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Research Article

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Delinquency Behaviors and Substance Use of Youth Exposed to the keepin' it REAL Substance Use Prevention Program

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Abstract

Introduction: Guided by problem behavior theory, this study examined the clustering of substance use and delinquency among early adolescents. Using longitudinal data, we also examined the effects of the Social and Emotional Learning (SEL)-based intervention keepin' it REAL (kiR) on class membership and transitions over time. **Methods**: A total of 3,921 seventh graders (51% male) participated in a randomized clinical trial conducted in the Midwest and middle Atlantic regions of the U.S. We assessed past-month substance use and past-year delinquency at baseline (beginning of 7th grade) and 2 follow-up periods (end of 8th and 9th grades). **Results**: Latent transition analysis identified four statuses across control and treatment conditions: Mild-Moderate Delinquency Behavior (MDB), Polysubstance Use + Moderate-Severe Delinquency Behaviors (PDB), Alcohol Use (AU), and No Risk (NR). Youth in the PDB status at Time 1 receiving the kiR intervention were more likely to transition to the NR status at Time 3 compared with the same status in the control condition. Furthermore, youth in the AU status at Time 3 exposed to kiR were less likely to transition to the PDB status at Time 4 compared with the same status in the control condition. **Conclusion**: Youth may benefit from exposure to SEL programs, such as kiR, which shows promise for reducing dual presenting problems (polysubstance use and delinquency) among higher-risk early adolescents (the PDB status). Further research should explore why and how kiR influences certain status at different time points.

Keywords: Latent transition analysis; Adolescent; Substance use; Prevention; Delinquency

Introduction

Prevention science has advanced to the point where ample evidence-based substance use prevention programs are available [1]. What is less developed is the science explaining how they work and for whom [2]. This explanation requires studies of co-occurrence, developmental processes, and subgroup analyses. In this paper, we explore subgroups based on risk status derived from adolescent substance use and delinquency as behaviors are often linked to one another [3-5]. While research has revealed a distinction between adolescent-limited delinquency and life-course delinquency [6], any delinquent tendencies in adolescence deserve attention and appropriate remediation in order to curtail the escalation of more serious deviance [7].

Recently, prevention researchers [3-5] explored how substance use and delinquency jointly comprise risk subgroups as well as how various risk subgroups change over time. Delinquency covers a broad range of behaviors, ranging from major antisocial acts to minor crimes, from aggressive and violent behavior to non-violent delinquency [8]. Findings from these studies support the importance of understanding the co-development of substance use and delinquency behaviors to advance both theory and practice. Yet little research has explored how subgroups with risky behaviors change over time in the prevention context. To fill this gap, this

study applies Jessor's [9,10] problem behavior theory to identify risk subgroups of youth based on substance use and delinquency behaviors and tests Jessor's [10] construct of transition proneness by comparing youths receiving and not receiving the intervention program keepin' it REAL (kiR).

Adolescent Substance Use and Delinquency

Adolescent substance use [11] and delinquency [8] continue to be major public health concerns in the United States [12,13]. While evidence suggests they are related [14,15], some studies show that substance use increases the risk of aggressive behavior [14], whereas others suggest the opposite directional causality, namely, that aggressive behaviors may precede the onset of substance use [15], and that a history of recurrent, problematic, impulsive aggression is a risk factor for the later development of substance use, rather than the reverse. Clearly, this relationship is exceedingly complex and moderated by a host of factors that may (and often do) change in unexpected ways over time [16,17]. As a result, more research with a developmental focus is needed to clarify the ways these behaviors cluster together and reconfigure over time.

Problem behavior theory [9,10] helps us understand this challenge through proposing that risky behaviors in youth are related to one another because they stem from shared common factors. Studies in the U.S. [3,4] and Sweden [5] using advanced longitudinal cluster-analyses identified different subgroups engaging in these behaviors. These subgroups can be characterized as "no risk," "single problem behavior," and "co-occurring substance use and delinquency." The studies also examined whether youth in different subgroups transitioned to other subgroups over time. In general, members of the no risk and co-occurrence subgroups had higher probabilities to stay in the same subgroup across time compared with those in single behavior subgroups [3-5], suggesting that knowing an individual's subgroup can help predict the likelihood of group membership maintenance vs. group membership change. Jessor [10] has referenced this idea as transition proneness, defining it as a "differential adolescent readiness" (p. 7) to initiate new behaviors, marking a change in developmental status. This developmental perspective has been born out in studies of transitional proneness from individuals who do and do not have sex [18] and from those who do and do not drink [19], but few studies have examined the transition of a larger constellation of behaviors across time; moreover, little is known about the extent to which interventions might impact this transitional proneness, and whether the effect of those interventions differs depending on one's risk subgroup.

