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Prediction of Cannabis Use Disorder between Boyhood and Young Adulthood:

Clarifying the Phenotype and Environment

Levent Kirisci, PhD, Ralph Tarter, PhD, Ada Mezzich, PhD, Ty Ridenour, PhD, Maureen Reynolds, PhD, and Michael Vanyukov, PhD

Center for Education and Drug Abuse Research, University of Pittsburgh, School of Pharmacy, Pittsburgh, Pennsylvania

Abstract

Employing a prospective paradigm, this investigation derived the childhood phenotype and the environment associated with risk for cannabis use disorder. Two hundred and sixteen boys were evaluated between age 10–12 on a comprehensive protocol using self, mother, and teacher reports and followed-up at ages 19 and 22 to determine the presence of cannabis use disorder. The Transmissible Liability Index (TLI) and Non-Transmissible Liability Index (NTLI) were derived using item response theory. Logistic regression was conducted to evaluate the accuracy of the indexes, singly and in combination, to predict cannabis use disorder. The TLI and NTLI together predicted with 70% and 75% accuracy cannabis use disorder manifest by age 19 and age 22. Sensitivity was 75% at both ages 19 and 22, whereas specificity was respectively 51% and 64%. The findings pertaining to sensitivity indicate that SUD risk for cannabis use disorder can be screened in childhood; however, the specificity scores demonstrate that a low score on the TLI does not inevitably portend a good prognosis up to 10 years later.

Cannabis is the most frequently used illicit drug. Huge expenditures and intensive effort are accordingly directed at reducing prevalence of consumption through interdiction; criminal prosecution; crop poisoning; and family-, school-, and community-centered prevention programs. These efforts notwithstanding, the prevalence of cannabis use is high, and currently is essentially the same as two decades ago. In 2006, the annual prevalence was 31.5% among high school seniors compared to 33.1% in 1988,¹ when the Office of National Drug Control Policy was established.

Experimentation with drugs during adolescent development does not invariably portend an adverse outcome.² Regular cannabis users, however, have elevated rates of psychiatric disorder. Notably, the rates of anxiety and depression disorders are as high as 31% and 46% among adolescents who have used cannabis at least 10 times.³ Evidence has also been accrued that indicates that habitual cannabis use amplifies the risk for psychosis.⁴ Whereas lifetime prevalence of cannabis dependence in the population is 4.2%,⁵ up to 90% of affected individuals have a co-occurring mental disorder.⁶ The epidemiological findings underscore both the importance and difficulty of detecting high risk youths.

One method of identifying high risk youths is based on the observation that children whose parents have substance use disorder (SUD) are 4–7 times more likely to also develop SUD.⁷ However, parental history as a method of detecting high risk youth is appropriate for

characterizing a *sample*, not a quantification of risk status of *individuals*. Another strategy involves identifying youths according to presence of a psychiatric disorder (eg, conduct disorder) that commonly precedes first drug exposure.⁷ A major drawback to this approach is that the psychiatric characteristics in childhood, which are associated with heightened SUD risk, span several diagnostic categories.⁸ Hence, relying on this approach diminishes prediction accuracy inasmuch as the various diagnostic categories contain elements of the liability to develop SUD. A third strategy involves using a cutoff score on a psychological trait that is known to be associated with amplified risk (impulsivity, risk taking, deviance proneness, etc.). Insofar as many traits having varying salience predisposed to substance use disorder, this approach similarly yields a high rate of misclassifying youths. In effect, the methods used in research to study high risk youths are not applicable for estimating individual risk.

