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Using Attitudes, Age and Gender to Estimate an Adolescent's Substance Use Risk

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Abstract

Purpose—The purpose of this paper is to present a strategy for estimating an individual's risk of alcohol, cigarette and cannabis use that relies on an assessment of an adolescent's age, gender and attitude.

Methodology—The authors assembled surveys from 35,987 11 through 17 year-olds assembled from 36 databases were analysed to examine the relationship between attitude and behaviour.

Findings—Attitudes were strongly correlated with concurrent use of alcohol, drunkenness, smoking, and cannabis, with point biserial correlations of -0.555 , -0.517 , -0.552 and -0.476 , respectively. Logistic regression provided a means for using age, gender and attitudes to estimate an individual's risk of engaging in substance use behaviour. Developmental changes in attitudes were estimated by analysing changes in scores associated with percentile rankings for each age and gender group. Projected year-to-year changes in attitude were used as a heuristic for estimating future risk.

Research limitations—Analyses relied on cross-sectional panel data. Analyses would benefit from longitudinal data in which age-related changes in attitudes could be more precisely modelled.

Practical implications—Information about estimated current and future risk may use useful for motivating the adoption and implementation of effective prevention approaches by parents and care providers.

Originality—The authors present a novel method for estimating an individual's risk of substance use knowing attitude, age and gender.

Keywords

adolescents; alcohol; drunkenness; cigarettes; cannabis; estimating risk; prevention; parents; clinicians

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Introduction

Substance use during adolescence remains a major source of risk for physical and mental health outcomes. For the population in general, the relationship between age, gender and the prevalence of adolescent substance use is well known. For example, since 1991 the Monitoring the Future project has collected surveys annually from approximately 50,000 8th, 10th and 12th grade students in the USA (Johnston et al, 2013). These surveys assess gateway drugs - alcohol, cigarettes, and cannabis (Kandel, 2002) - as well as a host of other illicit drugs including cocaine, heroin, methamphetamine, etc. A similar survey is periodically conducted by the U.S. Centers for Disease Control and Prevention, the Youth Risk Behaviour Survey (Eaton et al., 2012) in which the 30-day prevalence of alcohol, cigarettes and cannabis are assessed for students in grades 9 through 12. European countries also participate in the European School Survey Project on Alcohol and Other Drugs (ESPAD), a periodic student surveys that assess substance use prevalence (Hibell et al., 2012).

These surveys reveal that the prevalence of substance use increases with age. As can be seen in Table 1, recent Monitoring the Future published results reveal that the 30-day prevalence rates of cannabis use rose from 6.5% of 8th grade students to 17.0% of 10th grade students to 22.9% of 12th grade students. The 30-day prevalence of drinking alcohol had a similar pattern of increased onset by grade (11.0%, 27.6%, and 41.5% for grades 8, 10, and 12, respectively). Self-reported drunkenness (3.6%, 14.5%, and 28.1% for the same grades) and cigarette smoking (4.9%, 10.8%, and 17.1%) followed a similar pattern. Similar results have been reported for students participating in the Youth Risk Behavior Survey (Eaton et al., 2012). The most recent ESPAD report (Hibell et al., 2012) does not break down rates of use by age or grade.

Decades of these data have accumulated and demonstrate that the likelihood of engaging in these substance use behaviours always increases with age, yet knowledge of these general trends does not lend itself to estimating risk for individual adolescents. Despite the replicability of these patterns, parents and health care providers may not appreciate the risk an individual adolescent may face for initiating use. Indeed, at present, other than relying on age-based prevalence rates (such as those presented in Table 1), there is no published method that allows someone to estimate the substance use risk of an individual child. Having access to child-specific information about current and future risks is expected to be motivating and may be valuable for guiding decisions and prescribing solutions. Information about risk is expected to be most effective when presented in conjunction with tailored interventions and training. Strong evidence shows that intervention during early adolescence is most effective (Cuijpers, 2002; Tobler et al., 2000).

