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Nicotine Dependence and Problem Behaviors Among Urban South African Adolescents

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Abstract

Tobacco use and its concomitant, nicotine dependence, are increasing in African countries and other parts of the developing world. However, little research has assessed nicotine dependence in South Africa or other parts of the African continent. Previous research has found that adolescent problem behaviors, including tobacco use, tend to cluster. This study examined the relationship between nicotine dependence and adolescent problem behaviors in an ethnically diverse sample of urban South African adolescents. A community sample ($N = 731$) consisting of “Black,” “White,” “Coloured,” and “Indian” youths aged 12–17 years was drawn from the Johannesburg metropolitan area. Structured interviews were administered by trained interviewers. Nicotine dependence was assessed by the Fagerström Test of Nicotine Dependence. Logistic regression analyses showed that higher levels of nicotine dependence significantly predicted elevated levels of violent behavior, deviant behavior, marijuana and other illegal drug use, binge drinking, early sexual intercourse, multiple sexual partners, and inconsistent condom use, despite control on the adolescents’ demographic characteristics, peer smoking, conflict with parents, peer deviance, and the availability of legal and illegal substances. These relationships were robust across ethnicity and gender. The findings indicate the need for policy makers and prevention and intervention programs in South Africa to consider adolescent nicotine dependence in conjunction with comorbid problem behaviors, including other substance use, sexual risk behaviors, and deviant behaviors.

Keywords

Nicotine Dependence; Problem Behaviors; South African Adolescents

While levels of tobacco consumption have been decreasing in the past decade in developed countries, tobacco use is becoming more of a problem in African countries and other parts of

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Conflicts of Interests

The material contained in this manuscript represents original work, has not been published elsewhere, and is not under consideration for publication elsewhere. Our findings pose no conflict of interests. The authors have full control of all primary data and agree to allow the journal to review the data if requested.

the developing world. In South Africa, an estimated 20,000 adults die from tobacco-related causes per annum (Sitas et al., 2004), and as elsewhere, tobacco use is associated with lung cancer and other diseases (Mzileni, Sitas, Steyn, Carrara, & Bekker, 1999; Sitas et al., 2004). Approximately 31% of South African high school students in Grades 8 to 11 (mean ages 14 – 17) were smokers of tobacco products in 2002, with about one fifth of them being current (past 30-day) smokers (Reddy et al., 2003).

Nicotine dependence is one of the major hazards of tobacco use. Many people continue to use tobacco products despite consequent health and social problems because of their dependence on nicotine. Adolescents can often become physically dependent on nicotine very soon after they first start smoking (O'Loughlin et al., 2003).

Few published studies have assessed nicotine dependence directly among young people (or adults) in South Africa or other parts of the African continent (but see Fakhfakh et al., 2003, Ndiaye et al., 2003, Yazidi, 2002, and Panday, Reddy, Ruiters, Bergström, & de Vries, 2007). To date, only one study has examined adolescent nicotine dependence. In their study of over 500 South African adolescents, Panday and colleagues found that weekly smokers were more likely to be dependent on nicotine than monthly smokers. In addition, there is indirect evidence that many South African adolescents who smoke cigarettes become dependent on nicotine. For example, almost half of the current smokers in a survey of high school students in South Africa reported having tried but failed to quit smoking in the previous year (Reddy et al., 2003).

The importance of examining the comorbidity of nicotine dependence and involvement in problem behaviors has been stressed by several authors (e.g., Colby, Tiffany, Shiffman, & Niaura, 2000; McMahon, 1999). Research has confirmed that adolescent problem behaviors tend to cluster (e.g., Barrera, Biglan, Ary, & Li, 2001; Elliot, Huizinga, & Menard, 1989; Jessor, Donovan, & Costa, 1991). For example, in the United States tobacco use was found to be related to several problem behaviors, including sexual risk behaviors, aggression, alcohol use, and marijuana use (Busen, Modeland, & Kouzekanani, 2001; Unger, Sussman, & Dent, 2003; Valois, Oeltman, Waller, & Hussey, 1999). In South Africa, Flisher and colleagues (Flisher, Ziervogel, Chalton, Leger, & Robertson, 1996) found significant relationships among a number of problem behaviors including substance use, violent acts, and sexual behaviors. Panday and colleagues also found that weekly smokers, compared to monthly smokers, were more likely to engage in risk-taking behaviors, which included other substance use, gambling, and truancy.

