Adolescent Substance Use

A Prospective Longitudinal Model of Substance Use Onset Among South African Adolescents

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Substance use onset among Colored adolescents between eighth and ninth grades in an urban area of Cape Town, South Africa was examined using latent transition analysis. Longitudinal self-report data regarding substance use (N = 1118, 50.9% female) were collected in 2004 and 2005. Results indicated that the pattern of onset was similar across genders; adolescents first tried either alcohol or cigarettes, followed by both, then dagga (cannabis), and then inhalants. The prevalence of lifetime cigarette use was slightly greater for females; dagga (cannabis) and inhalant use were greater for males. The similarity of developmental onset in the current sample to previous international work supports the promise of adapting prevention programs across contexts. The study's limitations are noted.

Keywords Substance use onset; gateway drugs; South Africa; latent transition

analysis; gender differences; adolescent drug use

Introduction

Knowledge regarding the developmental patterns of onset and use of tobacco, alcohol, cannabis, and other drugs is especially important for prevention scientists who aim to intervene in slowing the process of substance initiation. The majority of prevention pro- grams do aim to intervene early in the onset process, because onset of cigarette and alcohol use at younger ages are documented predictors of illicit drug use among American teens (Lewinsohn, Rohde, and Brown, 1999; Yu and Williford, 1992). The initiation and progres- sion of substance use among adolescents in the United States have received considerable attention (Chung, Park, and Lanza, 2005; Collins, Graham, Long, and Hansen, 1994; Kandel and Yamaguchi, 1993). The gateway theory suggests that adolescents tend to initiate substance use with alcohol and/or cigarettes before using other drugs. Although there is some contention regarding the universality of the gateway theory (e.g., Golub and Johnson, 2002; Patton, Coffey, Carlin, Sawyer, and Lynskey, 2005), research on American youth has largely documented a stage-wise progression of substance use among adolescents, beginning with alcohol or cigarettes and progressing to more consistent use of these substances and use of illicit drugs (Chung and Martin, 2001; Guo, Collins, Hill, and Hawkins, 2000; Kandel and Yamaguchi, 1993; Newcomb and Bentler, 1986). In a study of adolescents in six European nations, tobacco use was prospectively predictive of alcohol use (Wetzels, Kermers, Vitória, and deVries, 2003). There is evidence that patterns of onset by age may be similar across North and South America and Europe, although prevalence rates vary by culture (Vega et al., 2002).

Less is known about the process of substance use onset outside of North America and Europe. However, as scientists seek to implement substance use prevention programs in diverse cultural contexts and to implement prevention programs abroad, it is important to ask first whether or not the progression of

substance use onset is similar across cultures. A clearer understanding of basic processes underlying adolescents' progression through the stages of substance use (e.g., Kandel and Yamaguchi, 1993) and the conditions under which substance use begins and continues, including potential differences in substance use onset by individuals of different demographic and cultural groups, can inform prevention efforts. For example, the assumption made by many American prevention programs is that the first substance with which an adolescent experiments is likely to be either alcohol or tobacco. However, this may not generalize to other countries, based on research indicating that individuals who have similar cultural and ethnic backgrounds may have similar levels of risk for using substances that are unique to their subgroup (Chen et al., 2002).

Longitudinal data regarding onset of substance use is scarce, but prevalence data regarding differences in engagement in substance use by racial and ethnic background caution against automatically generalizing across contexts. For example, White adolescents in Britain drink more than Asian and Black adolescents in Britain (Rodham, Hawton, Evans, and Weatherall, 2005), and Hispanic Americans have a higher prevalence of cannabis and inhalant use than White Americans (Ramirez et al., 2004). Adolescents of different races may also have different sequences of substance use initiation; for instance, South African Colored adolescents retrospectively report using cigarettes earlier than alcohol, while South African White and Black adolescents report using alcohol and cigarettes first (Flisher, Parry, Muller, and Lombard, 2002). Differences in the prevalence and progression of substance use onset by race and culture support the importance of investigating the developmental progression of substance use in context.