This project evaluated the accuracy of predicting cannabis use disorder, joining Falconer's⁹ conceptualization of multifactorial inherited liability with a measurement model emphasizing the utility of item response theory (IRT).^{10,11} It is noteworthy that the multifactorial model is currently the prevailing framework guiding research pertaining to SUD etiology.^{12,13} Risk for SUD can be divided into two orthogonal dimensions^{10,11}: *transmissible liability* (encompassing both genetic and environment components shared between parents and offspring) and *nontransmissible factors*. Employing the family high-risk paradigm, the transmissible component of risk thus relates the child's characteristics with parental SUD. Hence, where differences are observed between children of SUD and non-SUD parents, it can be concluded that they relate to the genetic and environmental factors concomitant to parental affected status. Extending the research by Vanyukov et al.,¹⁴ this study examined the contribution of transmissible liability in conjunction with environment factors to predict cannabis use disorder by age 22. Notably, by age 22, the peak period of developing cannabis use disorder has passed.¹⁵

In summary, this project constitutes the first stage of research translation, namely, using etiology information to develop assessment tools to estimate individual risk for cannabis use disorder. Demonstrating that it is possible to identify youths who are at high risk for cannabis use disorder provides the foundation to design prevention interventions targeted at the factors associated with risk.

METHOD

Participants

The sample consisted of 333 boys enrolled in a longitudinal research program directed at elucidating the etiology of SUD consequent to the consumption of illegal drugs. Baseline evaluation was conducted when the boys were 10–12 years of age, and follow-up assessments were conducted when they attained 12–14, 16, 19, and 22 years of age. The assessment points were selected so as to track the subjects through the critical transitions from childhood through adolescence to adulthood without undue burden on the participants and taking into account project resources. Because cannabis use disorder is infrequently manifest by ages 12–14 and 16, the outcome evaluations in this study were conducted at ages 19 and 22, at which time the lifetime risk peaks.¹⁵ Of the total sample, 216 boys completed the baseline and two outcome evaluations. As can be seen in Table 1, retained and attrited participants at baseline were similar with respect to grade in school, family socioeconomic status,¹⁶ and ethnic distribution. Attrited subjects had lower full-scale IQ measured by the WISC-III-R; however, the mean score in both groups was in the normal range. Females were not included in the sample because none had attained 22 years of age, owing to the fact that their recruitment began several years after the boys.

By age 19, offspring of SUD+ fathers compared to offspring of SUD- fathers had higher rates of cannabis use disorder/dependence (23% vs. 6%, $\chi^2 = 20.30$, $p < .001$), depression (17% vs. 3%, $\chi^2 = 19.37$, $p < .001$), anxiety disorder (15% vs. 2%, $\chi^2 = 19.89$, $p < .001$), and antisocial personality disorder (8% vs. 2%, $\chi^2 = 9.26$, $p < .002$). The rate of cannabis use disorder-abuse approached significance (11% vs. 6%, $\chi^2 = 3.11$, $p = .08$). Specific differences in comorbidity patterns could not be assessed due to sample size limitations.

The boys were recruited through their biological fathers who satisfied DSM-III-R criteria for either a lifetime diagnosis of substance use disorder (abuse or dependence) involving consumption of an illicit compound or had no adult onset axis I psychiatric disorder. Childhood psychiatric disorder was not an exclusion criterion. With the exception of psychosis, comorbid psychiatric disorder was not an exclusion criterion in SUD+ probands. None of the SUD- probands had an adult onset psychiatric disorder. Because of low prevalence of men with SUD consequent to illicit drug use who also have a 10–12-year-old son, it was necessary to employ several strategies to recruit the sample. Approximately 75% of the SUD fathers (probands) were recruited using newspaper and radio advertisements, public service announcements, and random digit telephone calls. The remainder were identified after they were discharged from treatment for substance abuse. Previous analyses have shown that socioeconomic status, SUD severity, and pattern of comorbid psychiatric disorder in this sample are similar to age-equivalent men with SUD in the Epidemiologic Catchment Area Study.¹⁷ The SUD- men were accrued using the same recruitment sources with the one exception that none were acquired from treatment facilities.