However, to date, no community studies have examined the relationship between nicotine dependence and problem behaviors in South Africa. Violence, delinquent behavior, sexual risk behaviors, and substance use are among the major problem behaviors that affect young people in South Africa (Reddy et al., 2003). The current study thus examined whether a major physiological concomitant of tobacco use, dependence on nicotine, predicts adolescent problem behaviors, including substance use (marijuana use, other illicit drugs, and binge drinking), sexual risk behaviors (early sexual intercourse, inconsistent condom use, and multiple sexual partners), and delinquent behaviors (deviance and violence).

We included peer smoking as a proxy for the sociobehavioral dimension of tobacco use into our analyses to assess whether nicotine dependence was uniquely associated with these problem behaviors. Peer smoking is closely linked with adolescent smoking because adolescents tend to seek out peers who are similar to themselves in terms of their behaviors, a mechanism referred to as assortative peer selection (Kandel, 1996). In addition, adolescents' reports of their peers' smoking tend to mirror their own smoking (Baker, Brandon, & Chassin, 2004), making peer smoking a suitable proxy for their own tobacco use.

Among the theories which may explain an association between nicotine dependence and problem behaviors, Problem Behavior Theory (Donovan & Jessor, 1985; Jessor, et al., 1991) posits that adolescent problem behaviors, including tobacco use, alcohol use, illegal drug use, sexual risk behaviors, and delinquency comprise a single behavioral syndrome, which is the expression of an underlying personality dimension, such as unconventionality (Donovan & Jessor, 1985).

Some recent research suggests that such a personality dimension may be the phenotypic expression of a genetic predisposition, and thus may be partially responsible for both the vulnerability to nicotine dependence and a tendency to engage in risk behaviors (e.g., Kreek, Nielsen, Butelman, & LaForge, 2005; Iacono, Malone, & McGue, 2003; Iacono, Malone, & McGue, 2008). For example, it is possible that an inherited predisposition to behavioral disinhibition may express itself in adolescent risk behaviors, including substance use disorders, antisocial behavior, and personality traits related to behavioral undercontrol (Iacono et al., 2003). In addition, environmental factors, such as familial and extra-familial role models, are of importance in the development of an unconventional personality (e.g., Brook et al., 1990).

Social influences may also, in part, explain the association between nicotine dependence and other problem behaviors. Characteristics of the social environment may underlie the relationship between a particular problem behavior or trait (here: nicotine dependence) and other problem behaviors (e.g. Ary, Duncan, Biglan, et al., 1999; Brook, Brook, Gordon, Whiteman, & Cohen, 1990; Catalano & Hawkins, 1996). In the current study, we explicitly focus on this explanatory mechanism by including variables representing social influences in the adolescents' environment, which may be related to both nicotine dependence and other problem behaviors.

For example, associating with deviant peers is likely to be related to both tobacco use (and the resulting nicotine dependence) and other problem behaviors, as peers who engage in deviant behaviors typically smoke and reinforce adolescents' own propensity for tobacco use and deviance (Fergusson, Swain-Campbell & Horwood, 2002; Morojele et al., 2002; Parry, Morojele, Saban, & Flisher, 2004). Biglan and colleagues (Biglan, Duncan, Ary, & Smolkowski, 1995) found that associating with deviant peers predicted smoking with statistical control on peer smoking. In the current study, we therefore include peer deviance as a predictor of other problem behaviors, along with nicotine dependence and peer smoking.

The quality of the relationship between parents and their children may also underlie the observed relationship between nicotine dependence and problem behaviors (Ary, Duncan, Duncan, & Hops, 1999; Brook et al., 1990). For instance, conflict with their parents may lead adolescents to smoke and become dependent on nicotine, as well as to engage in other problem behaviors (such as drug use or violence). In this study, we include a construct measuring the degree of adolescents' conflict with their parents.

