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Depressed mood and the effect of two universal first grade preventive interventions on survival to the first tobacco cigarette smoked among urban youth

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Abstract

Introduction—As part of an evaluation of two first-grade, universal preventive interventions whose proximal targets were early learning and behavior, we investigated the influence of depressed mood, the interventions, and their interaction on survival to the first tobacco cigarette smoked through age 19. One intervention focused on improving teacher behavior management and instructional skills (Classroom-Centered, CC) as a means of improving student behavior and learning and the other on the family–school partnership (FSP). Variation in the relationship between depressed mood and first cigarette smoked by gender and grade was also examined.

Methods—Self-reports of smoking behavior and depressed mood were collected on an annual basis from grade 6 through age 19. The present analyses were restricted to the 563 youth who had never smoked by grade 6, or 83% of the original sample of first grade participants. Discrete-time survival analysis was used to examine the effects of depressed mood and the interventions on survival to the first tobacco cigarette smoked.

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Contributors

Nicholas Ialongo and team of Johns Hopkins Center for Prevention and Early Intervention conducted the interventions and followed up the youth. All authors were involved in design of this specific study. Yan Wang reviewed the literature, conducted statistical analyses, and wrote the first draft. Nicholas Ialongo and Hanno Petras advised on the statistical models and operationalization of the variables. Elizabeth A. Stuart advised on the multiple imputation. Nicholas Ialongo and all other authors contributed to revisions of the paper. All authors contributed to and have approved the final manuscript.

Conflict of interest

No author on this manuscript has any personal or financial interest that would influence the results.

Results—Depressed mood was associated with reduced survival time to the first cigarette smoked (adjusted hazard ratio, aHR: 1.4; 95% CI: 1.1–1.9), whereas the CC intervention prolonged survival time (aHR: 0.8; 95% CI: 0.7–0.9). No significant variation in the effect of depressed mood on survival was found by gender or grade, nor was the effect of the CC intervention moderated by depressed mood.

Conclusions—Strategies to prevent tobacco cigarette smoking should include both a focus on depressed mood in adolescence as well as on early success in elementary school.

Keywords

Tobacco smoking; Depressive symptoms; Gender; Intervention studies; Adolescent

1. Introduction

Adolescence is a critical period for the onset and establishment of smoking behaviors. Fewer than 6% of 12 year olds report having smoked a cigarette, whereas over half (56%) have smoked a cigarette by age 18 (SAMHSA, 2006). The sharp increase between ages 12 and 18 argues for great urgency in initiating plans to prevent tobacco smoking among adolescents. This need has also been supported by findings that the younger an individual smoked her/his first cigarette, the higher the chance that s/he smoked regularly or developed nicotine dependence in adulthood and the lower the chance that s/he successfully quit smoking in later life (Breslau et al., 1993; Breslau and Peterson, 1996; D'Avanzo et al., 1994). In addition, research has reported that starting smoking at a younger age is related to a greater likelihood of DNA damage to lung tissue (Wiencke et al., 1999), as compared to individuals who start smoking later.

The process of tobacco smoking consists of several stages: preparatory, trial, experimental and regular (Flay et al., 1983). Although the first puff of tobacco is the earliest stage of smoking, several recent studies suggest that a person's first puff may lead rapidly to symptoms of nicotine dependence and escalating tobacco use, especially for individuals who reported feeling relaxed after their first puff (e.g., DiFranza et al., 2007). Consistent with these findings, Fidler et al. (2006) reported that, relative to youth who have never smoked, youth who tried smoking, but stopped, are more susceptible to taking up smoking again even after a 3 year cessation. In addition, it is difficult to quit smoking at the more advanced stages, e.g., regular smoking (Killen and Fortmann, 1994), when the smoker has become increasingly dependent on nicotine. Therefore, although public health efforts traditionally focus on helping regular smokers quit smoking, researchers have recently recommended that strategies should be focused on delaying or preventing smoking the first tobacco cigarette (National Cancer Institute, 1991). To do this, it is necessary to study the factors associated with smoking the first tobacco cigarette among adolescents, so that prevention strategies can address those risk factors. Studies have reported that sociodemographic, some environmental and familial factors are related to smoking initiation (Cohen et al., 1994; Elkins et al., 2007; Kandel et al., 2004; Unger and Chen, 1999). However, although high rates of smoking have been reported among individuals with mental health problems, such as depression, anxiety or panic disorder (Lasser et al., 2000), it is not clear how mental health problems interact with the first smoking experience. Therefore, the relationship between mental health problems, such as depression, and smoking initiation requires further investigation.

It is well-documented that depression is associated with nicotine involvement, although the mechanisms underlying the association are not clear (Breslau et al., 1991; Fergusson et al., 2003; Goodman and Capitman, 2000; Wang et al., 2005). Prospective studies have mainly

focused on the association between depression and the advanced stages of smoking, e.g., regular smoking or nicotine dependence. There is strong evidence that depression is associated with an increased risk of progression from smoking initiation to nicotine dependence, and a decrease in the likelihood of quitting smoking (Anda et al., 1990; Fergusson et al., 2003). This has led some to posit that depressed individuals may use tobacco to self-medicate their depressed mood (Breslau et al., 1991; Killen et al., 1997; Pomerleau and Pomerleau, 1992). On the other hand, depression also has been found to follow smoking cessation (Glassman et al., 2001).

In terms of earlier stages of smoking, findings are mixed regarding whether depression has effects on the first tobacco cigarette smoked among adolescents. Some studies suggest that, among adolescents, depressed mood is modestly associated with a greater likelihood of smoking the first tobacco cigarette (Killen et al., 1997; King et al., 2004; Lam et al., 2005; Polen et al., 2004; Weiss et al., 2005). For example, Weiss et al. (2005) found that among 1558 sixth-grade non-smokers, depressive symptoms at baseline and an increase in depressive symptoms from sixth grade to seventh grade, respectively, increased the risk of first time smoking by seventh grade. In an epidemiological sample of 1364 twins and their families representative of the state population of Minnesota, King et al. (2004) found that major depressive disorder at age 11 was associated with a two-fold increase in the risk of first time smoking between ages 11 and 14 (OR: 2.0, 95% CI: 1.2, 3.4). In contrast, other studies have found that depressed mood was not associated with first time smoking among adolescents (Gritz et al., 2003; Kandel et al., 2004; Wu and Anthony, 1999). Using a nationally representative sample from the National Longitudinal Study of Adolescent Health (Add Health), Kandel et al. (2004) found that depression had no effect on first time smoking within the following year, after adjusting for individual, school and state variables. In a regional sample of school students (aged 8–9 to 13–14 years), Wu and Anthony (1999) found that antecedent depressed mood was not associated with a subsequent risk of smoking a tobacco cigarette for the first time.