Attitudes

The concept of attitudes was first introduced as a fundamental social psychological concept by early theorists (Allport, 1935; Heider, 1946; Krech & Crutchfield, 1948) who sought to characterize an individual's motivation or disposition to behave. Since then, the history of how attitudes have been conceptualized and measured and the role they play in behaviour

has continued to be central to understanding people's social behaviour (Briñol & Petty, 2012).

In its simplest formulation, attitudes may refer to liking or disliking, agreeing or disagreeing, judging rightness or wrongness, or making some other affective analysis about a topic. Many who assess attitudes continue to think in this way, using scales in which survey participants are asked to make summary judgments. However, from early in the history of theory and research on attitudes, attitudes have also been characterized as complex phenomena reflecting the accumulation of multiple components. For example, an early theory proposed that attitudes were based on three components: affect, beliefs, and behaviour (Hovland, McGuire, Abelson & Brehm, 1960). In a similar vein that emphasized the multi-component nature of attitudes, Heider (1958) proposed that individuals actively strive to find balance multiple components of attitudes. This idea was further explored by Festinger (1954; 1962) who developed a *theory of cognitive dissonance* in which individuals actively seek to resolve conflicting attitudinal components.

Attitudes have, from early on, been recognized to have a social perception component. For example, Festinger (1954) argued that people evaluate their attitudes in references to the perceived attitudes of those around them. Ajzen & Fishbein (1977) theorized that attitude specificity (linking specific attitudes with specific behaviours versus linking general attitudes with behaviour) was essential to understanding how attitudes function. In their early research (Ajzen & Fishbein, 1973) and in their subsequently developed *theory of reasoned action* (Ajzen & Fishbein, 1980) a number of components of attitude were examined, including concepts related to the perceptions of the behaviour of others and social norms, values and intentions.

Our approach to attitudes greatly reflects the latter approach. That is, while attitudes may have an overall singular affective component, we postulate that attitudes are most appropriately represented by a complex constellation of cognitions. Our research on attitudes began decades ago with a search for core components of substance use prevention programs. Two reviews, one of school-based research (Hansen, 1992) and one of programs listed on the U.S. National Registry of Evidence-based Programs and Practices (NREPP: Hansen et al., 2007) allowed us to identify mediating variables that researchers and prevention programme developers had targeted for change in their interventions. We and others (e.g., Derzon, 2000) examined the research literature and identified a handful of variables that then served as the basis for future etiologic research and programme development.

From this research and in line with many of the theories that have been outlined above, we view attitudes as having both a person-centred component (intentionality and incongruence between desired lifestyle and risky behaviour) and a social perception component (what is perceived and expected of peers and parents). It should be noted that variables assessed in the social component are perceptions, not external realities. For example, Stattin and Kerr (2000) note that assessments of parental monitoring collected from children only loosely correspond when the same questions are asked of parents. Similarly, adolescents often exaggerate the prevalence and acceptability of peer substance use (Botvin et al., 1995; Sussman et al., 1988). It is thus the perception of social behaviour that contributes to

attitudes. The origin and development of attitudes during adolescence is likely to reflect the interplay of private thinking that is heavily influenced by proximal social forces such as peers and parents. Together these components reflect a young person's motivation or disposition to engage in behaviour. These components are distinctly different from concepts that focus on skills and competencies, temperament, personality and observable environmental variables.

There has been extensive research on these components. Research has found that intentions and commitment to not engage in substance use (Collins, Ellickson & Bell, 1998; Flay, Hu & Richardson, 1998; Malmberg et al, 2012; McMillan & Conner 2003), perceptions that substance use fits or does not fit with a desired lifestyle (Liu, Flay & Aban Aya Investigators, 2009; McNeal & Hansen, 1999), perceptions about peer use and social norms (Botvin et al., 1992; Chassin et al., 1991; Kosterman et al., 2000; Krosnick et al., 2006; Olds, Thombs & Tomasek, 2005; Wilks, Callan & Austin, 1989), and parental monitoring and communication (Borawski et al., 2003; DiClemente et al., 2001; Jackson, Henriksen & Dickinson, 1999; Li, Stanton & Feigelman, 2000; Reimuller, Hussong & Ennett, 2011; Steinberg, Fletcher & Darling, 1994) are all correlated with and predictive of alcohol, tobacco and cannabis use.