Characteristics of the larger social environment, including schools and neighborhoods, may also influence both levels of nicotine dependence and other problem behaviors, in particular other substance use. Being exposed to contexts in which legal and illegal substances are readily available not only gives adolescents access to these substances, but also brings them in contact with people (often older peers) who engage in other problem behaviors. In the current study, we include a proxy for the presence of substances in the adolescents' environments by asking how difficult it is for adolescents to obtain legal (alcohol, tobacco) and illegal substances (marijuana, other illegal drugs).

If the association between nicotine dependence and problem behaviors persists despite the inclusion of these factors (peer smoking, peer deviance, conflict with parents, and availability of substances), this supports the notion that a personality dimension, such as unconventionality,

underlies adolescent substance use disorders, including nicotine dependence, as well as other problem behaviors above and beyond the impact of social influences.

Based on previous research and Problem Behavior Theory, we hypothesized that nicotine dependence would be related to delinquency (violent behavior, deviant behavior), sexual risk behaviors (early sexual intercourse, inconsistent condom use, and multiple sexual partners), and substance use (binge drinking, marijuana use and other illicit drug use) among adolescents in South Africa. We included peer smoking as a control variable to see whether there was a unique relationship between nicotine dependence and problem behaviors above and beyond a sociobehavioral dimension of tobacco use. We also included measures of a conflictual relationship with parents, peer deviance, and the availability of substances in the environment to see whether these social influences would account for the relationship between nicotine dependence and adolescent problem behaviors.

Method

Participants

This study included 731 adolescents, 47.3% male and 52.7% female, drawn from Johannesburg, South Africa. The ethnic breakdown of the study sample was 35.4% “Black African” (N=259), 30.4% “Coloured” (a South African term used for individuals of mixed ancestry; N=222), 26.5% “Indian” (N=194), and 7.7% “White” (N=56)¹. The adolescents ranged in age from 12 to 17 years, with a mean age of 14.55 years (SD=1.68). At the time of the interview, 96.2% of the adolescents reported being in school. The mean grade level was 8th grade. The languages spoken most often at home included: English (42%), Afrikaans (25%), IsiZulu (18%), SeSotho (6%), with the remaining 9% speaking a variety of other indigenous languages such as SeTswana and SePedi. Ninety-two percent of the participants reported Johannesburg as their place of birth, while 7% reported another part of South Africa as their birthplace. One percent of the participants reported having been born in another part of Africa or another part of the world. In addition, 55% of the participants reported living with their biological fathers and 80% with their biological mothers. The number of amenities present in the home was used as a proxy for SES. Out of a possible score of 12, an average of 9.2 (SD=2.46) amenities was reported (the list of amenities included electricity, a radio, a television, a telephone, a refrigerator, a freezer separate from the refrigerator, a stove, an oven, a microwave, a computer, a washing machine, and a car).

Procedure

A stratified, random sampling approach was used to obtain the sample. Census enumeration areas (EAs) were stratified by race and socioeconomic status, based on the 1996 population census. Socioeconomic status was determined through employment rates recorded for the heads of household. The adolescent respondents were recruited from households within the selected EAs. A starting point was designated randomly for each area, and every tenth household was visited in person to determine if an eligible adolescent resided there. Eligible adolescents were defined as those between the ages of 12 and 17 years, inclusive. When more than one adolescent in a household qualified for the study, we used a random selection procedure to determine which one to include. The refusal rate was low; over 90% of selected adolescents agreed to participate in the study.

¹South Africans were categorized according to their race during apartheid as “Black African” (of African descent), “Coloured” (of mixed European and African descent), “Indian” (of Asian/Indian descent) or “White” (of European descent). These racial categories continue to be employed by the South African census today. The authors do not subscribe to these classifications in any way.

The instrument was translated from English into three languages, Afrikaans, SeSotho, and IsiZulu. In order to guarantee that the questionnaires retained their meaning after translation, all instruments were translated back into English and checked against the original English version. All discrepancies were corrected.

Individual, in-person interviews were conducted by trained interviewers after obtaining informed consent. Informed written consent was obtained from a parent or guardian, prior to getting assent in writing from the adolescent. After obtaining consent, a private location was found to administer the questionnaire. This was either a room in the participant's residence, or an outdoor location far enough away from anyone else to ensure privacy. Whenever possible, interviewers and participants were matched on gender and ethnicity, and participants were administered the questionnaire in their language of choice.