Social Emotional Learning Interventions and their Impact on Risk Subgroups

It is useful to examine whether intervention programs encourage movement from higher to lower risk subgroups across time, such as Social and Emotional Learning (SEL) interventions that promote growth in positive behaviors and inhibit development of negative behaviors. Social and emotional skills are critical to healthy development and reduce risk behaviors [20]. Evidence suggests that SEL interventions impact both conduct problems [21,22] and substance use [20,23]. Social and emotional curricula encourage youth to acquire and effectively apply skills including but not restricted to emotion management, setting and achieving positive goals, feeling and showing empathy for others, establishing and maintaining positive relationships, and making responsible decisions [24]. A meta-analysis of SEL interventions evaluations revealed statistically significant increases in social-emotional skills and fewer conduct problems, emotional distress, and substance use [20,25]. However, the question remains whether these programs extend to subgroups of youth that may vary in their levels of risk. This study uses the SEL-based keepin' it REAL (kiR) program to better understand its impact on participants' risk subgroup memberships.

"keepin' it REAL" Intervention

keepin' it REAL (kiR) is a multicultural middle school curriculum based on SEL [26] and Narrative Engagement Theory (NET) [27]. kiR promotes the development of social and emotional competencies using NET, which argues that narrative health messages offer advantages over other message forms (e.g., didactic/informational), particularly when trying to reach low awareness and/or message-resistance audiences [27]. Narratives that engage an audience through the qualities of interest, realism, and identification provide cognitive and behavioral models of healthy behaviors that "re-story" or change the narrative about unhealthy but potentially favorably perceived behaviors such as substance use.

Based on NET, program developers of kiR identified youth narratives about drugs, drug use, and drug offers from years of research into substance use offer resistance processes [28]. This research shaped the development of the curriculum and provided content for examples, classroom activities, and narrative videos modeling effective resistance strategies to promote social and emotional competencies. Based on SEL, kiR teaches youth to identify risks and consequences, develop decision making skills, identify sources of social support, and promote anti-drug norms. kiR was found to be effective in reducing substance use in several group randomized trials [29,30]. kiR produced significant effects on overall substance use in an urban, multi-ethnic middle school sample [30] and a culturally-adapted version for rural middle schools also provided evidence of effectiveness [31]. For further description of the adaptation processes see Appendix A. In this study we utilized data from the rural middle school project to identify subgroups regarding substance use and delinquency as well as kiR's effects on subgroups transitions and membership. The following research questions were posed:

RQ1: Are there discrete subgroups of individuals based on their patterns of substance use and delinquent behaviors?

RQ2: Do the transition probabilities and memberships in subgroups differ between youth receiving kiR and youth not receiving kiR?

Methods

Study Procedure and Participants

The initial recruitment involved 60 rural middle schools from Pennsylvania and Ohio of which 39 agreed to participate with 14 assigned to the control condition, 11 to the kiR original curriculum condition, and 14 to the kiR rural curriculum condition [32] (for more details see second author's paper [31] for Consort Flow Diagram). Thirty-two teachers in both treatment conditions received curriculum materials and in-person training before they delivered the intervention as a part of the regular curriculum.

We obtained passive parental consent and active student assent for all three years of the study. One month prior to each survey administration parents were sent a message from the school notifying them that surveys would be administered to their students as a part of implementing their substance use prevention curriculum and providing contact information as well as a form to submit if they did not want their student to participate in the survey. Students whose parents did not consent were provided with an alternative task during the survey administration. Students with parent consent were asked to assent to survey participation before survey administration. All students who were present in class during survey administration provided assent. Students were then administered paper-and-pencil surveys in the fall of 2009 (T1: 7th grade; pretest), in spring of 2010 (T2: 7th grade; 11 weeks after the pretest), spring of 2011 (T3: 8th grade; 12 months after immediate posttest) and again in the spring of 2012 (T4: 9th grade; 24 months after immediate posttest). The intervention was implemented within 3 days of the pretest. Students in the treatment received the curricula over a 10-week period (1 lesson per week; 30-40 min/lesson) delivered by trained teachers. Students in the control group schools received no program. Data from T2 were not analyzed because it was an immediate posttest. We received approval from a university institutional review board before initiating the study.