Procedure

The parents provided written informed consent prior to administering the research protocols when the boys were 10–12 years of age. Parents and children were also informed that privacy was protected by a Certificate of Confidentiality. To ensure that there was no coercion by the parents for their child to participate, conversations in a private room were conducted by trained clinical associates while describing the study to determine their reasons for participating. Following this discussion, the child signed an assent form that was read to them describing their willingness to participate. Written informed consent was provided by the participants at ages 19 and 22 prior to commencing the research protocols. At each timepoint after the consenting procedure was concluded, the boys were administered breath alcohol and urine drug screens to ensure that their responses were not biased by recent substance use. A positive finding resulted in rescheduling the participant. The research protocols were administered in fixed order by trained research associates. Upon completion of the protocol, a debriefing was conducted in a private room. Prior to discharge from the laboratory, monetary payment was made to compensate the participants for their time and to offset travel and parking expenses.

Predictor Variables (Ages 10–12)

Transmissible Liability Index (TLI)—Research on a twin sample has shown that the *transmissible liability index* (TLI) has 80% heritability (Vanyukov, personal communication) and in a family study predicted SUD outcome by age 19 with 68% accuracy.¹⁴ Furthermore, each standard deviation increment on the mean score of the sample that was obtained by the person was associated with an increase of 70% probability that cannabis use disorder would be manifest during the ensuing year. The same method was used in this study to determine whether the TLI is predictive of cannabis use disorder. First, items were selected from psychological and psychiatric questionnaires and aggregated into conceptual domains. This task, guided by findings reported in the empirical literature pertaining to the characteristics thought to be associated with the susceptibility to develop SUD,^{18,19} was carried out by faculty at the NIDA-funded Center for Education and Drug Abuse Research (CEDAR). Emphasis in item selection focused on characteristics indicating deficient psychological self-regulation

spanning cognitive, emotion, and behavior domains of measurement.¹⁸ The questionnaires consisted of child self-report, mother informant reports, and teacher informant reports, as well as several diagnostic interviews. After the selection of the initial pool of items was completed, exploratory and confirmatory factor analysis was conducted. Constructs reflecting the measurement domains that distinguished offspring of SUD+ and SUD- men (indicating transmissible SUD liability) were retained. Importantly, the TLI items were not selected or included in the index based on prediction of outcome, but rather on discrimination between children of SUD+/- fathers. Next, the constructs were submitted to confirmatory factor analysis to ensure unidimensionality of the index. Lastly, item response theory (IRT) analysis was performed to calibrate the items (determine item discrimination and threshold parameters). The TLI derived in this fashion thus contains the fewest and most robust items, accounting for 26% of item variance and having internal reliability of .87. The items comprising the TLI are shown in Table 2.

Non-Transmissible Liability Index (NTLI; Age 10–12)—The NTLI is intended to account for the portion of variance associated with SUD risk that is due to non-transmissible factors. Items were identified empirically that encompassed family, peer, school, and neighborhood contexts that significantly correlated with cannabis use disorder to determine how this portion of variance of SUD risk adds to the contribution of the TLI. Development of the NTLI involved several stages. First, a panel consisting of CEDAR faculty assigned the items to family, peer, school, and neighborhood environment domains based on their face validity. Next, logistic regression analysis was conducted on each item to determine whether it predicted cannabis use disorder by age 22. The items that significantly predicted this outcome were retained, while the remainder were deleted from further consideration. Exploratory and confirmatory factor analysis, subsequently performed on the retained items, documented unidimensionality. Further pruning of the item set at this stage was conducted by removing items with low (<.4) factor loading.

To ensure that the NTLI is a “pure” indicator of the environment, variance overlap with the TLI was eliminated using regression analysis. It is noteworthy that this procedure resulted in removal of less than 7% of NTLI variance; thus, there was very little overlap between the TLI and NTLI even without statistical removal of covariance. By design, and refined by statistical analysis, the NTLI and TLI are thus orthogonal dimensions of the risk for SUD. Lastly, confirmatory factor analysis was performed to ensure that this residual score depicted one dimension, scalable by item response theory. The resulting continuous residuals were rescaled into multi-category items upon which IRT analysis was utilized to derive the NTLI. The items comprising the NTLI are shown in Table 3.