Our own research (Fearnow-Kenney, Hansen & McNeal, 2002) has shown that intentionality, incongruence, and normative beliefs are not only highly inter-related, each contributing to a single factor, but are also strong predictors of future alcohol, cigarette and cannabis use. Studies examining the role of these variables in mediating the outcomes of school-based prevention programs have also demonstrated that many of these play crucial roles in programme success (Donaldson, Graham & Hansen, 1994; MacKinnon et al., 1991; McNeal, Hansen, Harrington & Giles, 2004).

Estimating Risk

The purpose of this paper is to present a methodology for estimating the risk of alcohol, cigarette and cannabis use for any adolescent of known age and gender. We extend this method to create a model that uses expected changes in attitudes to estimate future risk. We demonstrate how substance use behaviours can be estimated for an individual adolescent.

At the outset, we underscore that this model does not purport to evaluate the causes of behaviour. Future behaviours are subject to many influences and whether or not an individual adolescent ultimately engages in substance use cannot be known for certain. Nonetheless, as with many other health outcomes, risk can be estimated. Once risk is estimated, outcomes can be changed with intervention.

Method

Sources of Data

Our research team has been involved in multiple research projects that span the 1990s through the present during which surveys have been collected. Several large projects were conducted in Kentucky, Illinois, Missouri, Nebraska, and North Carolina between 1991 and 2004. In addition, we began offering an evaluation service beginning in 2000 for groups who

wished to conduct local evaluations of their drug prevention programs. Data from assembled for this analysis from these projects were from 30 or more U.S. states and from Northern Ireland. From among these various projects and evaluations, we selected pretest surveys where an intervention was implemented or accumulated surveys where no intervention was tested. Posttest from intervention studies were excluded to prevent confounding of results by interventions. Data were extracted from 36 databases, each distinguished by the version of the survey they employed. Overall, 35,987 surveys were assembled for analysis for which there was complete data on all measures. Of these, 3,051 (8.5%) were from accumulated projects where surveys were administered on two occasions with a one year interval between administrations. Table 2 presents the distribution of age and gender for those whose surveys were included.

Measures

Measures from each survey to be used for analysis were selected based on prior research in which they served as correlates of alcohol, cigarette or cannabis use (Derzon & Lipsey, 1999; Fearnow-Kenney, Hansen & McNeal, 2002; McNeal & Hansen, 1999; McNeal et al., 2004). All surveys assessed gender and either age or U.S. school system grade. For the latter, grade was transformed to yield an approximation of age by adding 5 to the value of the grade reported. For example, students reporting they were in 6th grade were presumed to be 11 years old.

Surveys included past 30-day assessments of drinking alcohol, getting drunk, smoking cigarettes, and using cannabis. When questions assessed quantity or frequency of use, measures were rescaled to be dichotomous with values of 0 for non-participation and 1 for participation in the behaviour. It has long been known that there are strong correlations among the behaviours (Donovan & Jessor, 1985; Kandel, 2002), each was considered separately because each was expected to have a different base rate of prevalence (see Table 1). The ultimate goal of this research is also intended for use by parents who may find information about specific substances more useful than a generalized notion of substance use.

Surveys also included items to assess attitudinal components. These measures included assessments of normative beliefs about the prevalence and acceptability of alcohol, tobacco, and cannabis use (Grube, Morgan & McGree, 1986; Hansen et al., 1988; McNeal & Hansen, 1999; Olds, Thombs & Tomasek, 2005), commitment to avoid drug use (intentionality; Maglica, 2011; McNeal & Hansen, 1999; Pomery et al., 2009), lifestyle incongruence (the perception that drug use would interfere with life goals; McNeal & Hansen, 1999), and parental monitoring and communication about drug use (DiClemente et al., 2001; Stattin & Kerr, 2000).