A total of 3,921 students participated in the study. At baseline, all students reported themselves as 7th graders (mean age of 12.31, SD = 0.50). The sample was 51% male and 49% female. Consistent with their rural communities, the majority reported themselves as white (79.1%), with the remaining reporting being Hispanic (2.2%), Asian or Pacific Islander (0.4%), African American (1.6%), Native American (1.6%), mixed (1.4%), and not reported (13.7%). Control consisted of 1,362 students (35%), 919 students (23%) were in kiR, and 1,640 students (42%) in kiR rural.

Measures

Past-month substance use (Latent Class/Transition Analysis Indicators; T1, 3 & 4). Guided by a previous school-based intervention study [33], we measured the amount of alcohol, cigarettes, marijuana, and chewing tobacco used in the past-30 days with nine response options for alcohol (1 = None. I have never had even one sip of alcohol ~ 9 = More than 30 drinks), with eight response options for cigarettes (1 = None, I have never even had one puff ~ 8 = More than 2 packs of cigarettes) and for marijuana (1 = None ~ 8 = More than 40 times), and seven response options for chewing tobacco (1 = None ~ 7 = More than 30 times). We created binary variables (e.g., alcohol use: Yes vs. No) for each substance because of skewness.

Past-year delinquency (Latent Class/Transition Analysis Indicators; T1, 3 & 4). Participants reported their past-year delinquency behavior using three items from the antisocial behaviors questionnaire [34,35]. The items included "In the past year (12 months) have you stolen anything that did not belong to you?/destroyed anything on purpose which did not belong to you?/been in a physical fight?" using three response options (1 = never, 2 = yes, once, 3 = yes more than once).

Analytical Plan

We performed a 3 step Latent Transition Analysis (LTA) [36] using Mplus 7.4 [37], requiring three sequential steps: identifying the measurement model including measurement invariance, estimating measurement errors at each time point using the measurement model in step 1, and estimating transition probabilities by considering measurement errors in step 2.

Step one: We developed a measurement model by estimating latent status with seven indicators (i.e., monthly alcohol, cigarette, marijuana, chewing tobacco, yearly theft, damage, and physical fight) at each time point with assumption of measurement invariance but not estimating transition probabilities in the analysis. To find the optimal number of statuses, several statistical indicators were considered: Akaike information criterion (AIC) [38], Bayesian Information Criterion (BIC) [39], and entropy [40]. Lower values of AIC and BIC indicate a better model fit. Entropy is an indicator of quality of class classification (range: 0-1), with the higher value indicating better class separation. Also, we considered the theoretical interpretation, indicating that k statuses provided additional and meaningful statuses compared with k-1 statuses across time. All criteria were considered in determining the optimal number of statuses.

The measurement invariance assumption was tested by comparing a model with restricted item response probabilities across time points (BIC= 47802.25) with another model (BIC=57556.26) with unrestricted item response probabilities across time points.

The smaller BIC of model 1 led us to conclude that our assumption was met.

After identifying the number of statuses in the measurement model with measurement invariance, we tested whether both curriculum groups (e.g., kiR rural and kiR original) would have the equivalent "composition" of k statuses in a measurement model. We compared model A (BIC=34107.52) with restricted item response probabilities between these two curriculums (e.g., kiR rural and kiR original) with model B (BIC=34326.85) with unrestricted item response probabilities between two curriculums. We concluded that "composition" in k statuses in both curriculum groups were equivalent given the lower BIC. Based on this information we combined the two curricula conditions into one "treatment condition" for a more easily interpreted LTA model.

We also tested whether the "composition" (configuration) of the k statuses remained equivalent between the experimental conditions (e.g., combining two curriculum conditions: "treatment" thereafter and control) in a measurement model. We restricted item response probabilities between the experimental conditions (e.g., treatment and control). We compared BIC in this model (BIC=52677.77) with the model of unrestricted item-response probabilities between the experimental conditions in the measurement model (BIC=52943.06) and concluded that "composition" in k statuses in each experimental condition was equivalent because of a smaller BIC. Thus, we concluded that the final measurement model had equivalent "composition" at k statuses for each condition (i.e., control vs treatment) and time.