Outcome Variables

Cannabis Use Disorder (Ages 19, 22)—Lifetime diagnosis of cannabis use disorder using DSM-IV criteria was determined by a clinical committee, which reviewed the results of the SCID²⁰ along with additional medical, legal, psychiatric, and psychological information obtained from other facets of the research protocols administered to the sample. At ages 19 and 22, 19.3% and 28.7% of the sample, respectively, qualified for cannabis use disorder diagnosis (abuse or dependence).

Statistical Analysis

Logistic regression analysis was used to determine whether the TLI and NTLI predicted cannabis use disorder. Upon obtaining a significant odds ratio, receiver operating curve (ROC) analysis was conducted to determine the accuracy of these indexes for identifying youths who subsequently manifest this outcome 10–12 years after baseline evaluation. These analyses were computed separately for the TLI and NTLI as well as their combination.

RESULTS

Table 4 depicts the results showing that the TLI is a significant predictor of cannabis use disorder. As expected, the NTLI is a significant predictor of cannabis use disorder because it was composed of items that were correlated with this outcome. This finding is thus not of importance; rather, the extent to which the NTLI adds to the TLI to predict cannabis use disorder beyond the contribution of individual liability alone is of scientific interest. As can be seen, the two indexes predict cannabis use disorder at age 19 with 70% accuracy. In effect, the NTLI increases prediction accuracy by only 5% beyond the transmissibility index alone. Sensitivity and specificity are respectively 75% and 51%, using a cutoff score of 0.20. In addition, positive predictive value and negative predictive value are respectively 28% and 89%, using 19.3% as the base rate (rate of cannabis use disorder in the sample).

The TLI and NTLI are also significant predictors of cannabis use disorder manifest by age 22. Together, their classification accuracy is 75%, which is 5% higher than the TLI alone. Sensitivity and specificity are 75% and 64% using a cutoff score of 0.24. Furthermore, positive predictive value and negative predictive value are 47% and 86%, using 28.7% as the base rate of cannabis use disorder diagnosis at age 22.

DISCUSSION

To our knowledge, this study is the first attempt to derive instrumentation for determination of the individual's risk for developing cannabis use disorder. Predicting this outcome with 70–75% accuracy after a decade has elapsed underscores the feasibility of identifying high risk children. The prediction accuracy after this long period is especially impressive in light of the fact that the characteristics associated with risk for cannabis use disorder becomes most pronounced during adolescence concomitant to sexual and neurological maturation. Previous discussions have documented the contribution of maturational processes on the manifestations of behaviors that potentiate substance use.^{21–23} In effect, this study predicted cannabis use disorder prior to adolescence, when the behavioral and social risk factors become increasingly prominent.

Notably, the characteristics constituting the TLI are diverse, encompassing behavior (eg, “bites fingernails”), emotion (“excitability”), cognition (eg, “suicidal thinking”), interpersonal adjustment (eg, “annoy people to get even”), and daily routine (eg, “eat at same time daily”). The liability to cannabis use disorder thus transcends the characteristics associated with any particular diagnostic category.

This study was confined to the prediction of cannabis use disorder. Inasmuch as cannabis is the most frequently used illicit drug, it provides an anchor for identifying threshold scores on the TLI and NTLI for predicting other types of SUD. Commensurate with the common liability model,^{10,11} supported by investigations documenting significant shared genetic^{24–26} and phenotypic^{27,28} variance in the risk for SUD across the DSM-IV drug categories, the two indexes in combination may potentially yield cutoff scores for detecting youths who are at high risk for SUDs besides cannabis use disorder. Toward this goal, further research needs to be conducted using different paradigms and focusing on different populations to further document the utility of these measures. Moreover, while prediction accuracy at this juncture is moderate, future research that expands on the method described herein to encompass additional indicators may lead to practical instruments for identifying high-risk children and adolescents.

