender interaction term, entered into the primary main effect model, did not generate a statistically significant parameter estimate suggesting that the CAN/smoking link did not vary significantly across genders. Controlling for the propensity to be included in the study sample did not alter these results.

Question 3

Results from the first exploratory mediation strategy—bivariate double correlation tests—are presented in the first two columns of Table II. Findings indicate that the study mediators from both blocks related significantly to both the explanatory and outcome variables at the .01 or .05 α-levels.

In the remaining columns, Table II displays results from the simple hierarchical regression, our second exploratory mediation strategy. Each model yielded a significant adjusted relation between the individual mediator and daily smoking. Percent reductions of the CAN-smoking link ranged from 12.4% to 34.3%, with juvenile delinquency and adult arrest conviction individually accounting for over 30% of the main effect. Highest grade completed reduced the original main effect by 27.6%, while life satisfaction did so by 20.0%. The remaining mediator measures individually reduced the main effect relation anywhere from 12.4% to 17.1%. Including the variable reflecting the propensity to be counted in the study sample did not alter the hierarchical regression test results.

Results from the SEM analysis are shown in Figure 1. In this highly controlled environment, parent involvement in child’s schooling was not significantly associated with child maltreatment while depression was not significantly related to smoking. Consequently, both were dropped from the analysis, yielding a more parsimonious, better fitting model. To ensure the model would not benefit from further variable trimming, we assessed model fit after removing each mediator measure. In all cases, fit indices significantly worsened according to χ² difference tests.

As Fig. 1 demonstrates, all four block 1 mediators were significantly related to CAN. Each path of effect emerged net of the other three, with standardized path estimates exceeding an absolute value of .14. Subsequently, each significantly predicted at least two second block mediators, with delinquency exerting a strong magnitude of effect on adult arrest conviction and highest grade completed (i.e., standardized beta weights of .34 and −.33, respectively). Reading achievement was strongly associated with highest grade completed (i.e., beta of .35), while socio-emotional skills notably reduced the likelihood of adult tobacco smoking in a significant direct path of effect (i.e., beta of −.09).

Of the second block mediators, adult arrest conviction and substance abuse forged comparatively strong associations with the outcome (i.e., betas of .42 and .32, respectively). Conversely, measures of highest grade completed and life satisfaction were more weakly associated with the outcome. Goodness of fit indices suggested the model fit the data well (i.e., RMSEA of .045, SRMR of .013, AGFI of .95). It accounted for 39.5% of the outcome’s variance while reducing the magnitude of the original main-effect relation by 100%.
<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Correlations</th>
<th>Marginal effect coefficients from probit regression models predicting daily smoking&lt;sup&gt;a&lt;/sup&gt; (p-values)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAN</td>
<td>Daily Smoking</td>
</tr>
<tr>
<td>1. Indicated maltreatment (CAN), ages 0–17</td>
<td>– –</td>
<td>– –</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.006) (0.015)</td>
</tr>
<tr>
<td>2. Parent involvement in school, grades 4–6</td>
<td>–.126**</td>
<td>–.104**</td>
</tr>
<tr>
<td>3. School mobility, grades 4–8</td>
<td>.131**</td>
<td>.103**</td>
</tr>
<tr>
<td>4. Juvenile delinquency</td>
<td>.170**</td>
<td>2.22**</td>
</tr>
<tr>
<td>5. Socio-emotional skills, grades 6–7</td>
<td>–.101**</td>
<td>–.124**</td>
</tr>
<tr>
<td>6. Reading achievement, grade 8</td>
<td>–.107**</td>
<td>–.124**</td>
</tr>
<tr>
<td>7. Highest grade completed, by age 22</td>
<td>–.116**</td>
<td>–.198**</td>
</tr>
<tr>
<td>8. Depression, ages 22–24</td>
<td>.099**</td>
<td>.178**</td>
</tr>
<tr>
<td>9. Life satisfaction, ages 22–24</td>
<td>–.088**</td>
<td>–.205**</td>
</tr>
<tr>
<td>10. Substance abuse, ages 16–22</td>
<td>.075*</td>
<td>.236**</td>
</tr>
<tr>
<td>11. Adult arrest conviction, ages 18–21</td>
<td>.127**</td>
<td>.282**</td>
</tr>
<tr>
<td>Percent reduction of main-effect</td>
<td>– –</td>
<td>– –</td>
</tr>
</tbody>
</table>

*<sup>p</sup> < .01; *<sup>p</sup> < .05

<sup>a</sup>Models include covariates—sex, race, parental substance abuse, risk index, and any CPC preschool participation—along with the primary explanatory variable child maltreatment from ages 0 to 17. Mediators are introduced individually into the main-effect model. Maltreatment’s parameter estimate from the main-effect analysis is published in column labeled 1. Each subsequent column (2–11) lists a modified marginal effect estimate for the CAN measure along with a parameter estimate associated with a single mediator. Additionally, a mediation effect statistic representing a percent reduction of the original main-effect is included in the last row.
Discussion

Major Contributions

Question 1
Results from question 1 supported our hypothesis and reinforced conclusions from prior empirical work indicating that CAN significantly predicts later cigarette smoking. Our findings validate this relation of interest with prospective data, multiple controls for sociodemographic characteristics, and official measures of child maltreatment that incorporate three major subtypes of CAN.