Step two: We ran a LCA with k classes at each time point to produce the most likely class variables and classification errors at each time point using latent class posterior distribution obtained in the results of the final measurement model (e.g., k statuses with measurement invariance). We fixed measurement parameters using estimated values of the final measurement model. We also calculated the log ratios from classification errors tables for the most likely class at each time point to prepare for the mode in the step 3.

Step three: We used the most likely class variable at each time point in the second step as latent statuses indicators for each time point with parameters fixed at the log ratios. We estimated transition probabilities and class membership difference by including experimental conditions as a covariate (0 = control vs 1 = treatment) to answer RQ2 (read these to learn more about LTA with covariates [37,41]. The least risky behavior group (e.g., No Risk) served as the reference group (i.e., testing significant transition probabilities and class membership difference between control and treatment) in a series of multinominal regressions (IV: experimental conditions) to answer RQ2. Because LTA estimates transition probabilities at a specific time (t) given their status at a prior time (t-1), we did not control prior transition probabilities from T1 to T2 when we employed a series of multinominal regression. We removed 28 youth (12 students in the control and 16 students in the treatment) because they did not provide any information on the variables of interest (e.g., past-month alcohol, past-year fight) across time. These 28 youth were not significantly different from remaining sample in terms of gender, age, and study condition but these 28 youth were less likely to be White (54%) compared with remaining sample (White:79%; χ (1)=11.10, p<.001). We employed a full information maximum likelihood (FIML) procedure to deal with missing data [42]. We also controlled for clustering at the school level with the command "complex" and "cluster" in the analysis, which adjusts the standard errors using a sandwich estimator [37]. Examination of pretest equivalence showed no significant differences in past-month substance use and past-year adolescent delinquency tendencies between control and treatment at baseline at $p < .05$. We noted that gender and age were not significantly different between two conditions although more people in the control (83%) reported themselves as White than did those in the treatment (77%, χ (1)=16.22, p<.001). Youths reported at least one lifetime experience on alcohol (24%), cigarette (12%), marijuana (2%), and chewing tobacco (10%). Despite no significant differences about most lifetime history of substance use in experimental conditions, youths in the control had slightly higher reports on lifetime chewing tobacco (11%) compared with those in the treatment (9%; χ(1)=7.15, p=.008).

Attrition Analysis

Participants who completed the surveys at Time 3 and Time 4 were significantly different in terms of substance use and delinquency from participants present only at baseline. Youths who used alcohol (χ (1)=4.83, p=.03), cigarettes (χ (1)=17.21, p<.001), marijuana (χ (1)=7.08, p=.008); destroyed something (χ (2)=9.48, p=0.009); or were involved in a physical fight (χ (2)=22.42, p<.001) at baseline were more likely to attrite from the study at Time 3. Youths who used alcohol (χ(1)=15.37, p<.001), cigarettes (χ (1)=26.84, p<.001), marijuana (χ (1)=19.69, p<.001), chewing tobacco (χ (1)=8.64, p=.003); destroyed something (χ (2)=21.85, p<.001); or were involved in a physical fight (χ (2) = 69.31, p<.001) at baseline were more likely to attrite from the study at Time 4.

Results

The number of participants reporting past-month substance use increased over time, while the overall trend in past-year adolescent delinquency tendencies varied (See Table 1).