Several limitations in the findings are noteworthy. Importantly, this study was confined to males. Inasmuch as the risk for and rate of development of SUD is not the same between genders,²⁴ the findings cannot be assumed to apply to females. In addition, the sample was not drawn randomly from the general population but rather ascertained on the basis of presence/

absence of SUD in the proband father. The family high-risk paradigm was employed because it is efficient for yielding an enriched sample that is at high risk for developing SUD. This is an important logistical consideration in research because the assessment of manifold biobehavioral processes contributing to SUD risk require operational resources that usually exceed the capacity of epidemiological investigations. Nevertheless, the possibility needs to be entertained that the children of SUD+ and SUD- proband fathers derive from different populations, which could have biased the results. Along these lines, unknown effects resulting from attrition may also have biased these results, although, as shown in Table 1, the only distinguishing factor was IQ at the time of baseline evaluation. More importantly, however, the retained participants did not differ from those who attrited on the TLI and NTLI. Moreover, it is important to note that the TLI and NTLI cannot be inferred to measure all factors associated with risk for cannabis use disorder. Also, at this juncture, it has not been determined whether the indexes differentially predict diagnosis of abuse or dependence. Addressing this issue requires a larger sample than studied herein. Further research is needed to add to the comprehensiveness of the indexes as well as cross-validate them in other samples. Finally, it is important to reiterate that because the NTLI was derived based on its predictive ability, it cannot be construed to reflect a practical measure for identifying high risk youth until it is cross-validated on another sample. The TLI on the other hand was not derived based on prediction but rather on item discrimination between high- and low-risk groups. Hence, the findings of this study are not tautological; rather, they indicate that the addition of a validated index of nontransmissible factors to transmissible liability measurement only modestly improves prediction of cannabis use disorder.

In summary, the present investigation demonstrated that it is feasible to identify boys at high risk for cannabis use disorder using indexes developed to evaluate transmissible and nontransmissible liability. The scores on these indexes together in 10–12-year-old boys predict cannabis use disorder by age 22 with 75% accuracy. These findings support the feasibility of accurately identifying high risk youths for targeted intervention. In addition, the results potentially have heuristic value for research aimed at elucidating the etiology of SUD. The observation that the transmissible component of SUD risk spans cognitive, emotion, and behavioral domains of psychological functioning underscores the need to advance research beyond ubiquitous features such as impulsivity or sensation seeking. Indeed, emerging evidence obtained from diverse sources indicate that failure to acquire psychological self-regulation during childhood and adolescence, linked to somatic neurological and sexual maturation mechanisms, is the cardinal feature of SUD risk during childhood and adolescence.

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TABLE 1
Comparison of the retained and attrited samples on baseline variables

	Participants (completers) (n = 216)	Attrited subjects (n = 117)	t (df = 331)	p
Family SES	41.53 (14.13)	39.79 (12.83)	1.11	.27
Grade in school	4.61 (1.15)	4.59 (1.02)	-.17	.87
Full scale IQ	111.22 (16.12)	105.30 (15.39)	3.25	.001
Transmissible Liability Index (TLI)	-.07 (1.02)	.08 (1.04)	-1.31	.19
Non-Transmissible Environment Index (NTEI)	.05 (.57)	.09 (.72)	-.63	.53
Ethnicity	%	%	χ^2	p
Euro-American	75.5	74.4	.05	.82
African-American	24.5	25.6		

TABLE 2

Items comprising the transmissible liability index (TLI)

Item text	Response categories	Respondent	Source
Characteristics of child prior to age 13: 1. Lying 2. Stealing 3. Impulsive	1 = Yes, 2 = No	Parent	Tarter Childhood History Questionnaire ¹
4. Did you often annoy people on purpose to get even? 5. Did you often do things to annoy people like grabbing another child's hat? 6. Did you blurt out answers to questions before they had been completed or did you get into trouble because you would rush into things without thinking? 7. Were things so bad that you were thinking a lot about death or that you would be better off dead? 8. Did he often do things to annoy people like grabbing another child's hat? 9. Did he often annoy people on purpose to get even?	0 = No, 1 = Yes	Child	K-SADS-E ²
10. Did he have difficulty staying in line in the supermarket or waiting for his turn while he was playing with other children? 11. Did he blurt out answers to questions before they had been completed or did he get into trouble because he would rush into things without thinking? 12. Did he get into trouble a lot for talking out of turn in school or talking without the teacher calling on him or for bothering people? 13. Did he get into trouble because he would do things without thinking about them first, for example running into the street without looking?	0 = No, 1 = Yes	Parent	
14. I interrupt on people when they are speaking. 15. He/she interrupts on people when they are speaking.	0 = Never true, 1 = Occasionally true, 2 = Mostly true, 3 = Always true	Child	Dysregulation Inventory ³
16. Excitable, Impulsive best describes the child	0 = Not at all, 1 = Just a little, 2 = Pretty much,	Teacher	Conners Teacher Questionnaire ⁴