The interviewer read the questionnaire aloud to the participant and recorded her/his responses. For questions of a sensitive nature (e.g., sexual behavior), participants were given the instrument and requested to record the answers themselves. The questionnaire took approximately one hour to complete. At the end of the interviews the participants were offered a resource list of treatment services but did not receive any monetary incentive for their participation. All procedures and consent forms were approved by the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria and the New York University School of Medicine's Institutional Review Board.

Measures

Instrument development was based on the results obtained from focus group sessions and a pre-test of a pilot questionnaire among adolescents in South Africa (Morojele, Brook, & Kachieng'a, 2006). These preliminary studies were conducted in order to ensure that the adapted measures were culturally relevant and linguistically appropriate for use in South Africa.

The Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker & Fagerström, 1991) was used to measure levels of nicotine dependence. The questionnaire consists of six items and scores can range from "0" to "10", with a 0 indicating no dependence and 10 being the most dependent. The items on the FTND assess the number of cigarettes typically smoked, smoking when sick, difficulty refraining from smoking in forbidden places, the time between waking up in the morning and smoking the first cigarette (reverse scored), smoking more frequently during the first hours of the morning, and which cigarette the respondent would hate to give up most ("the first one in the morning" or "all the others"). The FTND has been used with adolescents and young adults and has demonstrated acceptable psychometric properties (Clark, et al., 2005; Haddock, Lando, Klesges, Talcott, & Renaud, 1999; Robinson, Berlin, & Moolchan, 2004). In the current study, Cronbach's alpha for the FTND was 0.62. For the purposes of this study, due to recognition of nicotine dependence as a dimensional rather than a discrete phenomenon, a continuous version of this measure was employed (see also Panday et al., 2007).

Peer smoking was assessed by a single item asking how many of the participant's friends smoked on a regular basis (1 – none; 4 – most). Peer deviance, a six-item scale ($\alpha = 0.79$), assessed the number of the adolescents' friends who engaged in deviant behavior (Brook, et al., 1990). A sample item read "How many of your friends have been in trouble with the police or the law for something they did?" The scales assessing conflict with mother ($\alpha = 0.66$) and conflict with father ($\alpha = 0.73$) each had three items measuring the degree to which the adolescents resisted their parents' rules and guidance (Schaefer & Finkelstein, 1975). A sample item read "Sometimes you go against your father's/mother's wishes." Because of their high correlation ($r = 0.60$), we combined these two items into one construct, "conflict with parents."

Availability of substances (tobacco, alcohol, marijuana, and illegal drugs other than marijuana) was measured by questions asking how hard it was for the participant to obtain each of these substances (1 – very easy to get; 4 – very difficult to get; $\alpha = 0.80$).

Eight types of problem behaviors were considered as the dependent variables: the number of violent acts perpetrated by the participant (e.g., using a weapon against someone; 3 items; 1 – never, 5 – 5 or more times; $\alpha = 0.68$); deviance [e.g., stealing something worth more than R35 (approximately \$6), cheating on tests; 1 – never, 5 – 5 or more times; $\alpha = 0.59$]; the number of days in one month on which the participant had engaged in binge drinking (defined as 5 or more drinks during one sitting); the greatest frequency of marijuana use in one's lifetime (1 – never; 5 – once a week or more); the greatest frequency of other illicit drug use in one's lifetime (1 – never; 5 – once a week or more); having had sexual intercourse ("Have you had sexual intercourse?"); inconsistent condom use ("How often are condoms used when you and your partner(s) have sexual intercourse;" 1 – never; 5 – always; 9 – never had sex); multiple sexual partners (About how many different people have you had intercourse with;" 0 – never had sex, 1 – one person, 2 – two people, 3 – three or four people, 4 – five or six people, 5 – seven or eight people, 6 – nine or more people).