The application of prevention programs and principles developed in one country and imported to other countries will be better informed by understanding similarities and differences in the onset processes. In order to begin to address

the question of the cultural generalizability of previous findings about the substance use onset process, this study examined longitudinal patterns of substance use onset in South Africa. The only previous study of which the authors are aware that investigates substance use onset transitions among South African youth was conducted by Flisher et al. (2002). This study, which was based on retrospective reports of age at first use of a variety of substances, was the first to address substance use transitions among youth in any part of the developing world. The authors found that South African adolescents first used either cigarettes or alcohol, then progressed to cannabis use, followed by experimentation with ecstasy or crack (Flisher et al., 2002). Attempts to replicate these results regarding the patterns of substance use initiation have not been made, either using retrospective studies or prospective longitudinal investigations of transitions of use among persons over time.

In addition to the question of whether there are cultural differences overall, the question of whether there are gender differences in substance use onset is also important. For the most part, existing literature has indicated that there are differences in drug use prevalence, with boys showing more use, and more advanced use, than girls. Similar gender differences have been reported in several countries and cultures (e.g., Epstein, Botvin, and Diaz, 2002; Isralowitz and Rawson, 2006; Johnston, O'Malley, Bachman, and Schulenberg, 2003; Rodham et al., 2005). Flisher et al. (2002) and Parry et al. (2004) suggest that this overall pattern holds in South Africa. There have been few studies indicating gender differences in the onset process itself, although there is some evidence that experimentation with cigarettes may be more predictive of serious drug use among females than among males (Kandel and Yamaguchi, 1993; Yamaguchi and Kandel, 1984). Flisher et al. (2002) did not find gender differences in sequences of substance use initiation among South African youth.

The Present Study

The present study is a prospective longitudinal analysis of transitions in stages of

substance use initiation among adolescents in Cape Town, South Africa. Participants were members of the control group in an intervention trial focusing on improving leisure time use and reducing risky behaviors (Caldwell, Smith et al., 2004). Understanding the stage-wise progression of substance use onset in this sample will guide future interpretation of intervention results in context. Specific research questions were: (1) What are the overall patterns and prevalence of substance use among South African adolescents? and (2) What are the differences between males and females in patterns and prevalence of substance use?

The current study is unique in at least three ways. First, it includes inhalants, which are often overlooked in studies of substance use transitions (Anderson and Loomis, 2003). Use of inhalants can lead to serious health effects (Anderson and Loomis, 2003) which is an issue in both developing and developed nations (Sloboda, Kozel, and De La Rosa, 1995). Parry et al. (2001) showed that a quarter of adolescents in grades 7, 10, and 11 in Pretoria, South Africa have inhaled at least one substance, as compared to about one-tenth of American adolescents aged 14 to 17 years (Wu, Pilowsky, and Schlenger, 2005). This suggests that inhalants may be an especially important substance to consider in research on African populations, although their place in substance use onset is largely unknown. Second, the study utilizes a person-centered approach, modeling the initiation of four different substances prospectively over time. This approach has the particular advantage of describing how individuals initiate substances over time, rather than relying exclusively on community-wide prevalence statistics. Third, the current study is one of the first to investigate substance use progression longitudinally among adolescents in a developing nation. Substance use is a concern in Africa because of its negative health and social effects on the population and the likely positive association with the growing HIV/AIDS epidemic (Parry et al., 2002; Peltzer and Cherian, 2000; Simbayi et al., 2004). A first step toward implementation of effective programing is the increase in understanding of current developmental processes. In

addition, when compared with similar data on substance use among adolescents in the United States, these results will provide new information about the similarities and differences in substance use patterns for American and African youth.