Risky behaviors*	Baseline (T1)	Time 3 (appx. 1.5 year follow-up)	Time 4 (appx. 2.5 year follow-up)
	n (%)	n (%)	n (%)
Monthly alcohol use			
No	3085 (94.00)	2197 (81.98)	2453 (77.26)
Yes	197 (6.00)	483 (18.02)	722 (22.74)
Monthly Cigarette use			
No	3188 (96.81)	2409 (89.75)	2718 (85.66)
Yes	105 (3.19)	275 (10.25)	455 (14.34)
Monthly Marijuana use			
No	3265 (99.15)	2548 (94.93)	2877 (90.84)
Yes	28 (0.85)	136 (5.07)	290 (9.16)
Monthly Chewing tobacco use			
No	3180 (96.69)	2465 (91.91)	2856 (89.90)
Yes	109 (3.31)	217 (8.09)	321 (10.10)
Yearly experience to stole anything			
No	2840 (86.88)	2249 (83.82)	2677 (84.29)
Once	313 (9.57)	245 (9.13)	284 (8.94)
More than once	116 (3.55)	189 (7.04)	215 (6.77)
Yearly experience to destroy anything			
No	2784 (84.75)	2214 (82.37)	2623 (82.56)
Once	358 (10.90)	278 (10.34)	305 (9.60)
More than once	143 (4.35)	196 (7.29)	249 (7.84)
Yearly a physical fight			
No	2327 (70.79)	1984 (73.84)	2380 (74.82)
Once	555 (16.88)	428 (15.93)	495 (15.56)
More than once	405 (12.32)	275 (10.23)	306 (9.62)
Note: *There were no significant differences in risky behaviors between control and treatment at baseline at p-value, 0.05.			

Table 1: Frequency and Percentages of Substance use and Externalizing Behaviors across Time.

Substance Use and Delinquency Behaviors Status

Table 2 contains the model fit indices for the measurement model. Although the measurement model with 5 statuses had a smaller BIC, it had lower entropy (.614). Also, in the 5-status measurement model, one status had very low prevalence rendering it uninterpretable in a series of further analyses (e.g., <1 % in overall sample).

Model	Log Likelihood	df	AIC	BIC	adj BIC	Entropy
2 classes	-24518.98	23	49083.95	49228.10	49155.01	0.72
3 classes	-23996.56	36	48065.12	48290.73	48176.33	0.72
4 classes	-23698.58	49	47495.17	47802.25	47646.55	0.71
5 classes	-23569.39	62	47262.78	47651.33	47454.33	0.61
6 class	Not identified					

Note: Model selection was performed before we compared with control and treatment only model. That is, these fit statistics refer to an unconstrained model regarding experimental condition in LCA.
Df: Degree of freedom, AIC: Akaike Information Criterion, BIC: Bayesian Information Criterion

Table 2: Measurement Model Fit indices.

As a result, we selected the more parsimonious 4-status measurement model, labeling these: 1) Mild-Moderate Delinquency Behaviors (MDB), 2) Alcohol Use (AU), 3) Polysubstance + Moderate-Severe Delinquency Behaviors (PDB), and 4) No Risk (NR).

Table 3 contains the item response probabilities for each status. Youths in the MDB status reflected the lowest probability of using any substance but reflected moderate probabilities for delinquency behaviors. Youths in the AU status had relatively moderate probabilities of using alcohol within the past month, but relatively moderate probabilities of not using cigarette, marijuana and chewing tobacco in the past month. AU had relatively high probabilities of reporting in "never" engaging in delinquency behaviors in the past year. Youths in the PDB status had the highest probabilities across all five substances used and lowest in reporting "never" on delinquency. Youths in the NR status had the lowest item probabilities across all risky behaviors.

	Mild-moderate Delinquency behavior	Alcohol Use	Polysubstance + moderate-severe Delinquency Behavior	No Risk
Estimated Prevalence (%) Time 1				
Control	171 (12.67)	17 (1.26)	10 (0.74)	1152 (85.33)
Treatment	331 (13.02)	31 (1.22)	29 (1.14)	2152 (84.62)
Time 3				
Control	95 (7.04)	125 (9.26)	46 (3.41)	1084 (80.30)
Treatment	213 (8.38)	190 (7.47)	73 (2.87)	2067 (81.28)
Time 4				
Control	81 (6.00)	254 (18.81)	75 (5.56)	940 (69.63)
Treatment	177 (6.96)	387 (15.22)	142 (5.58)	1837 (72.24)
Item-response probabilities				
Monthly Alcohol use				
No	.83	.40	.20	.96
Yes	.17	.60	.80	.05

Monthly Cigarette use				
No	.96	.53	.25	1.00
Yes	.04	.47	.75	.00
Monthly Marijuana use				
No	.99	.79	.33	1.00
Yes	.01	.21	.61	.00
Monthly Chewing				
tobacco use				
No	.95	.65	.54	.99
Yes	.05	.35	.46	.01
Yearly theft				
Never	.47	.85	.20	.96
Once	.33	.14	.21	.04
More than once	.20	.02	.60	.01
Yearly damage				
No	.29	.87	.12	.96
Once	.43	.13	.20	.04
More than once	.29	.00	.68	.00
Yearly physical fight				
No	.35	.53	.22	.86
Once	.32	.31	.24	.11
More than once	.33	.16	.55	.04

Note: Sample size for the control condition was 1,350 and sample size for the treatment condition was 2,543 across three time points. Due to rounding up, item probabilities within each indicator can be larger or less than 1.