Inconsistent condom use was dichotomized by assigning "0" to those who had not had sex and to those who indicated that they always used condoms. The rest of the answers (ranging from "used condoms often" to "had sex but never used condoms") were coded as "1." Having multiple sexual partners was dichotomized by assigning "0" to those who had not had sexual intercourse and those who reported having had sex with one person. All other answers were coded as "1." Early sexual intercourse was coded as "1," for having had intercourse, and "0" for no report of sexual intercourse within the participant's lifetime.

All other problem behaviors which had been measured on a continuous scale (i.e., violence, deviance, binge drinking, marijuana use, and other illicit drug use) were dichotomized at one standard deviation above the mean. The reason for dichotomizing these measures was to create a high-risk group of adolescents, who engaged in the risk behavior at a significantly higher level than their peers.

Statistical Analysis

First, we examined the bivariate relationships between the demographic measures (age, gender, SES, and ethnicity), peer smoking, conflict with parents, peer delinquency, the availability of substances and each of the six problem behaviors. Four separate ethnicity variables were created, and each group was compared to the remaining three ethnic groups (e.g., one set of analyses compared "Black" participants with their "White," "Indian," and "Coloured" counterparts). We then conducted a series of logistic regression analyses to assess the association between nicotine dependence and each problem behavior. Odds ratios and 95% confidence intervals were computed for each of the five problem behaviors. These analyses also included gender, age, ethnicity, peer smoking, conflict with parents, peer delinquency, and the availability of legal and illegal substances. SES (as measured by household amenities) was not included in the analyses because it had not predicted any of the problem behaviors in the bivariate analyses.

Results

The mean value on the FTND was 0.40, with a standard deviation of 1.11. The results of the logistic regression analyses examining the relationship of the control and social influence variables (i.e., demographic measures, peer smoking, conflict with parents, peer delinquency, and the availability of substances) with each of the problem behaviors are presented in Table 1. As shown in Table 1, older adolescents were significantly more likely to engage in violent

and deviant acts, binge drinking, and drug use. Furthermore, older adolescents were more likely to have had sexual intercourse, have multiple sexual partners, and use condoms inconsistently. With one exception (i.e., binge drinking), being male was significantly associated with an increased likelihood of engaging in each of these problem behaviors. SES was not related to any of the problem behavior outcomes. Peer smoking was also related to all eight problem behaviors at a statistically significant level. Having delinquent peers was significantly related to increases in the odds of engaging in each of the eight problem behavior outcomes, as were conflict with parents and the availability of substances. Black adolescents, compared to all other ethnic groups, were less likely to report having had sexual intercourse and to use marijuana and other illegal drugs at high levels. White adolescents, compared to their peers from other ethnic groups, were more likely to have had sexual intercourse. Indian adolescents, compared to all other ethnic groups, were less likely to use condoms inconsistently, while “Coloured” adolescents were more likely to report having multiple sexual partners, use condoms inconsistently, engage in binge drinking, and use marijuana at high levels.

The findings of the logistic regression analyses for examining the associations between nicotine dependence and the problem behaviors are presented in Table 2. Higher levels of nicotine dependence were associated with an increased risk of engaging in all of the eight problem behaviors, controlling for the demographic variables, peer smoking, conflict with parents, peer delinquency, and the availability of substances. Higher scores on the FTND were associated with an increased likelihood of committing acts of violence, delinquent behavior, having had sexual intercourse, inconsistent condom use, and having multiple sexual partners. In addition, nicotine dependence was linked with increased odds of binge drinking, marijuana use, and other illicit drug use at high levels. To test whether the relationships between FTND scores and the problem behaviors differed across gender and/or ethnicity, we created interaction terms between the FTND scores and gender, and between the FTND scores and ethnicity. Dummy codes, with Black adolescents as the implied reference group², were created. None of these interaction terms were statistically significant, and therefore they were not included in the final models.

Discussion

This study found that nicotine dependence is associated with elevated levels of adolescent violence, deviance, binge drinking, marijuana use, and other illicit drug use, as well as with early sexual intercourse, inconsistent condom use, and having multiple sexual partners despite the inclusion of demographic factors, peer smoking, conflict with parents, peer deviance, and the availability of legal and illegal substances, including tobacco.