All individual attitude items had weights between 0 and 10, with intermediate scores equally interspersed. Four-point scales had answers with weights of 0, 3.3, 6.7, and 10. Five-point scales had weights of 0, 2.5, 5, 7.5, and 10. Because these items were developed to be used in evaluating interventions, the direction of weighting followed from the goals of these interventions; weights of 0 were theoretically least desired and weights of 10 were most desired. Attitude was calculated by averaging across all items. No matter which items and

how many items were included, Attitude scores were thus standardized as varying between 0 and 10. Our ultimate goal is to be able to clearly present findings to parents and practitioners. Scales ranging from 0 to 10 are highly interpretable by non-researchers.

The number of items and wording of Attitude items varied from dataset to dataset. (Each dataset was essentially distinguished by the version of the survey that was employed.) Nonetheless, items assessed in all of the 36 datasets overlapped considerably. On average, there were 25.6 Attitude items per survey (S.D. = 5.3). The modal survey included 28 items. The survey with the most items included 35 items and the smallest included 13 items. The average Cronbach alpha for the Attitude scale across datasets was .883 (S.D. = .047) and ranged from .746 to .980. In none of the 36 datasets did an item need to be dropped because of a noticeable increase in the alpha coefficient when deleted. Alpha coefficients were calculated separately for each age and gender category for the contributing datasets. Table 3 provides evidence that internal consistency was acceptable for both girls and boys and across all age groups.

Analyses

All analyses were performed using SPSS 20.0 (2011).

Human Subjects Protection

Data were de-identified (no names or affiliations were listed) and derived from archived sources. The IRB agreed that these data qualified for an exemption from requiring informed consent based on U.S. CFR §46.101(b)(4) which states that research is exempt when a study uses existing data for which the information is recorded in such a manner that subjects cannot be identified.

Results

Attitudes and Substance Use

The first step in creating a risk index was to determine if adolescents' attitudes were correlated with each of four behaviours and to determine the degree to which age and gender moderated such relationships. Point biserial correlations were calculated between Attitude and each of the four behaviours (Alcohol, Drunkenness, Cigarettes and Cannabis; see Table 4). Correlations between Attitudes and each of the substances were statistically strong (greater than or near .5), suggesting that Attitude could be used as a viable diagnostic device for estimating current substance use.

We used analysis of variance to further examine the relationship between Age, Gender and Attitude. Age ($F_{6,35973} = 1153.995$, $p < .0001$, $\eta^2_p = 0.161$) and Gender ($F_{1,35973} = 425.176$; $p < .0001$, $\eta^2_p = 0.012$) were both independently related to Attitude. (The interaction between Age and Gender had a negligible effect size; $\eta^2_p = 0.002$.) Table 5 presents Attitude scores for adolescents of different ages. As can be seen, not only were Attitude scores more negative (closer to 0) among older adolescents, there was also greater variability as they aged. Attitude scores were generally more negative (closer to 0) among boys than among girls. For subsequent analyses, Attitude, Age and Gender were all retained.

Estimating Concurrent Risk

We completed logistic regression analyses for each of the four substance use behaviours. Attitude, Age and the Attitude $\times$ Age interaction were included as independent variables. For Drunkenness, only data from survey participants who reported they had consumed alcohol were included. Analyses were completed separately for girls and boys. Logistic regression results are summarized in Table 6.

While all analyses resulted in significant models, parameter estimates for each gender and for each behaviour differed. Nonetheless, knowing a young person's age, gender and attitude yielded a strong statistical estimate of risk for engaging in current substance use. Interpretation of these findings is clarified by examining the graphs of calculated estimates as seen in Figures 1(a) through 1(h). Estimates of risk were calculated using:

$$Fp(x) = \frac{e^t}{1+e^t}$$

where $Fp(x)$ is the expected probability of behaviour and t is:

$$B_{Intercept} + B_{Attitude} \times Attitude + B_{Age} \times Age + B_{(Attitude \times Age)} \times (Attitude \times Age)$$

Estimates of drunkenness risk in Figures 1(c) and 1(d) are a product of results of the logistic regression and the corresponding estimated risk of alcohol use.