Methods

Design and Participants

The participants in this project resided in a township established during the Apartheid era, about 15 miles outside of Cape Town, South Africa. The area suffers from high unemployment and students live in crowded neighborhoods of largely government-supplied housing. The adolescents are participants in the first large randomized control trial of HealthWise South Africa, a school-based leisure, life-skills, and sexual education intervention which was adapted from the TimeWise program (Caldwell, Baldwin, Walls, and Smith, 2004) by American and South African researchers and local teachers and school administrators (Caldwell, Smith et al., 2004). HealthWise South Africa, funded by the National Institutes of Drug Abuse, was pilot tested in 2003 and the longitudinal trial began in 2004. Its efforts are currently being evaluated. Of 25 local schools, six were excluded due to concerns about their ability to function effectively in a research program. Four schools were selected at random to participate in the randomized control trial of the HealthWise South Africa program ($n = 913$), and five schools served as matched controls ($n = 1,291$). Of all eligible students ($N = 2,417$), 3.4% did not participate because of personal or parental refusal and 5.5% failed to complete the survey as a result of school absences.

Adolescents were members of the randomized no-treatment control group of the HealthWise South Africa program (Caldwell, Smith et al., 2004). Participants were followed longitudinally from the beginning of eighth grade (Time 1, $M = 13.99$ years of age) until the beginning of ninth grade (Time 2). Religious affiliation of adolescents was 21.9% Catholic, 44.3% other Christian,

and 31.4% Islam. The majority, 57.4%, reported speaking mainly English at home, 48.4% Afrikaans, and 3.1% Xhosa. Most participants (89.8%) identified as Colored (i.e., of Asian, European, and African descent), with an additional 5.9% identifying as Black, 3.8% as White, and 0.6% as Indian or other. For the present analyses, only Colored adolescents ($N = 1,118$, 50.9% female) were retained, due to potential differences by race and lack of power to model these differences in the current sample. Background characteristics are shown in Table 1.

Measures

Dynamic variables of interest tracked lifetime use of alcohol, cigarettes, dagga (cannabis), and inhalants at Time 1 and Time 2. Indicators of substance use were dichotomized for these analyses because we were concerned with whether or not adolescents had initiated use, and the order in which these substances were tried, rather than with their current level of use. Alcohol use was measured with the question, *"How many drinks of alcohol (including beer and wine) have you had in your entire life?"* with responses dichotomized to none or a few sips in church services (coded as 1) and part or all of one or more drinks (2). Cigarette use was indicated by asking, "*How many cigarettes have you smoked in your entire life?* "

Table 1

Selected background characteristics of colored adolescent participants in eighth grade (Time 1)

	(%)
Religion	
Catholic	19.7
Other Christian	45.7
Islam	33.2
Language spoken at home	
English	61.8
Afrikaans	52.1
Xhosa	0.9
Economic condition of home	
Have electricity	97.8
Have tap water	95.0
Have motorcar	58.8
> 2 people sleep same room	18.4
Family	
Live with Mother	88.8
Live with Father	69.2

Note. $N = 1,118$.

(none or a few puffs = 1, more than 1 = 2). Use of cannabis, called *Dagga*, was assessed with "*How many times have you used dagga in your entire life*?" (never = 1, one or more times = 2). Finally, *Inhalant* use was coded based on responses to the question, "*How many times in your entire life have you sniffed glue, or paint, or petrol on purpose to get high*?" (never = 1, one or more times = 2).

Overview of Analysis Strategy

Latent transition analysis (LTA) (Collins, Graham, Rousculp, and Hansen, 1997; Lanza and Collins, 2002; Lanza, Collins, Schafer, and Flaherty, 2005; Lanza, Flaherty, and Collins, 2002) was used to model stages of substance use as latent variables based on measurement of the dichotomous manifest indicators of lifetime substance use. LTA is useful for testing stage-sequential developmental models (e.g., Guo et al., 2000). LTA estimates three sets of parameters. One set of

parameters represents the proportion of participants in each latent stage, a second represents the conditional probability of transitions between stages, and a third describes the measurement precision of the model.