Similarly as noted by Goodman and Capitman (2000), the mixed findings regarding the relationship between depression and subsequent first smoking experience may also be attributed to the non-comparability of the samples and/or the different social contexts in which the adolescents lived. Additionally, nonstandardized measurements without proven validity and reliability (Gritz et al., 2003; Lamet et al., 2005; Polen et al., 2004) and convenience sampling designs (Gritz et al., 2003; Killen et al., 1997; Lam et al., 2005; Polen et al., 2004; Weiss et al., 2005) may also contribute to the lack of agreement among these studies. In addition, most of these studies were limited to observation periods of 1–2 years and did not allow examination of variation in the relationship between depressed mood and later first smoking experience by stages of adolescent development, e.g., early versus late adolescence.

There may also be important gender differences. It has been reported that adolescent girls are more likely to be depressed than adolescent boys (Kessler et al., 1993). However, there is not a gender difference in the rate of tobacco smoking in adolescence (SAMHSA, 2006). This suggests that a possible gender-specific relationship may exist between depression and tobacco smoking among adolescents. Such a gender-specific relationship has been supported by some cross-sectional and prospective studies (Killen et al., 1997; Wang et al., 2005). However, most studies on the association between antecedent depression and later first smoking experience have ignored any gender variation (Gritz et al., 2003; Kandel et al., 2004; Polen et al., 2004; Weiss et al., 2005).

Several other factors have also been reported to be associated with first smoking experience in prospective studies. The most robust relationship is with peer smoking (Kandel et al.,

2004; Unger and Chen, 1999). Youth might select peers who have similar smoking behavior as themselves, imitate the smoking behaviors of their peers, or start to smoke under peer pressure (Petraitis et al., 1995). Some studies have also found that a higher level of conduct problems increases the risk of later involvement in cigarette smoking, including smoking for the first time (Elkins et al., 2007; King et al., 2004). Inconsistent findings have been reported with regard to some other factors, such as parental monitoring (Cohen et al., 1994; Forrester et al., 2007) and family members' use of tobacco (Kandel et al., 2004; Unger and Chen, 1999). However, most studies on depression and later first smoking experience have ignored the possible confounding effects of some or all of these important possible contributing factors (Killen et al., 1997; King et al., 2004; Polen et al., 2004; Weiss et al., 2005; Wu and Anthony, 1999).

A primary purpose of this study is to fill the aforementioned gaps in the existing literature. Specifically, we examined survival to the first tobacco cigarette smoked as a function of antecedent depressed mood and the extent to which the relationship between depressed mood and time to the first cigarette smoked varied by gender and grade. The data for the present study comes from a longitudinal evaluation of two universal, first grade, preventive intervention trials (Ialongo et al., 1999b), wherein data on smoking were collected from grade 6 (approximately age 11.5) through 1 year beyond the participants' anticipated high school graduation date (approximately age 19). The present study also examined the effects of the two universal interventions on survival to first cigarette smoked and the extent to which the effects of the interventions varied as a function of depressed mood. Both of the first grade interventions focused on improving early aggressive/ disruptive behavior and academic achievement as a means of preventing later delinquency and substance use, including tobacco use. One intervention targeted teachers' behavior management and instructional skills (Classroom-Centered, CC) as a means of improving early behavior and achievement, whereas the second intervention targeted the family-school partnership as well as parenting practices relevant to child prosocial behavior and academic achievement (family-school partnership, FSP).

As described in detail in Ialongo et al. (1999b), the conceptual basis for the interventions was derived from the life course/social field framework (Kellam and Rebok, 1992) and its integration with Patterson et al.'s (1992) model of the development of antisocial behavior and substance use. Briefly, in the design of intervention trials, the CC and FSP interventions were hypothesized to reduce the early antecedent risk behaviors of aggressive/disruptive behaviors and poor academic achievement and their distal correlates, such as tobacco smoking, by improving teachers' and parents' disciplinary and instructional practices in the case of the CC intervention, and through the enhancement of parent-teacher communication in the case of the FSP intervention (Henderson, 1987; Sattes, 1985). The reductions in the early antecedent risk behaviors were hypothesized, in turn, to lower the risk for antisocial behavior and substance use in adolescence and young adulthood. Storr et al. (2002) and Furr-Holden et al. (2004) have previously shown both interventions to have a beneficial impact in terms of reducing early tobacco use through late childhood and early adolescence, respectively, although the impact on tobacco use appeared to be larger for the CC intervention. Neither study, however, examined variation in intervention response as a function of depressed mood or the main effect of depressed mood on survival to first cigarette smoked.

We had five study hypotheses: (1) that adolescents reporting depressed mood would tend to smoke a tobacco cigarette earlier than adolescents not reporting depressed mood, (2) that the relationship between depressed mood and survival to the first cigarette smoked would be stronger for males than for females, (3) that the relationship between depressed mood and survival to the first cigarette smoked would be stronger in the later grades as compared to

the earlier grades, (4) that both the CC and FSP interventions would have a significant but modest impact of delaying the first cigarette smoked and that the impact of the CC intervention would likely be greater than the FSP intervention given previous findings (Furr-Holden et al., 2004; Storr et al., 2002), and (5) that depressed mood would attenuate the effect of the interventions on survival to the first cigarette smoked.