All relationships between Attitude and estimated probability of behaviour were curvilinear. Girls' estimated probability of using alcohol and getting drunk (Figures 1a and 1c) were most clearly related to their attitudes, with relatively little distinction related to age and no Attitude $\times$ Age interaction. This is in contrast to findings for boys, whose alcohol use and drunkenness (Figures 1b and 1d) were differentiated by Age and Attitude $\times$ Age interactions, particularly for more negative attitudes. That is, it is especially among older boys with poorer attitudes that an increased probability of drinking and getting drunk is observed.

Both girls' and boys' estimated risk of smoking cigarettes (Figures 1e and 1f) and their estimated risk of using cannabis (Figures 1g and 1h) reflect the interaction between their attitudes and age. Younger adolescents who had more negative attitudes were less likely to use than older adolescents with the same attitudes. In all cases, positive attitudes were protective for all age groups for both genders.

An examination of Figures 1a through 1h also reveals another pattern. A discernible increase in the risk of alcohol use begins with attitude scores of 8 for girls and 9 for boys whereas the noticeable increase in risk of smoking and cannabis use begins with attitude scores of 6 for girls and 7 or 8 for boys.

It is possible to translate logistic regression results into the risk of an individual adolescent. Consider for example, a 13 year-old girl and boy each with an attitude score of 6.0. From the observed data, the girl's attitude score would be at the 17th percentile and the boy's score would be at the 29th percentile, both scores place them at greater than average risk for their

age group. Based on estimates from these analyses, the girl would be expected to have a 29.1% chance of drinking alcohol within a 30-day period, a 10.0% chance of getting drunk, an 11.7% chance of smoking cigarettes, and an 8.0% chance of using cannabis. The boy would have a 44.7% chance of drinking alcohol within a 30-day period, a 15.2% chance of getting drunk, a 17.2% chance of smoking cigarettes, and a 16.5% chance of using cannabis. These estimates have diagnostic utility given the observed relationships from these analyses.

A Strategy for Estimating Future Risk

As noted, analyses completed above are based on age, gender and attitudes as correlates of concurrent substance use behaviours. Because data are cross-sectional in nature, causality cannot be assumed modelled. We nonetheless acknowledge that prior research on the variables used in the construction of the attitude scale suggests that there may be a predictive relationship between attitudes and future substance use (Stacey et al., 1994). For example, there is longitudinal research on normative beliefs (Curran et al., 1997; Fearnow-Kenney et al., 2002; Fergusson et al., 2008; Grube et al., 1986; Iannotti et al., 1996), intentionality (Fearnow-Kenney et al., 2002; Gibbons et al., 1998; Maddanhian et al., 1988), lifestyle incongruence (Fearnow-Kenney et al., 2002; McNeal & Hansen, 1999) and parental monitoring and communication (Borawski et al., 2003; Chilcoat & Anthony, 1996; Cohen et al., 1994; Tobler & Komro, 2010) that demonstrate the predictive ability of these variables. Nonetheless, without longitudinal data in hand, we cannot measure changes in attitudes over time.

We posit a heuristic means of estimating future risk. As portrayed in Table 4, for boys and girls, there is a general trend of attitudes becoming more tolerant of use with age. That is, average attitude scores for younger adolescents are closer to 10 than are scores for older ones. We explore the possibility that knowing about developmental changes in attitudes can provide insights about future substance use risk.

To complete future estimates, we assume that percentile rankings remain the same across time. Maintaining one's exact percentile ranking is not likely to occur due to the time-varying nature of longitudinal data; however, it is practical for heuristic purposes. We also assume that the previously developed strategy for estimating the probability of using substances can be used as adolescents increase in years. That is, estimating future risk can be calculated using gender and attitude with age advancing year-to-year for each calculation.