Results

Model Specification

LTA was used to fit models with varying numbers of substance use stages (e.g., alcohol use only), in order to determine how many stages were needed to provide the best fit to the data. First, contingency tables were examined to determine which combinations of initiated substances were most prevalent, in order to obtain an initial sense of which stages would be likely to appear in the models fit. This initial look at the data clearly indicated that it was rare to have tried either dagga only or inhalants only, because a very small number of adolescents reported trying either dagga or inhalants without also having tried alcohol or cigarettes. This is reflected by the fact that these stages (Dagga Only and Inhalants Only) do not appear in the final models. Examination of contingency tables also suggested that, consistent with prior literature (e.g., Graham, Collins, Wugalter, Chung, and Hansen, 1991), both tobacco use and alcohol use should be included as possible starting points for substance use. Based on the contingency tables it appeared that models with five, six, and seven stages should be compared to determine which provided the best fit to the data.

Models were fit using WinLTA (Lanza et al., 2005). Models were fit separately for males and females in order to investigate whether models with the same number of stages fit best for both genders. Results indicated that a six-stage solution fit well and was readily interpretable for both males $[G^2(228) = 117]$ and females $[G^2(228) = 117]$. To test for measurement invariance across gender, a model constraining measurement parameters to be equal for girls and boys $[G^2(463) = 307]$ was compared to a model where parameters for girls and boys were allowed to be different $[G^2(455) = 274]$. A χ^2 difference test $[G^2(33) = 8, p < .001]$ revealed that better model fit resulted from allowing

measurement to vary for girls and boys. This indicates that measurement properties of the substance use items were different for boys and girls.

The parameters reflecting the measurement precision of the model describe the probabilities of item response conditional on latent stage (Table 2). For example, one measurement parameter expresses the probability of an individual in the alcohol only stage responding that he or she has used alcohol (in this case a value close to 1 indicates measurement precision). For both girls [$G^2(228) = 117$] and boys [$G^2(228) = 181$], a parsimonious six stage solution was determined to fit the data well, based on interpretability and model fit indicated by G^2, *AIC*, and *BIC*. Measurement parameters were constrained to be equal across time based on correct and incorrect classification for each item. For example, the probability of an adolescent in the alcohol only stage saying she had used alcohol was constrained to be equal to the probability of a girl in the alcohol and cigarettes stage saying she had used alcohol.

Table 2

Measurement parameters in final models

Panel A. Girls: Probabilities of positive responses to substance use items by stage

Stage	Cigarettes	Alcohol	Dagga	Inhalants
No use	0.02	0.06	0.00	0.02
Alcohol only	0.02	0.90	0.00	0.02
Cigarettes only	0.86	0.06	0.00	0.02
Cigarettes & alcohol	0.86	0.90	0.00	0.02
Cigarettes, alcohol, & dagga	0.86	0.90	0.88	0.02
Cigarettes, alcohol, dagga, inhalants	0.86	0.90	0.88	0.78
Panel B. Boys: Probabilities of positive responses to substance use items by stage				
No use	0.00	0.13	0.04	0.02
Alcohol only	0.00	0.85	0.04	0.02
Cigarettes only	0.84	0.13	0.04	0.02
Cigarettes & alcohol	0.84	0.85	0.04	0.02
Cigarettes, alcohol & dagga	0.84	0.85	0.86	0.02
Cigarettes, alcohol, dagga, inhalants	0.84	0.85	0.86	0.56

Table 3

Probabilities of stage membership (Time 1) and of stage transition

Stage	Time 1 prevalence	Time 2 transition probability						Time 2 prevalence
		1	2	3	4	5	6	
1. No use	0.496	0.576	0.127	0.112	0.119	0.053	0.018	0.286
2. Alcohol only	0.112	0[†]	0.402	0	0.419	0.171	0.009	0.105
3. Cigarettes only	0.089	0	0	0.462	0.334	0.139	0.065	0.097
4. Cigarettes, alcohol	0.197	0	0	0	0.509	0.472	0.019	0.235
5. Cigarettes, alcohol, dagga	0.081	0	0	0	0	1.000	0.000	0.232
6. Cigarettes, alcohol, dagga, inhalants	0.024	0	0	0	0	0	1.000	0.046

[†]Zero probabilities for backwards movement were fixed in this model.