The current study assessed a number of social influences which may underlie the relationship between tobacco use and other adolescent problem behaviors. Characteristics of peers, family, and the broader social environment may account, in part, for the relationship between nicotine dependence and problem behaviors (e.g. Ary, Duncan, Biglan, et al., 1999; Brook et al., 1990; Catalano & Hawkins, 1996). According to this reasoning, the association between nicotine dependence and problem behaviors would primarily exist because a third variable representing a social influence (i.e., peer delinquency, conflict with parents, availability of substances in the environment) underlies both nicotine dependence and other adolescent problem behaviors (i.e., violence, deviance, sexual risk behaviors, and substance use). For example, associating with deviant peers could lead adolescents to become nicotine dependent (as a consequence of tobacco use) and engage in deviant behavior because delinquent peers

²Black adolescents were chosen as the implied reference group because, compared to adolescents of other ethnic groups, they showed the lowest levels of engagement in problem behaviors.

have an influence on the adolescent's own behavior by modeling tobacco use and other problem behaviors.

Similarly, a conflictual relationship with one's parents may be a precursor to adolescents' engagement in a host of problem behaviors, including tobacco use (which is the precursor to nicotine dependence) and sexual risk behaviors, other substance use, and delinquent behaviors. However, it should be noted that adolescent problem behaviors may also lead to conflict between adolescents and parents.

Other aspects of the social environment in which adolescents spend their time (e.g., schools, neighborhoods) may also explain the relationship between nicotine dependence and problem behaviors, particularly the use of other substances. Interacting in contexts where adolescents can smoke cigarettes without detection will likely expose them to other substances, such as alcohol and illegal drugs, as well as increase contact with people who engage in other problem behaviors.

In this study, the relationship between nicotine dependence and problem behaviors was maintained despite the inclusion of variables which represent social influences on problem behaviors (i.e., a conflictual relationship with one's parents, peer deviance, and the availability of substances in the environment). These findings suggest that these powerful social influences on adolescent problem behaviors only partially explain the relationship between nicotine dependence and problem behaviors. In addition, the current study controlled for peer smoking, a proxy for the sociobehavioral dimension of adolescent tobacco use, suggesting that dependence on nicotine, not only its behavioral manifestation, smoking, may be related to violent and deviant behaviors, sexual risk behaviors, and increased use of other substances.

Our findings thus provide support for the notion that a personality dimension, such as unconventionality or a tendency towards behavioral disinhibition, may underlie both nicotine dependence and other adolescent problem behaviors. It is possible that such a personality dimension may, in part, be hereditary. For example, Iacono and colleagues (2008) suggest that a common genetic liability to behavioral disinhibition underlies an array of "externalizing attributes" (Iacono, et al., 2008, p. 325). Such a genetic diathesis would express itself in a tendency to behavioral undercontrol and be mediated by brain mechanisms related to cognitive control, impulsivity, and sensitivity to reward (Iacono et al., 2008).

Adolescence is the developmental period during which these faculties mature. Environmental risks, such as those tested in the current study, act upon genetic predispositions during this sensitive period to further increase the risk of adolescents' engaging in multiple problem behaviors. Thus, an interaction of genetic and environmental factors most likely explains the clustering of adolescent problem behaviors, including the addiction to nicotine, the tendency to engage in sexual risk behaviors, and the types of risk-taking behaviors which are embodied in both violent and deviant acts. Future research should focus on the interaction of environmental and genetically-based factors that may be of importance in the development of such a cluster of adolescent problem behaviors.

It is also important to acknowledge that there is a multitude of other social influences besides those included in this study, which may be of importance in explaining the association between nicotine dependence and other adolescent problem behaviors, among them other dimensions of the parent-adolescent relationship, involvement in romantic relationships, and contextual factors, such as the school environment.

Our findings confirmed the international and South African literature showing a greater tendency for males (than females) and older (rather than younger) adolescents to engage in problem behaviors (Brener & Collins, 1998; Flisher, Parry, Evans, Muller, & Lombard,

2003; National Institute on Drug Abuse, 2005; Reddy et al., 2003). These findings may be due to the greater independence and freedom to engage in problem behaviors that is often given to male and older adolescents (Jersild, Brook, & Brook, 1978). In addition many older adolescents are prematurely eager to adopt perceived adult behaviors such as drinking alcohol and sexual intercourse. We did not find that SES was related to any of the problem behaviors assessed in this study. This may have been due to the limited variance in our measure of SES, as 74% of the sample had 8 or more of the 12 household amenities examined. Although we found some ethnic differences in our bivariate analyses, these findings were not consistent across all behaviors and should be replicated before any conclusion can be reached.