We calculated attitude scores for each age group for multiple percentile groups. For each group of percentiles (i.e. for 11, 12, 13, 14, 15, 16 and 17 year-olds for any given percentile) definable patterns emerged. Essentially, across ages, the attitudes of adolescents in the higher percentile groups (those with the most intolerant of use attitudes) decreased modestly. For groups with lower percentiles (those with the most tolerant of use attitudes), age was associated with an acceleration of tolerance of use attitudes. To model changes that could be used for estimating year-to-year changes in attitudes, curvilinear functions were fit to the data for each percentile group. Figure 2 presents curve estimates for three selected percentile groups (10th, 50th and 90th) for girls and for boys.

As an example, consider the hypothetical 13 year-old girl described above whose attitude score of 6.0 placed her at the 17th percentile. Her attitude score would be expected to decrease to 5.3, 4.9, 4.6 and 4.5 at ages 14, 15, 16, and 17, respectively. Considering just the risk of 30-day alcohol consumption, the girl's risk would increase from 29.1% at age 13 to 59.4% at age 14, 69.7% at age 15, 84.0% at age 16 and 88.5% at age 17. Similarly, the hypothetical boy's 21st percentile score of 6.0 when 13 would decrease to 5.4, 4.9, 4.5 and 4.2 at in each subsequent year. The boy's risk would increase from 44.7% at age 13 to 64.0% when 14, to 79.2% when 15, 89.0% when 16 and 94.1% at age 17.

The picture would be very much different for a girl or boy whose initial risk was lower. For instance, consider a girl at the 90th percentile with attitude scores of 9.6, 9.4, 9.3, 9.2 and 9.1 for ages 13 through 17, respectively. Her estimated alcohol risk for each age would be 6.2%, 8.3%, 10.8%, 13.7% and 17.0%. For a boy whose attitude scores were at the 90th percentile, estimated age-specific attitude scores would be 9.4, 9.1, 8.9, 8.8 and 8.7. The age-specific risk of drinking alcohol would be 7.2%, 9.6%, 12.4%, 15.9% and 19.0%. Attitude percentile estimates for every 10th percentile are in Appendix 1.

Discussion

Summary of Findings

Heretofore, no systematic methods have been developed for estimating the risk individual young people have of engaging in substance use behaviours. Even though population prevalence data are readily available, these do not provide information about the risks faced by individual adolescents. There is an extensive body of research that demonstrate statistical relationships between theoretically derived risk and protective factors and substance use (e.g., Scheier et al., 1997). Heretofore, none of these findings have been used to create an actuarial model for estimating individual risk. Our approach takes analyses one step further and uses logistic regression outcomes to estimate individual risk. Being able to estimate individual risk may be important for those who care for adolescents, particularly when such information is coupled with knowledge about how risk may be reduced.

For drinking alcohol and getting drunk among girls, the observed pattern of risk was almost solely attributable to their attitudes. This is in contrast to findings observed for smoking cigarettes and using cannabis among girls and all four behaviours for boys where the primary determinant of observed risk was the interaction between age and attitude. While prevalence was expected to be modestly different for girls and boys, this difference in risk profile was not anticipated. These findings suggest that for girls of all ages, only attitude matters when it comes to understanding risk. For all other behaviours, understanding risk is complicated because risks due to attitude increase as adolescents grow older. As yet, we are not sure how to explain this anomaly.

The relationship between attitude and estimated probability of behaviour was not linear. One implication of this finding is that with subtle tolerance of use shifts in attitudes, risk may dramatically accelerate. To the degree this is the case, individuals responsible for implementing preventing measures may find that they are ill-prepared for the sudden onset

of substance use behaviours. Even understanding the process of risk-acceleration in a general sense may therefore be a valuable useful insight.