The parameters for both genders indicate a clear pattern of responses with most values close to either 0 or 1, although this is somewhat truer for girls. The exception is the parameter for boys corresponding to the probability of responding "yes" to the inhalants question, conditional on membership in the "Cigarettes, Alcohol, Dagga, and Inhalants" stage (0.56). Measurement properties are weaker for this substance, because of the relatively small proportion of adolescents using inhalants. The pattern of measurement parameters defines the interpretation of the six stages. For example, the alcohol and cigarettes stage is defined by a high likelihood of indicating the onset of use of alcohol and cigarettes and a low likelihood of indicating the onset of dagga and inhalants. In this sample, the overall pattern of measurement parameters is the same for both girls and boys, although the exact values differ. Therefore, the general meaning of the six stages is interpreted to be the same across genders. The six latent stages were interpreted as: no substance use; alcohol use only; cigarette use only; alcohol and cigarette use; cigarette, alcohol, and dagga use; and cigarette, alcohol, dagga, and inhalant use (Tables 3 and 4 report stage prevalence and transition probabilities for girls and boys, respectively). The proportion of the sample in each stage at each time point was freely estimated (see Guo et al., 2000). The transition probabilities capture the probabilities of moving between latent stages from Time 1 to Time 2. For theoretically

impossible transitions (e.g., from alcohol use to no lifetime use), parameters were fixed to 0. For substance use onset, this model implies that adolescents first choose to try either cigarettes or alcohol, then try both cigarettes and alcohol, then try dagga, and then try inhalants.

More girls (49.6% Time 1) than boys (41.4% Time 1) reported trying no substances. Between Time 1 and Time 2, 21% of girls and 13% of boys initiated substance use for the first time (from no use at the beginning of eighth grade.) The probabilities of transitioning between latent stages from Time 1 (beginning of eighth grade) to Time 2 (beginning of ninth grade) are shown in the transition probability matrices (Tables 3 and 4 for girls and boys, respectively). Over time, adolescents initiated use of a greater number of substances. More than half of the girls in the alcohol only and cigarettes only stages transitioned to use of multiple substances; and about half of the boys in the cigarettes and alcohol stage also began using dagga before Time 2. A greater percentage of individuals in the cigarettes only stage, compared to all other stages, transitioned to using all substances between eight and ninth grades.

Table4

Probabilities of stage membership (Time 1) and of stage transition (Time 2) for boys

Stage	Time 1 prevalence	Time 2 transition probability						Time 2 prevalence
		1	2	3	4	5	6	
1. No use	0.414	0.683	0.119	0.102	0.006	0.042	0.049	0.283
2. Alcohol only	0.145	0†	0.549	0	0.227	0.191	0.032	0.129
3. Cigarettes only	0.113	0	0	0.523	0.072	0.265	0.140	0.101
4. Cigarettes, alcohol	0.115	0	0	0	0.513	0.487	0.000	0.103
5. Cigarettes, alcohol, dagga	0.117	0	0	0	0	1.000	0.000	0.248
6. Cigarettes, alcohol, dagga, inhalants	0.097	0	0	0	0	0	1.000	0.137

†Zero probabilities for backwards movement were fixed in this model.

Substance Use Prevalence

The final LTA models also enable conclusions regarding prevalence of substance use to be drawn, by summing the percentage of individuals in the stages characterized by the use of each substance (e.g., for alcohol prevalence, add percentages of participants in the alcohol only; cigarettes and alcohol; cigarettes, alcohol, and dagga; and cigarettes, alcohol, dagga, and inhalants stages). These prevalence estimates are adjusted for measurement error. Lifetime prevalence rates for each of the four substances of interest are shown in Table 5 for girls and boys at Time 1 and Time 2. In eighth grade, more boys had tried alcohol (47%), cigarettes (44%), dagga (21%), and inhalants (10%), than girls (42% alcohol, 39% cigarettes, 11% dagga, 3% inhalants). However, by ninth grade girls had caught up with boys on lifetime use of alcohol (62%) and cigarettes (61% of girls, 59% of boys). Ninth grade boys continued to have greater lifetime prevalence of dagga use (39%) and inhalant use (14%) compared to girls (28% had tried dagga; 5% had tried inhalants).