2. Methods

2.1. Data source and sampling

Data were drawn from a preventive intervention trial conducted by the Johns Hopkins University Preventive Intervention Research Center (Ialongo et al., 1999b, 2001). In brief, a total of 678 urban first-graders – all children entering first grade in the fall of 1993 in 9 Baltimore City public elementary schools – participated in 2 school-based intervention trials targeting early learning and aggressive/disruptive behavior. Within each of the nine schools, children and teachers were randomly assigned with balancing for gender and a number of other variables (Ialongo et al., 1999b) to one of the three first grade classroom intervention conditions described above: the CC, the FSP, or the standard setting control condition. The control classrooms had the usual and customary curriculum and parent–teacher communication and interaction, without the special elements of the CC or FSP conditions. An attempt was made to follow all of the original youth who participated in first grade through 1 year past their anticipated high school graduation date. The Committee on Human Research of Johns Hopkins Bloomberg School of Public Health approved this research.

We first collected youth self-reported tobacco use in grade 6 and then annually through approximately age 19 (1 year beyond their anticipated high school graduation date). Therefore, we focus on the youth self-report assessment during this time period. A total of 37 youth (5%) had no self-report data at any of the 8 possible assessments in this period and nearly 3/4 of the participants had self-report data for at least 6 out of the 8 possible assessments. We used multiple imputation to account for the missing values, as described in detail later, and excluded from the study only the 37 youth who did not have data at any assessment. No significant differences were found with respect to age, gender, race/ethnicity, subsidized lunch status, intervention status, or problematic tobacco use of family members as assessed in first grade between the 37 youth excluded and the 641 youth remaining. Another 78 youth (12%) indicated having smoked by grade 6 by answering “yes” to the question “Have you ever smoked tobacco, even just a puff?” Since the 78 youth were no longer at risk of smoking their first cigarette after grade 6 and to sharpen our focus on the first cigarette smoking experience, these youth were also excluded from the analyses, leaving a total of 563 in the analytic sample. Of note, the 78 were not significantly different with regard to gender, race, or subsidized lunch status at entrance into the study in first grade. However, the 78 youth were on average slightly older than the other 563 youth (6.3 vs. 6.2, t -test $p = 0.035$) at entrance into first grade. Moreover, the mean score of baseline depressive symptoms at grade 6 for the 78 youth was significantly higher than that for the 563 youth (0.918 vs. 0.714, t -test $p = 0.001$). This difference in the level of depressed mood suggests that there might be a positive association between depressed mood and smoking initiation even among the youth at grade 6.

2.2. Selected sample characteristics

The analytic sample of 563 youth was composed of 53% males and 47% females (Table 1). The youth were predominantly African-American (87%). Most youth (97%) were between 5.0 and 6.9 years old at entry into first grade. The mean age was 6.2 years old ($sd = 0.4$, $range = 5.6–8.1$). Approximately two thirds (68%) of the youth qualified for reduced-cost or free lunch in the first grade. Approximately one third of the youth were assigned to CC

intervention classrooms, one third to FSP intervention classrooms, and one third to control classrooms in the first grade. An estimated 18% of the sample had problematic tobacco use by family members in first grade.

2.3. Assessments

2.3.1. Grade when the first tobacco cigarette was smoked—The primary response variable of interest in this study is the time elapsed to the first tobacco cigarette smoked. Using the audio computer-assisted self interview (ACASI) method, which has been shown to improve reliability in reporting of sensitive behaviors (Murphy et al., 2000), youth were asked “Have you ever smoked tobacco, even just a puff?” at each grade. The possible responses were “yes” or “no.” The earliest grade when the student answered “yes” to this question was used to indicate the grade when the student first smoked a cigarette, varying from grade 7 to 1 year beyond their anticipated high school graduation date. As reported in previous studies (e.g., Audrain-McGovern et al., 2004), a relatively large percentage of adolescent smokers are only beginner smokers and have never smoked a “full” cigarette. Therefore use of this question allowed us to examine the very earliest stage of nicotine involvement, which commonly happens during youth or adolescence.

2.3.2. Depressed mood—To assess the temporal relationship between antecedent depressed mood and the first cigarette smoked, depressed mood was assessed annually in grades 6–12, 1 year before each assessment of tobacco smoking. Depressed mood was assessed using the Baltimore How I Feel (Adolescent Version)—Youth Report (BHIF-AY; Ialongo et al., 1999a; Lambert et al., 2004) scale, which consists of 14 items on depressive symptoms (e.g., “I feel like crying” and “I am sad”). The items were keyed to DSM-IV criteria for a major depressive episode and dysthymia. At each grade, youth reported the frequency of symptoms over the last 2 weeks on a four-point Likert scale (0 = never, 1 = once in a while, 2 = sometimes, 3 = most times). As reported by Ialongo et al. (1999a), its 2-week test–retest reliability was 0.83. In the current sample, the Cronbach’s alpha of the BHIF-AY was 0.83. The average score of the 14 items was calculated for each student to indicate their overall level of depressed mood within the range 0–3. Since the average score was skewed, we chose to categorize this variable, as is done in numerous other epidemiological studies (e.g., Kellam and Anthony, 1998). To select the optimal cutoff point, three levels of this variable (highest tertile, middle tertile, and lowest tertile) were generated. The hazard of smoking the first tobacco cigarette in the 7-year follow-up period was calculated for each tertile and was found to be similar for youth in the highest tertile and youth in the middle tertile, as compared to youth in the lowest tertile. Therefore, to simplify the analyses, youth with depressed mood scores within the highest and middle tertiles were categorized as having a depressed mood and youth with scores within the lowest tertile as not having a depressed mood.

2.3.3. Other covariates

2.3.3.1. Sociodemographic characteristics: Sociodemographic characteristics, including age, gender, race and receipt of subsidized lunch, were obtained from school records at grade 1. Since there is little variation in the age of the youth entering first grade, we chose to categorize age in first grade as: “younger than 6.0 years” or “6.0 years or older”. The original sample participating in the intervention trial included African-American, European-American, and one Hispanic youth. The Hispanic student smoked his/her first cigarette by grade 6 and was thus excluded from the analyses. Therefore, ethnicity was categorized as African-American or European-American. Receipt of subsidized lunch was categorized into “free or reduced-cost” or “paid by child.” Eligibility to receive free or reduced-cost lunch was based on family income at or below 100 percent of the federal poverty level; therefore, we used receipt of subsidized lunch as a proxy for family income.