Item text	Response categories	Respondent	Source
The behavior of the child is best described as ...	3 = Very much		
17. ...often engages in physically dangerous activities without considering possible consequences (not for the purpose of thrillseeking, eg. runs into street without looking)	0 = Not at all, 1 = Just a little, 2 = Pretty much, 3 = Very much	Teacher	Disruptive Behavior Disorders Scale ⁵
18. ...has difficulty awaiting turn in games or group situations			
19. ...often blurts out answers to questions before they have been completed			
20. ...often interrupts or intrudes on others (eg, butts into other children's games)			
Describes your child now or within the past six months...			
21. Impulsive or acts without thinking	0 = Not True, 1 = Somewhat or sometimes true, 2 = Very true or often true	Parent	Child Behavior Checklist ⁶
22. Destroys things belonging to his/her family or others			
23. Disobedient at school			
24. Steals at home			
25. Bites fingernails			
26. Picks nose, skin, or other parts or body			
Describes the pupil now or within the past two months...			
27. Impulsive or acts without thinking	0 = Not true, 1 = Somewhat or sometimes true, 2 = Very true or often true	Teacher	Teacher's Report Form of the Child Behavior Checklist ⁷
28. Talks out of turn			
29. Aches or pains (not stomach or headaches) without known medical causes			
30. Headaches (without known medical causes)			
31. Deliberately harms self or attempts suicide			
32. I move a great deal in my sleep.	1 = Usually false 2 = More false than true 3 = More true than false 4 = Usually true	Child	Dimensions of Temperament Survey, ⁸ Revised ⁸
33. I don't move around much at all in my sleep.*			
34. I get hungry about the same time each day.*			
35. I usually eat the same amount each day.*			

Item text	Response categories	Respondent	Source
36. I eat about the same amount at supper from day to day.*			
37. My appetite seems to stay the same day after day.*			
38. My child moves a great deal in his/her sleep.	1 = Usually false 2 = More false than true 3 = More true than false 4 = Usually true	Parent	
39. In the morning, my child is still in the same place as he/she was when he/she fell asleep.*			
40. My child doesn't move around much at all in his/her sleep.*			
41. It takes my child a long time to get used to a new thing in the home.*			
42. It takes my child a long time to adjust to new schedules.*			
43. Changes in plans make my child restless.*			
44. My child resists changes in routine.			
45. I sometimes worry that I will not have enough to eat.	1 = Agree, 2 = Disagree	Parent	Child Abuse Potential Inventory (Form VI) ⁹
* Reverse-coded.			
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⁸ Lerner RM, Palermo M, Spiro A, Nesselroade AL. Assessing the dimensions of temperamental individuality across the life span: The dimensions of temperament survey. <i>Child Dev</i> . 1982;53:149-157.			

⁹ Milner JS. *The Child Abuse Potential Inventory: Manual*. Webster, NC: Psytec Corporation; 1980.