Discussion

Despite differences in culture, context, and ethnicity, South African youth in the current study evidenced similar substance use initiation patterns to those documented in American

Table 5

Lifetime prevalence rates (percentages) of substance use

Substance	Girls		Boys	
	8th	9th	8th	9th
Alcohol	0.42	0.62	0.47	0.62
Cigarettes	0.39	0.61	0.44	0.59
Dagga	0.11	0.28	0.21	0.39
Inhalants	0.03	0.05	0.10	0.14

research. Adolescents tend to use either alcohol or cigarettes, followed by whichever they have not tried, followed by use of cannabis (dagga). This pattern

held for both boys and girls. The role of inhalants has been less often included in substance use initiation patterns, but results suggest that inhalants are initiated at the most serious level of poly-drug use in the current sample. Adolescents who had tried inhalants had also tried alcohol, cigarettes, and dagga, which suggest that trying inhalants may be a specific indicator of risk for poly- drug experimentation. A similar conclusion has been reported in American research, which has documented the specifically high risk associated with inhalant use during adolescence for subsequent substance use disorders (Bennett, Walters, Miller, and Woodall, 2000; Wu et al., 2005). Future work focusing on the role inhalants play in patterns of initiation of substances is warranted, in both South Africa and the United States.

Substance use prevalence rates in this study were comparable to rates for Colored adolescents in cross-sectional South African studies, although eighth graders in this sample reported slightly higher levels of alcohol and dagga use (Flisher et al., 2002; Flisher, Parry, Evans, Muller, and Lombard, 2003; King et al., 2002). No African comparison study is available for transition probabilities between substance use stages because of the lack of longitudinal research in this area among developing nations. However, transition probabilities are slightly higher in the current model than comparable American models (e.g., Collins, Hyatt, and Graham, 2000), suggesting that South African youth may be on somewhat accelerated substance use trajectories between eighth and ninth grades as compared to adolescents in the United States.

Overall prevalence of substance use among youth in Cape Town was similar to or higher than the nationally representative Monitoring the Future (MTF) American sample (Johnston, O'Malley, Bachman, and Schulenberg, 2005) and levels of nonuse of substances in the current study were similar to American samples of 14- and 15-year olds (see Collins et al., 2000). MTF reports that 44.5% (43.1%) of American girls (boys) have used alcohol, 27.9% (27.4%) have used cigarettes, 14.9% (17.6%) have used cannabis, and 18.0% (16.7%) have used inhalants. There were exceptions to the similarity in prevalence rates. South African adolescents were more likely than American adolescents to report trying cigarettes, but less likely than American adolescents to have tried cannabis or inhalants by eighth grade. Gender discrepancies in substance use were more pronounced among South African youth, with boys on average reporting higher

levels of use than girls for alcohol, dagga (cannabis), and inhalants.

Cigarettes as a "Gateway Drug"

The group that was most likely to try all substances by the beginning of ninth grade was comprised of individuals who began substance use by smoking cigarettes. However, alcohol was the more common first substance initiated among participants in the current study, suggesting that the cigarette initiators may be an at-risk minority of adolescents (Graham et al., 1991; Newcomb and Bentler, 1986). In this sample, more adolescents reported having tried only alcohol than reported having tried only cigarettes, which is consistent with previous American and South African reports (Flisher et al., 2003; Newcomb and Bentler, 1986; Parry et al., 2004; Resnick et al., 1997). Youth who were using cigarettes only were most likely to transition to trying all substances. These findings echo results by Graham et al. (1991) and Collins et al. (2000) indicating that students who had tried only tobacco and not alcohol moved through the stages faster and were less affected by a prevention program. Previous research speaks to the ambiguity of the roles that cigarettes and alcohol may play in the progression of substance use. Newcomb and Bentler's (1986) suggestion that cigarettes may play a prominent role as a gateway substance to cannabis and "hard drug" use, whereas alcohol use may be a more stable behavior unto itself, is supported in the current sample for boys. However, girls who had only tried alcohol at the beginning of eighth grade where just as likely as girls who had only tried cigarettes to transition to cigarette, alcohol, and dagga use by ninth grade.