The present study is unique in a number of respects. First, it is one of the few studies, to our knowledge, to have assessed South African adolescents' levels of nicotine dependence using the FTND. Second, our sample was drawn from large and diverse communities, rather than schools, in Johannesburg, South Africa.

Among the limitations of the study is the use of a cross-sectional design, which prevents conclusions about the direction of the obtained relationships. Furthermore, all of the measures were based on the adolescents' self-reports, so the relationship between nicotine dependence and problem behaviors may be partly due to shared-method variance. Research conducted in the future should endeavor to obtain information from multiple sources. The use of a single item to assess peers' tobacco use represents another limitation. In a similar vein, our study is necessarily restricted by the survey measures, which only included a limited number of possible social influences on adolescent nicotine dependence and other problem behaviors. We were not able to include variables that could represent a personality dimension (e.g., impulsivity, novelty seeking), which may underlie both nicotine dependence and other problem behaviors. However, to the extent that such a construct is related to the other predictor included in the research (i.e., peer smoking, the association with deviant peers, conflict with parents, and the availability of substances), we were able to remove some of its effect. Nevertheless, future research would benefit from the inclusion of a measure of such a personality dimension.

Finally, no biological confirmation of self-reports of nicotine dependence was obtained in this research. However, there is evidence that adolescents' self-reports are consistent with direct measures of their tobacco use (e.g., Dolcini, Adler, Lee, & Bauman, 2003). Although the findings were based on a sample of adolescents from Johannesburg, the similarity between our results and those of other investigators in other countries attests to the generalizability of our findings.

Implications

The observed relationships between nicotine dependence and comorbid problem behaviors point to a need for policy makers and treatment and prevention programs to consider nicotine dependence among adolescents in South Africa as an area in need of urgent attention.

From a public health as well as from a clinical perspective, our findings suggest that the comorbidity of adolescent nicotine dependence and other problem behaviors should be addressed in prevention and treatment. For example, prevention programs aimed at reducing sexual risk behaviors (a major focus in South Africa) could include modules aimed at preventing substance abuse (legal and illegal) as well and thus reduce both the spread of HIV and the prevalence of substance dependence among South African adolescents. The comorbidity of nicotine dependence and other problem behaviors should also be considered in future research. For example, it would be important to examine the longitudinal trajectories of both nicotine dependence and problem behaviors and their relationship over time. This would provide insight into the developmental patterns of these phenomena from adolescence into adulthood. In addition, it would be worthwhile to examine the comorbidity of nicotine

dependence and psychiatric disorders in young adults. It is possible that the association between nicotine dependence and problem behaviors in adolescents, which was found in this research, will develop into a more severe type of comorbidity, between nicotine dependence and substance use disorders and other psychiatric disorders (e.g., antisocial personality disorder) in adulthood. From the standpoint of prevention science, it is therefore of crucial importance to identify the predictors of such comorbid relationships.

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Table 1

Prediction of Problem Behaviors from Demographic Factors, Peer Smoking, Conflict with Parents, Peer Delinquency, and Availability of Substances: Odds Ratios and 95% Confidence Intervals (C.I.)