2.3.3.2. Family members' problematic tobacco use: Tobacco use of family members has been reported to be associated with a greater risk of smoking the first tobacco cigarette among adolescents. Since data on tobacco use of family members when the youth were enrolled in middle or high school were not available, problematic tobacco use by family members collected from parent report at grade 1 was used instead. The primary caregiver was asked: "Would you say heavy tobacco use affected your family in the last 12 months?" (National Center for Health Statistics, 1991). The responses were "not at all," "a little," "some," and "a lot;" these were categorized as "no (not at all)" or "yes (a little, some and a lot)."

2.3.3.3. Parental monitoring: The parental monitoring construct was assessed at grade 6 with seven items from Patterson and Capaldi (1998)'s Structured Interview of Parent Management Skills and Practices—Youth Version (SIPMSP; Chilcoat et al., 1995). The scale includes seven items measuring such things as how often the youth tell their parents when they will be back or leave a note about their whereabouts when they go out. Items are rated on a five-point Likert scale (1 = all of the time to 5 = never). The average score of the seven items was calculated to indicate the overall parental monitoring level. Higher scores indicate less parent monitoring. Since the score was highly skewed, parental monitoring was categorized into two groups based on tertiles: "lower levels (within the middle or highest tertile)" or "higher levels (within the lowest tertiles)."

2.3.3.4. Conduct problems: As with depressed mood, we examined survival to the first cigarette smoked as a function of conduct problems or antisocial behavior. Similar to depressed mood, we wished to examine the temporal relationship between antecedent conduct problems and first cigarette smoked. Therefore, conduct problems were assessed in grades 6–12, 1 year before each assessment of tobacco smoking.

Conduct problems were self-reported by the youth via the Conduct Disorder (CD) Module from the computer administered version of the Diagnostic Interview Schedule for Children IV (CDISC-IV, Shaffer et al., 2000). The CDISC-IV CD module is a fully structured interview that generates a Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) diagnosis as well as the number of diagnostic criteria met and a symptom count for conduct disorder. Sample items on the conduct disorder scale include bullying others and cruelty to animals. In the present study we used the CD symptom counts in our analyses since very few youth met criteria for a CD diagnosis. Data on the earlier versions of the DISC (DISC 2.1, DISC 2.3), suggest adequate test–retest reliability (Jensen et al., 1995) and validity (Schwab-Stone et al., 1996). Since the symptom count scores were highly skewed, we chose to categorize this variable. It was categorized into "lower levels (no symptoms)" and "higher levels (at least one symptom)".

2.3.3.5. Peer smoking: As with depressed mood and conduct problems, peer smoking was assessed annually in grades 6–12, 1 year before each assessment of tobacco smoking, to examine the temporal relationship between antecedent peer smoking and first cigarette smoked. Peer smoking was assessed using a question from the Monitoring the Future national survey of tobacco, alcohol, and drug use among adolescents (Johnston et al., 1995): "How many of your friends smoke cigarettes?" The responses were "none," "very few," "some," "most" and "all of them"; these were further grouped as "no (none)" and "yes (very few, some, most and all of them)."

2.4. Statistical analyses

2.4.1. Statistical model—Discrete-time survival analysis (DTSA) was used to model survival to the first cigarette smoked (Muthen and Masyn, 2005). The event of interest was

defined for each participant as smoking a cigarette for the first time, and the survival time is defined as the time elapsed from grade 6 to the first cigarette smoked (a figure illustrating the model is available from the first author by request). The time scale was recorded in discrete-time intervals – grade levels – so although the time-to-event process may actually be more continuous in nature, the data limitations required the process be modeled using DTSA. This study included time-independent covariates (intervention status, age at grade 1, gender, race, receipt of subsidized school lunch, problematic tobacco use by family members and parental monitoring) and time-dependent covariates (depressed mood, conduct problems, and peer smoking). In particular, we treated the time-dependent covariates as time-lagged covariates with a 1-year time lag so that, for example, depressed mood in grade t is used to predict smoking a tobacco cigarette for the first time in grade $t + 1$. For each covariate, the proportional hazard assumption was assessed via a Likelihood Ratio Test (LRT). DTSA was performed using the *Mplus* 4.21 statistical software package (Muthén and Muthén, 1998–2007). All other analyses were performed with STATA 10.0 statistical software.

2.4.2. Detailed analysis procedure—Descriptive statistics were calculated for the whole sample as well as for males and females separately. Chi-square analyses were performed to assess the change in the frequency of peer smoking between grade 6 and grade 12, and paired t -tests were performed to assess changes in continuous scores, e.g., depressive symptoms and conduct problems, between grade 6 and grade 12. Non-paired t -tests were used to compare depressive symptoms and conduct problems at each grade and parental monitoring at grade 6 by gender. Chi-square analyses were used to compare the other (categorical) covariates by gender. The proportional hazards DTSA model assumes that the association between a covariate and the hazard of smoking a tobacco cigarette for the first time is constant across grades, which we assessed using LRTs. The LRT assessing the proportional hazard assumption for depressed mood actually assessed the variation in the relationship between depressed mood and smoking a cigarette for the first time across grades.

Applying the DTSA model with depressed mood and gender as the only two covariates, we estimated hazard probabilities and cumulative survival probabilities and then plotted curves to depict hazard or survival to the first tobacco cigarette smoked by depressed mood and gender. Then we estimated the hazard ratios (HRs) of smoking the first tobacco cigarette conditional on the level of depressed mood by running four models: (1) including only depressed mood as an independent variable, (2) including depressed mood and gender, (3) including depressed mood, gender, and the interaction between depressed mood and gender (LRTs were used to test the interaction between depressed mood and gender), and (4) including depressed mood, gender, their interaction (if it was statistically significant), and all the other covariates. The comparison between the unadjusted and adjusted HR estimates provides information about the extent to which the association between depressed mood and survival to the first cigarette smoked may be explained by other covariates.

Finally, to assess whether intervention influences the relationship between depressed mood and survival to the first cigarette smoked, two additional statistical models were performed and compared to model 4. The first model also included the interaction terms between depressed mood and intervention in the DTSA model after adjusting for other covariates. Since interventions that were implemented at grade 1 might influence the covariates measured after grade 1, the second model included regressions of the covariates measured after grade 1 (depressed mood, conduct problems, and peer smoking at grades 6–12 and parental monitoring at grade 6) on intervention status. In all of the DTSA models, standard errors were adjusted by the sandwich estimator to account for the clustering of youth within their first-grade classrooms.