The LTA Approach to Studying Substance Use Onset

LTA is particularly appropriate for modeling a process like the initiation of substance use, which is complex, dynamic, and multidimensional. LTA does not make any linearity assumptions about relations between substances within or between times or about the onset process itself across times. It also allows for multidimensionality in the phenomenon studied; in fact, this is a defining characteristic of latent class and latent transition models. In the present study, the onset process involves several substances and the LTA model allows individuals to exhibit different onset paths through the substances. For example, some individuals start the onset process with alcohol whereas others start it with tobacco. The current is designed to describe the order and rate at individuals first try a substance; in other words, as described above, this model

uses lifetime substance use variables as indicators. Such a model is less complex than one modeling current substance use. An LTA model of current substance use would include additional parameters representing the probability of moving "backwards" from a use to a no use category. In order to be an accurate representation of variations in current substance use, such a model would ideally be based on more frequently measured variables than were available in the present study.

Study's Limitations and Future Directions

This study utilizes self-report measures of lifetime substance use at two time points. Adolescent participants were only 15 years of age by Time 2, so we have captured an early stage of substance use onset, which is reflected in the relatively low prevalence of reported dagga and inhalant use. Because these substances appear to follow use of alcohol and cigarettes, the participants will likely continue to report increased use of dagga and inhalants in future data collection waves. Future work on this and other samples will enable study of continued initiation of substance use as adolescents move into young adulthood. Future work will also utilize additional measures of substance use added at later waves, including metham- phetamine ("tik") use. In addition, the current models focus on onset with measures of lifetime use. Analyzing measures of past 30-day use would allow investigators to distinguish between experimental or one-time use and more problematic levels of substance use. An individual who has tried a substance may have only experimented with alcohol or drugs without transitioning into more regular use, and thus may no longer be at risk for addiction or other associated negative consequences.

The results reported here suggest that adolescents in this South African sample follow a similar progression of substance use to reported trajectories among American youth. This indicated that models of substance use transitions from American samples may be appropriately adapted for descriptive and analytical use in African research. Understanding the characteristics of adolescent substance use over time can inform prevention and intervention efforts, for example, by identifying youth at risk for serious drug use from early substance use involvement. In addition, the relative similarity of patterns in the United States and South Africa supports efforts at adapting interventions from America to the African context. A clearer understanding of the role of cigarettes and alcohol as gateway substances is necessary for early intervention efforts to

decrease illicit drug use. These results suggest that preventing early initiation of cigarette and alcohol use, in particular, may help decrease the prevalence of multiple substance use among South African youth.

Conclusions

The importance of cigarettes and alcohol as posited "gateway drugs,"[1] revealed in research based on samples in the United States, appears to generalize to the current sample. In the African context, despite notable cultural, racial, and contextual differences from American research, similar patterns of substance use initiation emerged. As compared to adolescents in the United States, South African adolescents appear to experience accelerated transitions of substance use, indicating that preventive intervention is vital. It may be beneficial to target selective drug prevention efforts at individuals who initiate tobacco use early and quickly transition to multiple substance use. The evidence of developmental similarity between contexts supports the promise of adapting American prevention and intervention programs to the African continent.

Glossary

Gateway theory: A theory of adolescent substance use that states individuals tend to initiate substance use with alcohol and/or cigarettes before using other drugs.

Prospective longitudinal study: A study in which data collected at multiple time points are used to describe a phenomenon.

Latent transition analysis: A statistical method for testing stage-sequential developmental models.

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