Table 3: Estimated Prevalence and Item Response Probabilities for Three Time Points.

Prevalence and Class membership as Function of Experimental Condition

NR status youths had the highest baseline prevalence in both the control and in the treatment (Table 3). Youths in the experimental condition (e.g., treatment vs control) were not significantly associated with being in PDB, MDB, and MP status groups compared with NR status across times. NR was a reference group in a series of multinominal regressions to explore the association between experimental condition and class membership.

At baseline, the prevalence of the rest of three statuses in the control and treatment was similar. The second largest prevalence at this time point was MDB in both control and treatment. AU had the second lowest prevalence in both control and treatment. The lowest prevalence was PEB in both control and treatment. The odds of being in the MDB (b=0.04, SE=.19, p=.85, OR=1.04), AU (b=-0.02, SE=.62, p=.97, OR=0.98), and PDB (b=0.42, SE=.46, p=.35, OR=1.52) relative to the NR were not significantly different between control and treatment.

At Time 3, the second largest prevalence at this time point was MDB and the second lowest prevalence was AU in treatment. Yet the second largest prevalence in control was MDB and the second lowest prevalence was AU. The lowest prevalence at Time3 was PDB in both control and treatment. The odds of being

in the MDB (b=0.22, SE=0.32, p=.50, OR=1.25), AU (b=-0.27, SE=0.40, p=.50), OR=0.76), and PDB (b=-0.69, SE=.79, p=.38, OR=0.50) relative to the NR were not significantly different between control and treatment.

At Time 4, AU was the second largest status both in the control and treatment. MDB was the second lowest status in control and treatment. The PDB had the lowest prevalence in control and treatment. The odds of being in the MDB (b=0.05, SE=0.20, p=.79, OR=1.05), AU (b=-0.19, SE=.18, p=.28, OR=0.83), and PDB (b=0.04, SE=.19, p=.85, OR=1.04) relative to the NR were not significantly different between control and treatment.

Transition of Latent Substance Use and Delinquency Behaviors Status

Table 4 contains transition probabilities for each condition.

Control transition probabilities. At Time 1, youths in MDB (.41) and AU (.46) were more likely to move to NR at Time 3 than stay in the same MDB (.25) or AU (.37), respectively. Youths in the PDB at Time 1 were more likely to move to AU (.46) than stay in the same status (.39) at Time 3. Youths in the NR at Time 1 were more likely to stay in the same status at Time 3.

Youths in the MDB (.33) at Time 3 were more likely to move to NR at Time 4 than they were to remain in the MDB (.31). Youths in the AU were more likely to stay in the same status at Time 4 (.68). When AU youth transitioned, they were more likely to move to the PDB (.18). Also, youths in the PDB at Time 3 were more likely to stay in the same status at Time 4 (.43). When they transitioned, they were more likely to move to NR (.30) at Time 4. Youths in the NR at Time 3 were more likely to stay in the same status at Time 4.

Time 3								
Time 1	Control				Treatment			
	MDB	AU	PDB	NR	MDB	AU	PDB	NR
MDB	.25	.21	.13	.41	.28	.14	.13	.45
AU	.00ǂ	.37	.18	.46	.00ǂ	.93	.02	.05
PDB	.00ǂ	.46	.39	.14	.00ǂ	.03	.41	.57
NR	.05	.07	.02	.87	.06	.05	.01	.88
Time 4								
Time 3	Control				Treatment			
	MDB	AU	PDB	NR	MDB	AU	PDB	NR
MDB	.31	.21	.16	.33	.35	.15	.01	.40
AU	.00ǂ	.68	.18	.14	.07	.67	.06	.20
PDB	.00ǂ	.27	.43	.30	.03	.12	.55	.30
NR	.05	.13	.02	.81	.04	.11	.03	.82

Note. MDB: Mild-moderate Delinquency Behavior; PDB: Polysubstance + moderate-severe Delinquency Behavior; AU: Alcohol Use; NR: No Risk. Ref: Reference. ǂ transition probabilities are fixed as 0 because of empty jointed cells. Due to rounding up, sum of transition probabilities each raw in each experimental condition can be larger or less than 1.