2.4.3. Handling of missing values—A small proportion of youth had missing information on some of the covariates, for example, depressed mood, conduct problems or peer smoking in a certain grade. Instead of dropping the cases with missing data, which can yield incorrect inferences, multiple imputation methods were used to “fill in” (impute) the missing data for the covariates in this study (Rubin, 1987). We generated the imputations using the “ICE” command in STATA (Royston, 2004). This procedure assumes that the data is Missing At Random (MAR), which means that the probability of a value being missing may depend on observed values, but that it does not depend on unobserved values. Five imputations were created, on the basis that 5 imputations yields up to 91% efficiency even with fractions of missing information as high as 50% (Rubin, 1987). The five imputed datasets were analyzed using the Mplus software. The final results represent an average across the five imputed data sets, using the combining rules described in Rubin (1987).

One concern is that the individuals with whom we lose contact over time may be those who are more depressed. Multiple imputation attempts to deal with this by conditioning on the observed characteristics (e.g., depression levels in first grade), but there is still some concern that the missing data may be not missing at random (NMAR; Rubin, 1987). Although we cannot test empirically whether the data is NMAR, we have systematically assessed the differences in aggressive behavior and academic achievement (e.g., reading and mathematics test scores), between the youth with missing values and the youth without missing values at the end of each year. No significant differences were found with regard to these variables. We also compared the score of depressive symptoms at grade 1 and found no significant differences between the youth with missing values (mean = 0.82, sd = 0.02) and those without missing values (mean = 0.80, sd = 0.02, $p = 0.507$). In addition, as a sensitivity analysis, estimates obtained using list-wise deletion were compared with the estimates using the multiply imputed data. The two models had similar HR point estimates, suggesting that the HR estimates were not sensitive to a different method of handling the missing data.

3. Results

As shown in Table 1, approximately two-thirds (66%) of the youth had smoked a cigarette by 1 year beyond their anticipated high school graduation (approximately age 19). The average level of depressive symptoms declined from grade 6 (mean = 0.71, sd = 0.51) to grade 12 (mean = 0.54, sd = 0.50, paired t -test $p < 0.001$). In contrast, the rate of peer smoking was much higher for grade 12 (65%) than for grade 6 (26%, Chi-square $p < 0.001$). The reported number of conduct problems did not change significantly from grade 6 (mean = 0.18, sd = 0.38) to grade 12 (mean = 0.19, sd = 0.39, paired t -test $p = 0.442$).

Males and females did not differ significantly with regard to age, race, receipt of subsidized lunch, or family member tobacco use (Table 1). The score of parental monitoring was higher for males compared to females, indicating lower levels of parental monitoring for males than for females (t -test $p = 0.017$). Males and females also did not differ significantly with regard to the level of depressed mood at grade 6. However, the level of depressed mood was significantly higher for females than males in grades 7–12. In contrast, the number of conduct problems was consistently higher for males than females across grades 6–12, although the difference was only significant for grades 6 and 9. The proportion of adolescents with friends who smoked was smaller for the females compared to the males at grade 6; however, there were no significant differences on this measure between females and males in grades 7–12. Finally, the rate of ever smoking by 1 year beyond the anticipated high school graduation date did not differ significantly by gender (69% in males vs. 62% in females).

LRTs suggested that the proportional hazard assumption was not violated for depressed mood ($-2LL = 6.202$, $df = 6$, $p = 0.401$), which implies that the relationship between depressed mood and first cigarette smoked remained constant across grades. Similarly, the proportional hazard assumption was not violated for gender ($-2LL = 4.008$, $df = 6$, $p = 0.676$) or any of the other covariates. Therefore, the DTSA models were run with the proportional hazard assumption for all of the covariates.

Using the estimates based on the DTSA model with only gender and depressed mood as covariates, Fig. 1 depicts the hazard probability and the cumulative survival probability of smoking the first tobacco cigarette stratified by depressed mood and gender. The upper figure illustrates the hazard probability. The general pattern of hazards for each group was similar: the hazard probability was relatively stable across grades 7–11 with the lowest point at grade 11; however, there was an increase after grade 11 and the hazard probability reached its highest point at 1 year beyond anticipated high school graduation. In addition, this figure shows that the hazard probability was higher among the males with prior depressed mood, compared to the males without prior depressed mood. Similarly, it was higher among the females with prior depressed mood, compared to the females without prior depressed mood. The lower figure illustrates the survival probability. By 1 year beyond their anticipated high school graduation date, almost half (48.7%) of females without depressed mood and 41.8% of males without depressed mood remained smoke free. In contrast, only one-third of females (31.5%) with depressed mood and one-quarter (24.9%) of males with depressed mood remained smoke free.

The crude and adjusted HR estimates are presented in Table 2. Depressed mood was associated with a modestly reduced survival time to the first tobacco cigarette. The depressed youth were at a greater hazard of smoking a tobacco cigarette for the first time in the next grade compared to their non-depressed counterparts (crude HR: 1.6, 95% CI: 1.2–2.1, $p < 0.001$). The HR estimates after adjusting for the other covariates were similar to the crude HRs (aHR: 1.4, 95% CI: 1.1–1.9, $p = 0.009$ for depressed mood). The DTSA model stratified by gender showed that the HR of smoking a cigarette for the first time in relation to depressed mood was significant for males (aHR: 1.5, 95% CI: 1.0–2.3, $p = 0.035$), but not for females (aHR: 1.4, 95% CI: 0.9–2.1, $p = 0.132$). However, despite this apparent difference in significance of HRs between the genders, the interaction between depressed mood and gender was not statistically significant when explicitly tested ($-2LL = 0.572$, $df = 1$, $p = 0.450$).