TABLE 3
 Items comprising the Non-Transmissible Liability Index (NTLI)

Item text	Response categories	Respondent	Source
In the past 6 months, how often have you ...	0 = Almost never, 1 = Sometimes, 2 = Often,	Child on mother	Child's Relationship with Caretaker (PL534) ¹
1. Thought your mother was really good?			
2. Thought your mother really bugged you a lot?			
3. Thought that your mother gave you problems?			
4. Felt that your mother was easy to get along with?			
5. Liked being your mother's kid?			
6. How many things would you like to change about your mother?	0 = Nothing, 1 = A few things, 2 = A lot of things	Child on mother	
7. Over the past six months, how well did you get along with your mother?	1 = Not so well, 2 = Okay, 3 = Well	Child on mother	
8. My mother accepts what I expect of her in the family.	1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree	Child on mother	Family Assessment Measure, Dyadic Relationship Scale ²
9. I know what my mom means when she says something.			
10. My mom and I have the same views about right and wrong.			
11. My mom takes her share of family responsibilities.			
12. When I'm upset, I know my mom really cares.			
13. When I have a problem, my mom helps me solve it.			
14. My mom gets too involved in my affairs.			
15. My mom is right about the importance of education.			
16. My mom expects too much of me.			
17. Even if my mom disagrees, she still listens to my point of view.			

Item text	Response categories	Respondent	Source
18. My mom really trusts me.			
19. How often do you have a friendly chat with your mom?	1 = Almost never, 2 = Sometimes, 3 = Often	Child on mother	Supervision/Involvement Scale (PL536) ³
20. How often does your mom find time to listen to you when you want to talk to her?			
21. How often do you and your mom do things together at home?			
22. On weekdays, how often do you do something together with your mom?			
23. On weekend days, how often do you do something together with your mom?			
24. Do you like spending time with your mom?			
1. How often do you have a friendly chat with your dad?	1 = Almost never, 2 = Sometimes, 3 = Often	Child on father	
2. How often does your dad find time to listen to you when you want to talk to him?			
3. How often do you do something together with your dad on weekend days?			
4. Do you like spending time with your dad?			
In the past 6 months, how often have you...	0 = Almost never, 1 = Sometimes, 2 = Often	Child on father	Child's Relationship with Caretaker (PL534) ⁷
5. Thought your father was really good?			
6. Wished that you had a different father?			
7. Thought that your father gave you problems?			
8. Felt that your father loved you?			
9. Felt that your father was too strict or hard on you?			
10. Liked being your father's kid?			
11. Felt that when your father punished you, you got the punishment that you deserved?			
12. Over the past six months, how well did you get along with your father?	1 = Not so well, 2 = Okay,	Child on father	

Item text	Response categories	Respondent	Source
	3 = Well		
13. Is your father a good listener?	0 = Almost never 1 = Sometimes, 2 = Always	Child on father	Revised Parent-Adolescent Communication Form (PL535)
14. If you were in trouble, could you tell your father?			
15. Do you openly show your father that you like him?			
16. When you ask your father questions, do you get honest answers from him?			
17. Is it very easy for you to express all of your true feelings to your father?			
18. Do you tell your father about your personal problems?			
19. Can you let your father know what is bothering you?			
20. Do you think that your father feels close to you?			
21. Do you feel close to your father?			
22. My dad accepts what I expect of him in the family.			
23. I know what my dad means when he says something.			
24. My dad is reasonable when I make a mistake.			
25. My dad and I have the same views about right and wrong.			
26. My dad takes what I say the wrong way.			
27. When I'm upset, my dad usually knows why.			
28. When I'm upset, I know my dad really cares.	1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree	Child on father	Family Assessment Measure, Dyadic Relationship Scale ²
29. Even when I admit I'm wrong, my dad doesn't forgive me.			
30. When I have a problem, my dad helps me solve it.			
31. If my dad is angry with me, I hear about it from someone else.			