Table 4: Transition Probabilities among Latent Statuses (e.g., subgroups).

Treatment transition probabilities. At Time 1 treatment youth in the MDB (.45) were more likely to move to NR at Time 3 than they were to remain in MDP (.28). Youths in the AU at Time 1 were more likely to remain in the same status (.93) at Time 3. When they moved, they were more likely to move to the NR (.05). Youth in the PDB at Time 1 were more likely to move to NR (.57) than remain in the same status (.41) at Time 3. Finally, youths in the NR at Time 1 were more likely to remain in the same status at Time 3.

Youths in the MDB (.40) at Time 3 were more likely to move to NR at Time 4 than they were to remain in MDB (.35). Youths in the AU were more likely to remain in AU at Time 4 (.67). When they transitioned, they were more likely to move to NR (.20). Also, youths in the PDB at Time 3 were more likely to remain in PDB at Time 4 (.55). When they transitioned, they were more likely to move to NR (.30) at Time 4. Youths in the NR at Time 3 were more likely to remain in NR at Time 4.

Comparison transition probabilities between control and treatment

Two different transition probabilities between control and treatment were significantly different (See Table 5). First, PDB youth in the control group were less likely than the PDB youth in treatment to transition from Time 1 to Time 3 to AU, compared with the transition they made to NR between Time 1 to Time 3 (OR=.02, p<.001). Second, AU youth in the treatment group were less likely to than AU youth in control to transition from Time 3 to Time 4 to PDB, compared with the transition they made to NR between Time 3 and Time 4 (OR=.23, p<.001), implying that the kiR may prevent youth who use alcohol at Time 3 from escalating into polysubstance use along with moderate-severe delinquency behavior at Time 4.

Time 3				
	MDB	AU	PDB	NR
Given each status at Time 1	OR (SE)	OR (SE)	OR (SE)	
MDB	1.01(0.53)	0.63(0.36)	0.98(0.56)	ref
AU	-	26.19(111.52)	1.29(5.95)	ref
PDB	-	0.02(0.05)***	0.26(0.48)	ref
NR	1.25 (0.41)	0.76(0.31)	0.50(0.40)	ref
Time 4				
	MDB	AU	PDB	NR
Given each status at Time 3	OR (SE)	OR (SE)	OR (SE)	
MDB	0.94(0.58)	0.59(0.41)	0.49(0.29)	ref
AU	-	0.70(0.62)	0.23(0.22)***	ref
PDB	-	0.46(0.51)	1.31(0.78)	ref
NR	0.86(0.24)	0.83(0.17)	2.06(0.91)	ref

Note. MDB: Mild-moderate Delinquency Behavior; PDB: Polysubstance + moderate-severe Delinquency Behavior; AU: Alcohol Use; NR: No Risk. Ref: Reference. Transition probabilities from AU to MDB and PDB to MDB are fixed as 0 because of empty jointed cells in conditions, we could not test. We used multinominal regressions to test transition probabilities between two conditions (0=control vs 1=treatment). ***<.001

Table 5: Significant -Testing for Transition Probability between Two Conditions.

Discussion

The findings of this study extend prior research by identifying risk statuses based on combinations of substance use and delinquency. The study also provides a different perspective by using Jessor's [9,10] problem behavior theory, thereby extending its utility with a developmental focus on transition proneness. These findings suggest that transition proneness differs by subgroups and may guide intervention efforts toward a more tailored approach. Finally, the paper explores the effects of a prevention intervention, keepin' it REAL, on those transitions, thereby illustrating an innovative approach to evaluation.