In addition to depressed mood, peer smoking (aHR: 1.6, 95% CI: 1.2–2.1, $p < 0.001$ for peer smoking), conduct problems (aHR: 1.7, 95% CI: 1.2–2.4, $p = 0.003$), and receipt of subsidized lunch (aHR: 1.3, 95% CI: 1.0–1.7, $p = 0.048$) were also associated with greater hazards of smoking for the first time or reduced survival time to the first cigarette smoked in the adjusted models. Being African-American (aHR: 0.7, 95% CI: 0.5–0.9, $p = 0.010$) was associated with reduced hazards of smoking for the first time or prolonged survival time. Higher levels of parental monitoring were associated with reduced hazards of smoking for the first time when it was included as the only independent variable; however, the statistical significance disappeared after adjusting for all the other covariates. Gender, age, and family members' problematic tobacco use were not associated with survival to the first cigarette smoked either before or after adjusting for other covariates.

The CC intervention significantly reduced the hazard of smoking for the first time and thus prolonged the survival time to the first cigarette smoked in the 7-year follow-up (aHR: 0.8, 95% CI: 0.7–0.9, $p < 0.001$). In contrast, the FSP intervention did not have a significant impact on the hazard or survival (aHR: 1.0, 95% CI: 0.8–1.2, $p = 0.709$). No significant interaction was found between depressed mood and intervention ($-2LL = 2.024$, $df = 2$, $p =$

0.364). In addition, the model including regressions of the covariates measured after grade 1 (depressed mood, conduct problems, and peer smoking at grades 6–12 and parental monitoring at grade 6) on intervention obtained similar HR estimates of first cigarette smoking for the covariates (e.g., aHR: 1.4, 95% CI: 1.1–1.9, $p = 0.013$ for depressed mood). These results suggest that the relationship between depressed mood and survival to the first cigarette smoked was not influenced by the interventions conducted in grade 1, nor was the effect of the interventions on survival to first cigarette smoked modified by depressed mood in grades 6–12.

4. Discussion

The findings of this study add new evidence to the literature on the association between depressed mood and survival to the first tobacco cigarette smoked. Moreover, the present study extends the findings on the long-term effects of the CC and FSP universal, first grade interventions. The main findings of this study are (1) depressed mood was associated with reduced survival time to the first tobacco cigarette smoked; (2) this relationship was robust across approximately ages 11.5 to 19 with no significant variation across grades; (3) no significant male-female difference was found in the association between depressed mood and survival to the first cigarette smoked; (4) the CC intervention prolonged survival to the first cigarette smoked, whereas the FSP intervention did not; and (5) no evidence was found that the effect of the CC intervention on survival was moderated by depressed mood.

Our finding that depressed mood is associated with a greater hazard of first time smoking or reduced survival to the first cigarette smoked among adolescents is consistent with several prospective studies (Killen et al., 1997; King et al., 2004; Lam et al., 2005; Polen et al., 2004; Weiss et al., 2005), but not consistent with others (Gritz et al., 2003; Kandel et al., 2004; Wu and Anthony, 1999). Using a nationally representative sample of adolescents attending middle and high schools from the Add Health study, Kandel et al. (2004) found that the association between depressed mood at baseline and smoking a cigarette for the first time within the following year disappeared after adjusting for individual, school or state variables. This conclusion also held for its African-American sub-sample. The difference in sample characteristics (nationally representative African-American youth in that study versus urban, primarily African-American youth in ours) and the different measurement of depressive symptomatology might account for the discrepant findings. Wu and Anthony (1999) followed a sample of urban, predominantly African-American youth from late childhood into early adolescence and found that tobacco smoking was associated with greater risk of later development of depressed mood, but depressed mood was not associated with greater risk of subsequent first time smoking either before or after adjusting for other covariates. The reasons for the difference between the results of Wu and Anthony (1999) and the present study are not clear. Different sets of covariates cannot account for the discrepant results since there was no significant relationship detected between depressed mood and later smoking even before adjusting for other possible determinants in Wu and Anthony's (1999) study. In addition, different definitions of depressed mood can not account for the discrepancy since we used essentially the same measure of depressed mood and, when we categorized depressed mood in the same way as in Wu and Anthony's (1999) study, we still found an elevated hazard of first time smoking for adolescents with a depressed mood. One possible explanation for the differences in results is that although our study failed to find evidence of variation in the relationship between depressed mood and survival to the first time smoking by grade, this relationship may vary prior to grade 6, or age 12. Children in the middle to late childhood years may have less access to tobacco than adolescents, which may prevent children from using tobacco to cope with their depressed mood. It may be also the case that the number of youth experiencing depressed mood is higher in adolescence than in late childhood.

We found that the CC intervention, which was designed to improve teachers' instructional and classroom management practices, continued to delay first time cigarette smoking for youth in middle and late adolescence. However, the FSP intervention, which was designed to improve parent-teacher communication and parental teaching strategies and reported to significantly delay smoking initiation in childhood and early adolescence (Furr-Holden et al., 2004; Storr et al., 2002), did not play a significant role in delaying the youth's first time smoking in middle or late adolescence. As suggested in Ialongo et al. (1999b, 2001), one possible explanation is that the proximal and distal effects of the CC intervention on aggressive/disruptive behavior were generally larger and broader than for the FSP intervention. The reason for this may be the differential amount of training and coaching the CC teachers and FSP parents received. While the CC intervention teachers received 60 h of training and direct supervision in the use of the CC intervention, parents were offered a total of nine workshop sessions of approximately 90-min in length. Providing all first grade parents with as much training as the CC teachers received would not have proven feasible from a logistical or cost standpoint. As indicated in Ialongo et al. (1999b, 2001), we believe the optimal design for school-based universal preventive interventions would include a combined focus on the classroom and the family-school partnership, along with the nesting of indicated interventions within the universal intervention, with the indicated interventions aimed at children who have begun to manifest more serious problems such as conduct problems or poor academic achievement.

We had hypothesized that the effects of both interventions might be attenuated by depressed mood, but this did not prove to be the case. However, interactions, in general, require greater sample sizes than main effect analyses to detect significant effects (McClelland and Judd, 1993). Thus, the power to detect a significant intervention by depressed mood interaction effect may not have been sufficient given the modest effect of the CC intervention on survival to the first cigarette smoked.