Question 2
As expected, the difference between the CAN/smoking relations for males versus females was not statistically significant based on a simple test of moderation. This would suggest that maltreatment introduces behavioral health risks for both males and females.

Question 3
Our comprehensive mediation model fully explained the CAN/smoking link in our sample, as posited. Findings from our mediation analysis identified several adolescent domains through which long-term effects of CAN were transmitted. These included social maladjustment (i.e., socio-emotional skills deficits and delinquent behavior), poor cognitive performance/school adjustment (i.e., low reading achievement), and family instability (i.e., school mobility). Prior evidence suggests that individual, family, and school dynamics cluster and reinforce each other and may thereby amplify maladaptive developmental trajectories (Cicchetti & Toth, 2005). Our model revealed that these interrelated pathways may lead to health-compromising behavior in emerging adulthood.

For example, in our SEM model, the measure of adolescent socio-emotional skills linked directly to adult daily tobacco smoking. This finding suggests that smoking potentially fulfills a compensatory or regulatory role in emotion management, echoing the conclusion that emotion dysregulation predicts later smoking (Weinstein, Mermelstein, Shiffman, & Flay, 2008). Low scores on our measure of socio-emotional skills also reflect affiliations with anti-social peer groups, which correlate with poor behavioral health patterns in other samples as well (Townsend, Flisher, & King, 2003).
In our model, delinquency contributed to the outcome of interest indirectly in part by increasing the likelihood of later crime involvement. As expected, the delinquency-crime link was potent, underscoring the continuity of criminal involvement from adolescence to adulthood. Additionally, adult crime played a prominent role in explaining the CAN/smoking relation. All four first-block mediators related directly and significantly to our indicator of crime as did CAN. The centrality of adult crime in our model highlights the disruptive impact of arrest conviction in the lives of disadvantaged minority adults, with CAN introducing additive risk. Moreover, as our model and previous studies suggest, those engaged in ongoing criminal trajectories are at risk for adopting poor health habits (Piquero, Daigle, Gibson, Piquero, & Tibbets, 2007).

Although family support helped explain the CAN/smoking relation in exploratory contexts, it did not contribute significantly to the confirmatory, SES model. Its lack of robust effects may be due to three factors. First, our particular measure of parental school involvement may not fully capture developmentally critical parenting processes. Second, heterogeneous measures that contributed significantly to the model, i.e., delinquency and school mobility, may have absorbed family level variance and dampened the mediation effects of parent involvement in school. Delinquency, for instance, implies disruptions in parental supervision and monitoring while school mobility connotes family and residential instability. Third, for multi-problem families such as those in our sample with confirmed CAN reports, parental support may be too rare or too ineffective to influence the CAN/smoking connection.

SEM mediation results demonstrated that middle school reading achievement contributed to the model with several significant pathways, the strongest leading to educational attainment. This finding extends previous work linking CAN to decrements in educational performance and attainment (Stone, 2007). Three additional first-block mediators connected directly and strongly to educational attainment, suggesting that the effects of CAN on cognitive, scholastic, and socio-emotional development culminate partly in low educational attainment. Just over 60% of non-maltreated CLS participants are high school graduates, while only 33.1% of children who experienced CAN graduated. Although this low-income minority sample faces numerous risks for school failure, maltreatment contributed additional variance to the significant problem of low educational attainment which in turn directly increased the likelihood of adult cigarette smoking. The influence of educational attainment on behavioral health, especially at lower strata of the socio-economic scale, has been demonstrated previously (Topitzes et al., 2009).

Depression contributed mediating effects only in our exploratory models. Behavioral and physical health problems among AAs (e.g., smoking) might mask or supplant mental health symptoms (Jackson & Knight, 2006). This phenomenon, whereby the stress associated with low-income minority status and maltreatment is channeled through adverse behavioral health choices, may underlie the study’s SEM results in which depression succumbed to more influential block 2 mediators. Life satisfaction contributed modestly to our mediation models, however, compared to depression, it was a robust mediator across models. Psychological well-being for AAs may help mitigate the long-term behavioral health effects of trauma whereas for this same population, mental illness may be less likely to actualize these effects.