Findings reported here were based on cross-sectional analyses and cannot be used to infer causality between attitudes and behaviours. and cannot be used to infer causality. Next steps for the field to consider include gathering longitudinal data on attitudes to determine the degree to which changes in attitude can be modelled. Given the strength of correlational relationships observed, a broader adoption of measures included in the attitude scale is warranted, particularly in longitudinal research projects. (A copy of the most current survey used to assess Attitudes is in Appendix 2). This may involve developing and testing methods for routinely and rapidly gathering attitude data from adolescents. Over the past decades, methods for collecting attitude data have been systematized with schools being the primary site for survey administration. Methods may need to be adapted for use in home or clinical settings to provide risk information.

Implications for Intervention

The immediate goal of developing a method for diagnosing an individual adolescent's risk for future substance use is to provide a means to motivate those who are responsible for influencing youth to become engaged in prevention. Currently, the most widespread approaches to prevention are universal school-based interventions (Cuijpers, 2002; Ringwalt et al., 2009). Schools typically deal with classrooms of students, not individuals. To be useful to motivate schools to adopt prevention practices and tailor interventions to meet the needs of students, aggregated risk profiles may be offered. However, we perceive that there are risks associated with providing teachers and school administrators with individual student's risk information. In the first place, such information may be highly stigmatizing. In the second place, if risk status were used to congregate youth, the outcomes may actually increase risk (Dishion et al., 1999).

We believe the most useful approach to employing risk information will be to inform parents. Unlike school settings in which service providers change from year-to-year, parents have a permanence that allows preventive efforts to be continuous. The past several decades have witnessed the development of effective parent- and family-focused substance use prevention programmes (Kumpfer & Hansen, 2014). The major challenge these programs face is recruiting parents to participate (Heinrichs et al., 2005; Spoth & Redmond, 1993). There may be many barriers parents may face that reduce the likelihood of participation, including available time to meet in group settings and other resource issues. It is also possible that parents may simply not be aware of the risks their own children face for future drug use. Generally, people have a positivity bias (Lagattuta et al., 2012; Mezulis et al. 2004) which may translate into parents believing that risk for their child is lower than it actually is (Bogenschneider et al., 1998). Understanding future risk may help motivate parents to become engaged in long-term positive preventive strategies.

Novel strategies for informing parents about their child's risk and encouraging them to engage in preventive activities are needed that can be rigorously tested. Future interventions may need to be tailored to match the estimated risk of the adolescent (Wanyonyi et al., 2011). Parent- and family-focused intervention has typically relied on group centred

methods. Given the ability to estimate future risk at an individual level, programme developers may wish to begin exploring alternative methods for communicating key concepts and strategies that do not rely on group-based methods. For example, it may work well that paediatricians, who many early adolescents see as a routine part of health care, can serve as a conduit for assessment and parent training. Ultimately, parents and practitioners will need to have ready access to materials that allow them to interpret findings and adopt a positive plan for intervention. There are challenges that future research will need to address. It is not yet known how a parent might interpret a risk prediction. If a child's risk reflects the parent's own attitudes or behaviours they may feel stigmatised. Alternatively, a child's risk may conflict with parental attitudes and behaviours. Thorough testing will be needed to understand how such issues affect intervention effectiveness.

It may also be possible to develop interventions that directly involve adolescents. Especially for young adolescents, when risk tends to be lower, there may be benefit in considering strategies for providing feedback about current risk and a prognosis for future risk. However, such interventions may need to be carefully crafted so as to not give adolescents unwarranted expectations that actually lead them into early experimentation with substances. One strategy may be to ensure that realistic short-term consequences are included as part of any intervention (Hansen & Malotte, 1986). Rather than considering their own risk, such interventions may wish to focus on the hypothetical risk of similar people that may include teaching strategies for avoiding risk and changing one's risk profile. While possible, there are serious potential negative outcomes that should be guarded against and carefully monitored before such interventions are disseminated.