Item text	Response categories	Respondent	Source
32. My dad still likes me even when I argue with him.			
33. When there's a problem between us, my dad finds a new way of working it out.			
34. My dad often ruins things for me.			
35. When my dad gets angry with me, he stays upset for days.			
36. My dad gets too involved in my affairs.			
37. My dad gives me a chance to explain when I make a mistake.			
38. My dad is right about the importance of education.			
39. My dad expects too much of me.			
40. Even if my dad disagrees, he still listens to my point of view.			
41. My dad takes it out on me when he has had a bad day.			
42. My dad really trusts me.			
43. My dad is always on my back.			
44. There's a big difference between what my dad expects of me and how he behaves.			
45. I can count on my dad to help me in a crisis.			
46. My dad is right about the importance of being successful.			
1. In the past six months have any of your friends stolen something or purposely damaged property that did not belong to them or hurt someone seriously?	0 = Yes, 1 = No	Child on peers	Child Report on Peer Environment ⁴
2. Are there any kids in your group of friends who your parents disapprove of?			
During the past six months, how often has someone...	0 = Never, 1 = Rarely, 2 = Sometimes, 3 = Often	Child on peers	Opportunity/Resistance Scale ⁵
3. Said that you should go drinking with them?			
4. Put pressure on you to drink?			
5. Said that you have to get drunk to have a			

Item text	Response categories	Respondent	Source
good time?			
During the past six months, how many of your friends have...	0 = None of them, 1 = Few of them, 2 = Half of them, 3 = Most of them, 4 = All of them	Child on peers	Peer Delinquency Scale (PL526) ⁶
6. Stolen something worth less than \$5?			
7. Hit someone with the idea of hurting that person?			
8. Used a weapon, force or strong arm methods to get money or things from people?			
9. Used alcohol?			
10. Used marijuana or hashish?			
11. Think of the friends you usually have played or hung out with during the past six months. Were there any children in your group of friends of which your parents disapproved?	0 = No, 1 = Yes	Child on peers	Parents and Peers (PL540) ⁷
1. Do you know where people in your neighborhood or school get marijuana or other drugs?	0 = No, 1 = Yes	Child on neighborhood	Opportunity/Resistance Scale ⁵
2. Do you know where people in your neighborhood or school get marijuana or other drugs?	0 = Yes, 1 = No	Child on neighborhood	Child Report on Peer Environment ⁴
3. Do you personally know anyone who trades or sells drugs?			
1. Have you ever driven a car by yourself?	0 = No, 1 = Yes	Child on self	Opportunity/Resistance Scale ⁵
2. Have you ever gotten into a hitting fight with another kid?	1 = Yes, 2 = No	Child on self	Garnezy Child Interview ⁸

¹ Loeber R. *Child's Relationship with Caretaker (PL534)*. Pittsburgh Youth Study, Pittsburgh, Pa.: University of Pittsburgh; 1989.

² Skinner HA, Steinhauer PD, Santa-Barbara J. The Family Assessment Measure. *Can J Commun Ment Health*. 1983;2:91-105.

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- ⁴ Tarter R. *Child Report on Peer Environment*. Pittsburgh, Pa.: University of Pittsburgh, Center for Education and Drug Abuse Research (unpublished).
- ⁵ Loeber R. *Opportunity/Resistance Scale (PL544)*. Pittsburgh Youth Study. Pittsburgh, Pa.: University of Pittsburgh; 1989.
- ⁶ Loeber R. *Peer Delinquency Scale (PL526)*. Pittsburgh Youth Study. Pittsburgh, Pa.: University of Pittsburgh; 1989.
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- ⁸ Garmezy N. *Garmezy Child Interview*. 1985.

TABLE 4
 Prediction of cannabis use disorder by ages 19 and 22 using the TLI and NTLI

Prediction, age 10–12	Outcome, age 19						
	OR	95% CI (p)	Sensitivity	Specificity	Area under the curve	PPV	NPV
TLI	1.75	1.28–2.38 (<.001)	.71	.50	.65	.26	.87
NTLI	3.06	1.80–5.22 (<.001)	.68	.60	.64	.30	.88
TLI & NTLI	1.78; 3.01	1.27–2.49 (<.001); 1.74–5.22 (<.001)	.75	.51	.70	.28	.89
	Outcome, age 22						
TLI	2.27	1.55–3.33 (<.001)	.75	.54	.70	.41	.83
NTLI	2.76	1.49–5.14 (<.001)	.68	.52	.64	.38	.79
TLI & NTLI	2.46; 3.05	1.63–3.71 (<.001); 1.59–5.85 (<.001)	.75	.64	.75	.47	.86