Control Variable	Violence	Deviance	Sexual Intercourse	Multiple Sex Partners	Inconsistent Condom Use	Binge Drinking	Marijuana Use	Other Illicit Drug Use
Age ^a	1.47* (1.1–2.0)	1.75*** (1.4–2.2)	4.27*** (2.9–6.3)	5.02*** (2.8–9.0)	1.81** (1.3–2.6)	2.84*** (1.9–4.3)	2.80*** (2.1–3.7)	2.21** (1.4–3.6)
Male Gender	4.55*** (2.2–9.6)	2.29*** (1.5–3.5)	2.31** (1.4–3.9)	7.2*** (2.8–18.8)	3.17** (1.5–6.6)	1.80 (0.9–3.4)	2.29*** (1.4–3.7)	4.17** (1.5–11.4)
Amenities ^a	0.90 (0.7–1.2)	1.16 (0.9–1.4)	0.85 (0.67–1.1)	0.95 (0.7–1.3)	0.74 (0.5–1.0)	0.80 (0.6–1.1)	0.98 (0.8–1.2)	1.65 (1.0–2.7)
Peer Smoking ^a	1.79*** (1.4–2.4)	1.87*** (1.5–2.3)	2.14*** (1.7–2.7)	2.85*** (2.0–4.1)	1.48* (1.1–2.0)	2.06*** (1.5–2.8)	2.61*** (2.1–3.3)	3.19*** (2.0–5.1)
Conflict with Parents ^a	2.01*** (1.5–2.8)	1.90*** (1.5–2.4)	1.45*** (1.1–1.9)	1.65** (1.2–2.3)	1.72** (1.2–2.4)	1.99*** (1.4–2.8)	2.26*** (1.8–2.9)	2.65*** (1.7–4.2)
Peer Delinquency ^a	2.3*** (1.8–3.0)	2.57*** (2.1–3.2)	2.25*** (1.8–2.8)	2.87*** (2.1–3.9)	1.92*** (1.5–2.5)	2.38*** (1.8–3.1)	2.49*** (2.0–3.1)	3.05*** (2.1–4.4)
Availability of Substances ^a	0.38*** (0.3–0.6)	0.57*** (0.5–0.7)	0.52*** (0.4–0.7)	0.44*** (0.3–0.7)	0.53** (0.4–0.8)	0.50*** (0.3–0.7)	0.55*** (0.4–0.7)	0.29*** (0.2–0.6)
“Black” ^b	0.53 (0.3–1.1)	0.77 (0.5–1.2)	0.65 (0.4–1.2)	0.36* (0.2–0.9)	0.57 (0.3–1.2)	0.50 (0.2–1.1)	0.48** (0.3–0.8)	0.17* (0.0–0.7)
“White” ^b	0.90 (0.3–3.0)	1.03 (0.5–2.3)	2.23* (1.1–4.6)	1.60 (0.5–4.7)	1.97 (0.7–5.3)	1.74 (0.7–4.6)	1.49 (0.7–3.2)	2.66 (0.9–8.1)
“Indian” ^b	1.08 (0.5–2.1)	1.00 (0.6–1.6)	0.74 (0.4–1.3)	0.81 (0.4–1.8)	0.32* (0.1–0.9)	0.46 (0.2–1.1)	0.95 (0.6–1.6)	1.82 (0.8–4.3)
“Coloured” ^b	1.71 (0.9–3.2)	1.29 (0.8–2.0)	1.40 (0.8–2.3)	2.26* (1.1–4.5)	2.55** (1.3–5.0)	2.56** (1.4–4.8)	1.78* (1.1–2.8)	1.23 (0.5–3.0)

Note. Variables were tested individually.

*These measures were standardized.

^aThe implied reference group is all other ethnicities.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$;

Table 2

Prediction of Problem Behaviors from Nicotine Dependence: Odds Ratios and 95% Confidence Intervals (C.I.)

Predictor Variable	Dependent Measures	Odds Ratio	95% C.I.
Nicotine Dependence	Violence	1.32 [*]	(1.01–1.74)
	Deviance	1.36 ^{**}	(1.10–1.52)
	Early Sexual Intercourse	1.98 ^{***}	(1.56–2.51)
	Multiple Sex Partners	2.12 ^{***}	(1.54–2.91)
	Inconsistent Condom Use	1.62 ^{***}	(1.22–2.16)
	Binge Drinking	1.37 [*]	(1.06–1.77)
	Marijuana Use	1.66 ^{***}	(1.33–2.08)
	Other Illicit Drug Use	1.46 [*]	(1.03–2.06)

Note. These analyses controlled for age, gender, ethnicity, peer smoking, conflict with parents, peer delinquency, and the availability of substances. Age, conflict with parents, peer delinquency, the availability of substances, and nicotine dependence were standardized to permit comparisons of the magnitudes of the odds ratios.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$