We identified four discrete behavioral subgroups among young adolescents at baseline (e.g., early 7th grade) and Times 3 and 4 (e.g., end of 8th and 9th grades) based on indicators of substance use and delinquency. The findings echo previous LTA studies exploring the co-occurrence of substance use and delinquency behaviors that identified "Abstainer" (e.g., no engagement in risk behaviors), "Co-occurring" or "Regular-all" (e.g., engaging in both substance use and externalizing behaviors), and "Occasional law-breakers" or "Primary Delinquent" or "Delinquent-only" (e.g., low probabilities of substance use) [3-5]. The subgroups NR, PDB, and MDB are consistent with these findings. Given that Turner et al. identified "Dabblers" (e.g., moderate item-response probabilities on frequency on drunkenness and on infrequency on criminality), the AU status is somewhat consistent with previous findings.

Other findings speak to the general development of adolescent risk behaviors. The prevalence of youth in the AU subgroup increased over time, while those in MDB decreased. This trend is consistent with other developmental literature reflecting an increase of substance use as youth age into middle adolescence [43] with a decrease in aggressive behavior [44]. When early adolescents become more cognitively and emotionally mature, they are more likely to engage in problem solving approaches instead of delinquency to cope with stressors [45,46]. Research suggests that aggression diminishes in middle childhood and may be replaced by substance use [47,48].

This study provides empirical evidence of Jessor's [10] transition proneness among the co-occurring behaviors of delinquency and substance use. Jessor's [10] construct of transition proneness clarifies which adolescents are likely to engage in age-graded, norm-departing, transition-marking behaviors. Guided by this construct, as well as by evidence from past research on cascading effects [49], where difficulties in one domain (e.g., aggression) contribute to subsequent difficulties in another domain (e.g., substance use), the PDB subgroup within our sample was most at-risk. Future research should examine this readiness, or openness, to change among a broader population and with additional indicators of risk (e.g., internalizing behaviors).

This study suggests an innovative approach to understanding intervention effects by examining effects on transitional probabilities of risk group membership. Comparison of transition probabilities explores that in response to the kiR intervention, participants shifted their risk statuses to a less risky subgroup. The transition probability from PDB at Time 1 to NR at Time 3 in the treatment was larger than the transition probability from PDB to NR in the control, implying that kiR increased the probability of transitioning to NR. Youth at-risk benefit from exposure to an SEL program such as kiR, which shows promise for reducing dual presenting problems among higher-risk early adolescents (the PDB group). Also, the transition probability from AU at Time 3 to PDB at Time 4 in control and transition probability from the same path in the treatment were significantly different. Youth in the AU subgroup at Time 3 exposed to kiR were less likely to move to the PDB subgroup compared with those in the same status in the control. In other words, participation in the kiR intervention decreased the probability of AU youth moving to the higher risk profile.

These results suggest that the kiR intervention is a promising program, not only because it prevents substance use in early adolescents, as previously shown [30], but also may deter other risky delinquency behaviors [50], particularly among the higher risk subgroups. Further research with greater power to detect statistically significant differences is needed. Why and how the intervention influences certain subgroups at different time points should also be considered for research.

Limitations

Findings from this study should be carefully interpreted, given several limitations. First, our interpretations of how the kiR intervention influenced transition probabilities must be tentative because we could not rule out other possible confounding influences. Second, our sample was from rural middle schools and our findings may not be generalizable beyond rural populations in the US. Third, attrition analysis revealed that, as is typical, youth with more substance use and delinquency behavior at baseline were less likely to complete the surveys across time, although the difference between the number of youths engaging in substance use and delinquency behavior at baseline and the number of youths who did not complete follow-up surveys is small (e.g., <5%). Fourth, conclusions were based on small differences in prevalence and transitions so findings should be interpreted with caution. Also, low prevalence in PDB at baseline should be considered when interpreting these findings. Fifth, our statuses were based on chosen indicators, some of which were converted into binary measures because indicators were highly skewed. Finally, we did not include all delinquency behaviors items, nor other forms of externalizing behaviors, in the analysis.

Conclusion

Guided by Jessor's problem behavior theory, we identified four different types of adolescent statuses based on substance use and delinquency behavior as well as their transition proneness. SEL programs such as kiR may reduce dual presenting problems among higher-risk early adolescents.

Declaration of Conflicting Interests

The lead author, Hye Jeong Choi, has no conflicting interests and Drs. Hecht and Miller-Day own the copyright to the keepin' it REAL intervention. Dr. Pezalla has no conflicting interests.

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