4.1. Limitations and offsetting strengths

The study results should be evaluated in the context of some limitations. First, self-reported smoking may be subject to recall bias. However, recall bias might be reduced in this study since we interviewed youth yearly and inquired about lifetime smoking at each grade, rather than inquiring about age at first smoking experience. Second, the BHIF scale used to assess depressed mood in this study is not a clinical diagnostic test and depressed mood based on this scale is not equivalent to major depressive disorder. Yet, it is important to point out that some have argued that depression should be thought of in terms of a continuum (Goldberg, 2000; Angst et al., 2000). Consistent with this argument, a dose-response relationship has been reported between the number of depressive symptoms and the level of impairment in social functioning and the seeking of medical help for depression (Kessler et al., 1997). Third, the measure of familial smoking in this study was relatively limited. However, we do not believe a stronger measure of familial smoking would have affected our main results for the following reasons. First, the randomized design should have protected against differences among conditions in terms of baseline characteristics such as familial smoking, which could have served as confounders of the relationship between survival to first cigarette smoked and intervention status and depressed mood, respectively. Of note, we did not find differences between conditions on our measure of familial smoking. Second, when we included the familial smoking variable as the only covariate in a model with depressed mood or intervention status, respectively, there was not a significant change in the HR point estimate for either depressed mood or intervention status. Finally, the findings found here, using an urban, predominantly African-American sample, cannot be generalized to adolescents of other sociodemographic backgrounds in the absence of replication with more diverse samples.

Notwithstanding these limitations, this research has several advantages over previous studies. First, in contrast to most previous studies that followed up youth for only 1–2 years (Gritz et al., 2003; Kandel et al., 2004; Polen et al., 2004; Lam et al., 2005; Weiss et al., 2005), this study used a unique sample of adolescents followed up for 7 years, across middle and high school and 1 year beyond. In addition, in contrast to other studies that assessed youth only a few times within a long follow-up (e.g., King et al., 2004), in this study youth were assessed yearly. This might reduce the bias associated with the recall of the age at first smoking; the yearly assessment of depressed mood may also capture psychological fluctuations or instability. The yearly assessments, as well as the DTSA analytic strategy, allow a more precise inspection of the temporal relationship between antecedent depressed mood and subsequent first smoking experience in the following year. Second, the audio computer-assisted self interview (ACASI) method used for questions related to substance use may have increased response reliability by ensuring privacy (Murphy et al., 2000). Third, the study sample represents the youth who had not smoked by grade 6 out of the entire entering cohort of first grade children in 9 elementary schools in 1993. Thus, the selection biases associated with samples of convenience were avoided. Although there was a moderate level of attrition over time, there was no evidence of differential attrition and we used multiple imputation to address any subsequent missing data. Fourth, in addition to socioeconomic status, this study also measured other important environmental and personal determinants of adolescent smoking, such as conduct problems, parental monitoring, and smoking of peers and family members, some or all of which were not addressed in a number of previous studies (Killen et al., 1997; King et al., 2004; Lam et al., 2005; Polen et al., 2004; Weiss et al., 2005; Wu and Anthony, 1999).

4.2. Implications

Although it has been reported that nicotine has neuroregulatory effects on the central nervous system and nicotine use or withdrawal might increase vulnerability to depression (Goodman and Capitman, 2000; Wu and Anthony, 1999), the mechanism underlying the association between antecedent depression and later tobacco smoking might be better explained by the following plausible hypotheses as suggested by this research. First, tobacco smoking may induce a euphoric effect and therefore depressed individuals may smoke tobacco to self-medicate their depressed mood (Breslau et al., 1991; Killen et al., 1997; Pomerleau and Pomerleau, 1992). Second, the co-occurrence of depression and tobacco smoking may arise from some common factors predisposing some individuals to both depression and smoking, such as genetic or environmental factors, or personality (Fergusson et al., 1996; Kendler et al., 1993).

The demonstration of a reduced survival time to the first tobacco cigarette smoked for adolescents with high depressed mood favors the theory that depressed adolescents might use tobacco to self-medicate their depressed mood. Depressed adolescents may learn from family members or friends who smoke that tobacco can alleviate anxiety or depressed mood; therefore, they may try smoking to improve their depressed mood. Although genetic predisposition might not play as important a role in the initial smoking event as it does in escalation to regular smoking or nicotine dependence (Stallings et al., 1999), future prospective studies should examine whether genetic factors confound the relationship between depressed mood and survival to the first tobacco cigarette smoked. This study did not find significant variation in the relationship between depressed mood and survival to the first cigarette smoked by gender or grade within 7 years after grade 6, which covers an age range from 11.5 through 19. Future studies also need to further investigate the subgroup variation with larger samples.

This study may have important implications for tobacco smoking prevention strategies. The fact that the CC intervention did have a beneficial impact on survival to the first cigarette

smoked suggests that school-based programs targeting early aggressive/disruptive behavior and academic achievement in early childhood can work as an effective way to prevent or at least delay the onset of smoking. As seen in the present study, the protective effect of the CC intervention appears to continue through middle and late adolescence. In addition, given the high prevalence of major depressive disorder and subclinical depression (Kessler et al., 1997; Shaffer et al., 1996), this study suggests that there is an urgent need to prevent tobacco smoking among adolescents with depressed mood. Education and counseling on adverse health effects of smoking may be combined with treatment to motivate depressed adolescents to be smoke-free. This study also suggests that preventing depressed mood through reducing the risk factors for and enhancing the protective factors against depressed mood among school students may have a secondary benefit of lowering the rate of subsequent tobacco smoking. This might be implemented through school-based programs promoting positive school environments and teaching life skills since youth with good problem-solving and social skills have been reported to be less likely than others to become depressed (Bandura et al., 1999).

The finding that peer smoking is one of the strongest predictors of smoking for the first time suggests that strengthening parent-child relationships and promoting parental supervision of youth's affiliation with deviant peers may also help prevent youth from initiating smoking. Consistent with most previous studies (e.g., Elkins et al., 2007; King et al., 2004), youth with higher levels of conduct problems were found to be at greater hazard of smoking for the first time. The increased hazard for conduct problems is independent of depressed mood. Thus, youth with both depressed mood and conduct problems were at even greater hazards of smoking for the first time compared to the youth with either depressed mood or conduct problems alone. These results suggest that programs aiming to prevent smoking among adolescents should pay greater attention to youth who exhibit both depressed mood and conduct problems.

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Fig. 1.

Estimated hazard and survival probability of smoking a tobacco cigarette for the first time during the 7-year follow-up after grade 6 by antecedent depressed mood and gender in a sample of urban youth ($n = 563$).