**Limitations**

Three principal limitations qualify our findings. First, missing data and sample attrition are a concern given that selective attrition could bias results. For instance, we did not have valid data on every case for one of the covariate measures and for several mediators. To replace missing data, we employed an inferential imputation strategy that produced indicators with comparable properties as the original measures. Further, although sample tracking efforts resulted in uncommonly high recovery rates, we did lose ~25% of the original. To minimize the potential threat of selective attrition, we conducted robustness tests incorporating a propensity score measure into our original models. Although we accounted for missing data and sample attrition through these stated mechanisms, confidence in results is nonetheless affected.

Second, although we tested a relatively comprehensive model, our findings may be subject to omitted-variable bias. For instance, the CLS does not have information on individual or peer adolescent substance use, including smoking, both of which are significant and robust predictors of adult smoking (Mathers, Toumbourou, Catalano, Williams, & Patton, 2006). Minus earlier smoking and other substance use measures, our mediation findings linking adult substance abuse to adult smoking should be interpreted as correlational rather than predictive. Third, temporal overlap among certain measures may have influenced findings from our mediation analyses. For instance, the direction of the maltreatment-parent involvement relation is uncertain. Further, life satisfaction and depression were measured at the same point in time as our outcome variable. Our findings should be interpreted cautiously in light of these ambiguities.
Implications

Study results recommend certain treatment approaches or targets when working with economically and socially disadvantaged youth who have been maltreated. First, identification of maltreatment histories through screening assessments represents best practice (Spirito et al., 2003). Disadvantaged children of color face multiple risks and traumas, yet the impact of CAN appears to transcend the influence of other environmental conditions. If a history of CAN is established, impairments or instability in several domains might be expected and assessed (e.g., social adjustment, cognitive performance, and school functioning).

Turning to intervention, our results reinforce the importance of intra-individual developmental processes in promoting resilience among disadvantaged children who have been maltreated (Cicchetti & Toth, 2000). Facilitating emotion regulation and peer social skills, for instance, may buttress school success and weaken reliance on avoidant regulatory practices. Innovative approaches to emotion regulation training with disadvantaged, maltreated children are being piloted and evaluated currently. Protocols such as the neurosequential model incorporate principles of brain development into psychosocial treatment to enrich the neurocircuitry associated with emotion regulation and executive functioning (Perry, 2006).

Results from this current study also recommend engagement of family, school, and peer contexts to successfully treat maltreated children and adolescents. For instance, supporting residential and school stability, to the degree possible, potentially contributes to recovery from maltreatment. Working directly with caregivers of children and their charges may enrich family stability. Parent–child interaction therapy exemplifies a promising treatment strategy for families with verified maltreatment reports (Chaffin et al., 2004). Additionally, liaising with schools and families to strengthen the family’s school attachment may represent an effective intervention strategy. We also advise interfacing with schools to enhance the child’s school achievement. Furthermore, our results recommend interventions that prevent delinquent involvement among maltreated children. Multi-systemic therapy, an evidence-based practice to treat delinquent behavior, has been recently modified for use with maltreating families, yielding promising results for both youth and parents (Swenson & Chaffin, 2006).

The above-mentioned intervention strategies are meant to culminate, at least in part, in educational success and behavioral health. We do not recommend, however, an uninformed blending of these approaches. Instead, we propose a careful selection of strategies that match client presentation with effective treatment elements (Chorpita, Daleiden, & Weisz, 2005). Findings from impact studies integrated with sound theory and effective practice may help yield long-term, health-related benefits for victims of CAN.

Future Research

Results from this current study spawn interest in several future investigations. First, we did not test for differential impacts of maltreatment subtypes on our outcome of interest. Such analyses can help determine which maltreatment subtypes (i.e., neglect, physical abuse, and/or sexual abuse) are individually associated with behavioral health outcomes. Second, tests of a two-group mediation model would reveal if pathways from maltreatment to adult behavioral health differ across males and females, extending current findings and building on theory. These investigations would help distill main effect and mediation results of this current study.

Funding

Chicago Longitudinal Study grants from the National Institute of Child Health and Human Development (No. R01HD34294-06); Doris Duke Charitable Foundation (No. 20030035) supported the research reported herein. A Category A Research Grant from the Institute on Race and Ethnicity of the University of Wisconsin System provided additional funding for the completion of this study.

Conflicts of interest: None declared.

Received March 22, 2009; revisions received October 30, 2009; accepted November 2, 2009

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