Table 1

Selected sample characteristics of urban youth who had never smoked by grade 6 ($n = 563$).

Characteristics	Total ($n = 563$)		Male ($n = 297$)		Female ($n = 266$)		p^{***}
	n^a	%	n^a	%	n^a	%	
Age at grade 1 6.0 years	390	69	214	72	176	66	0.131
African-American	492	87	252	85	240	90	0.055
Received subsidized lunch	391	68	201	69	180	68	0.817
Depressive symptoms (mean (sd))	445	0.71 (0.51)	231	0.68 (0.48)	214	0.75 (0.54)	0.134
	469	0.61 (0.45)	248	0.55 (0.40)	221	0.68 (0.49)	0.002
	468	0.57 (0.46)	248	0.47 (0.37)	220	0.68 (0.53)	<0.001
	453	0.58 (0.49)	240	0.52 (0.44)	213	0.66 (0.53)	0.002
	439	0.52 (0.46)	231	0.41 (0.40)	208	0.65 (0.50)	<0.001
	450	0.54 (0.49)	242	0.45 (0.45)	208	0.64 (0.52)	<0.001
	502	0.54 (0.50)	255	0.44 (0.44)	247	0.64 (0.54)	<0.001
Problematic family tobacco use	95	18	51	18	44	18	0.825
Parental monitoring (mean (sd))	444	1.95 (0.67)	230	2.02 (0.67)	214	1.87 (0.66)	0.017
Conduct problems (mean (sd))	437	0.18 (0.38)	226	0.23 (0.42)	211	0.13 (0.33)	0.008
	468	0.18 (0.39)	248	0.19 (0.39)	220	0.18 (0.39)	0.919
	466	0.23 (0.42)	247	0.26 (0.47)	219	0.21 (0.41)	0.253
	454	0.26 (0.44)	241	0.31 (0.46)	213	0.21 (0.41)	0.015
	440	0.28 (0.45)	232	0.31 (0.47)	208	0.24 (0.43)	0.065
	450	0.24 (0.43)	242	0.28 (0.45)	208	0.21 (0.41)	0.085
	502	0.19 (0.39)	255	0.22 (0.41)	247	0.16 (0.37)	0.078
Peer smoking at grade 6	115	26	63	27	52	24	<0.001
Peer smoking at grade 7	143	30	69	28	74	33	0.184
Peer smoking at grade 8	187	40	92	37	95	43	0.180
Peer smoking at grade 9	228	50	126	52	102	48	0.350
Peer smoking at grade 10	243	55	126	55	117	56	0.720
Peer smoking at grade 11	284	63	150	62	134	64	0.593
Peer smoking at grade 12	326	65	165	65	161	65	0.911
Intervention status	185	33	100	34	85	32	

Characteristics	Total (n = 563)		Male (n = 297)		Female (n=266)		*** p
	n ^a	%	n ^a	%	n ^a	%	
FSP	199	35	105	35	94	35	0.879
Ever smoking by 1 year beyond high school graduation	371	66	205	69	166	62	0.098

^aThe number is not necessarily equal to total number (or number of males or females) multiplied by % due to missing values for some covariates.

p-value indicates p value for Chi-square analysis or t-test.

Table 2

Estimated hazard ratio (HR) of smoking a tobacco cigarette for the first time during the 7-year follow-up after grade 6, in relation to depressed mood, intervention and other covariates ($n = 563$).

Characteristics	Having ever smoked a cigarette by 1 year beyond grade 12				First cigarette smoking					
	Non-cases ^a		cases ^a		Crude HR	95% CI	p	Adjusted HR	95% CI	p
	nb	Row% ^b	nb	Row% ^b						
Depressed mood	No	65	41.9	90	58.1	1.0	Reference	1.0	Reference	
	Yes	90	31.0	200	69.0	1.6	1.2–2.1	<0.001	1.4	1.1–1.9
Gender	Female	100	37.6	166	62.4	1.0	Reference	1.0	Reference	
	Male	92	31.0	205	69.0	1.2	0.9–1.5	0.200	1.2	0.9–1.5
Intervention	Control	55	30.7	124	69.3	1.0	Reference	1.0	Reference	
	CC	70	37.8	115	62.2	0.8	0.7–0.9	0.005	0.8	0.7–0.9
Age (years)	FSP	67	33.7	132	66.3	0.9	0.7–1.2	0.641	1.0	0.8–1.2
	6.0	133	34.1	257	65.9	1.0	Reference	1.0	Reference	
Race	<6.0	59	34.1	114	65.9	1.0	0.7–1.3	0.886	1.0	0.8–1.4
	White	17	23.9	54	76.1	1.0	Reference	1.0	Reference	
Receipt of subsidized lunch	African-American	175	35.6	317	64.4	0.7	0.6–1.0	0.045	0.7	0.5–0.9
	No	68	38.6	108	61.4	1.0	Reference	1.0	Reference	
Problematic family tobacco use	Yes	123	32.3	258	67.7	1.3	1.0–1.6	0.039	1.3	1.0–1.7
	No	154	35.7	277	64.3	1.0	Reference	1.0	Reference	
Parental monitoring	Yes	27	28.4	68	71.6	1.2	0.9–1.7	0.198	1.1	0.8–1.6
	Lower levels	102	32.4	213	67.6	1.0	Reference	1.0	Reference	
Conduct problems	Higher levels	53	41.1	76	58.9	0.7	0.6–0.9	0.016	0.8	0.6–1.1
	Lower levels	134	37.3	225	62.7	1.0	Reference	1.0	Reference	
Peer smoking	Higher levels	18	23.1	60	76.9	1.9	1.4–2.7	<0.001	1.7	1.2–2.4
	No	132	40.0	197	60.0	1.0	Reference	1.0	Reference	
	Yes	23	20.0	92	80.0	1.8	1.4–2.3	<0.001	1.6	1.2–2.1

^a“Case” is defined as the youth who had ever smoked a cigarette by 1 year beyond grade 12 and “non-case” is defined as the youth who remained smoke-free at 1 year beyond grade 12.

^bThe numbers or proportions for time-variant variables (depressed mood, conduct problems, and peer smoking) refer to the values at grade 6.