Caveats

Several caveats are needed about these findings. First, it is important to understand that estimating risk is fundamentally different than predicting the future. For any given adolescent, numerous factors may inflate or suppress risk beyond those suggested by this model. The method for estimating future risk assumes no intervention is planned; should interventions occur (a desired outcome), future risk can be lessened. We selected one variable (attitude) that was highly correlated to behaviour; however, the correlation was not perfect. Selection of attitude was based on past research and the availability of large numbers of cases. There are undoubtedly other variables, including socioeconomic indicators for which we had no data, that might be used that future research may wish to examine that may increase the precision of prediction. It is incumbent on the field to test these other variables to see if equal or superior risk estimating methods can be developed.

Second, it should be noted that all data were cross-sectional and consisted of multiple non-equivalent panels. In many respects, the limits applied to interpreting meta-analyses apply to these findings as well (Hedges & Olkin, 2014). It is assumed that current risk is related to future risk for individuals, and that attitudes systematically worsen and risk increases over time for individuals. Longitudinal data would clearly be superior to modelling the development of risk. Unfortunately, insufficient numbers of cases of longitudinal data were available to us; most datasets included adolescents who received an intervention. This

precluded our ability to use anything other than cross-sectional data to model developmental changes in attitudes and the interplay between attitude and behaviour.

Third, as reported by Monitoring the Future, Youth Risk Behaviour Survey and ESPAD researchers and evidenced in this project's results, prevalence of substance use behaviours is subject to numerous influences that affect rates of behaviour. Prevalence rates change from year-to-year and from location-to-location. Even risk estimates that are designed to match recent reports of behaviour are inherently imperfect. With changes afoot such as the legalization of cannabis and the introduction of e-cigarettes and other innovations, future base rates may change markedly. Therefore, a significant amount of latitude should be allowed in interpreting the specific risk estimates. Even though projections are expected to be informative, they will not and cannot be precise. Box and Draper (1987, p. 424) note that "all models are wrong, but some are useful." We intend to create a useful model that might provide better estimates of future risk than are otherwise available.

Fourth, there may be other criteria that might well be considered that the current approach ignores. There are numerous other psychosocial and demographic and environmental characteristics that have been considered in research on substance use aetiology. Adjusting models and estimates based of such factors may prove worthwhile in terms of honing tools related to forecasting future behaviour. Nonetheless, as a first approach to addressing the challenge of estimating future risk, the model developed holds promise.

Conclusion

A method for estimating current risk for drinking alcohol, getting drunk, smoking cigarettes and using cannabis was developed. This method is based on data from an amalgam of 36 datasets. These data were used to create models that reflected underlying relationships among gender, age, attitude, and substance use behaviour. Modelling developmental changes in attitudes allows the model to be extended to estimate future risk. The resulting risk estimation approach represents an important step toward developing a method for motivating care providers to take meaningful steps to prevent the onset of substance use.

Summary of policy and practice implications

The routine use of attitudes to estimate risk of substance use may improve providers' motivation and ability to implement appropriate preventive services to adolescents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Figure 2.

Table 1
Recently Reported Prevalence of Substance Use Behaviours from Two U.S. Surveys.

	Grade	Age*	Drinking	Drunkenness	Cigarettes	Cannabis
<i>Monitoring the Future</i>	8	13	11%	4%	5%	7%
	10	15	28%	15%	11%	17%
	12	17	42%	28%	17%	23%
<i>Youth Risk Behaviour Survey</i>	9	14	30%	14%	3%	18%
	10	15	36%	18%	4%	22%
	11	16	43%	25%	8%	26%
	12	17	48%	35%	11%	28%

Table 2

Distribution of Age and Gender

Age	Boys	Girls	Total
11	3,600	3,892	7,492
12	4,079	4,497	8,576
13	3,102	3,377	6,479
14	2,660	2,969	5,629
15	1,594	1,706	3,300
16	1,682	1,217	2,899
17	856	756	1,612
Total	17,573	18,414	35,987

Table 3

Cronbach Alpha Coefficients Averaged across Contributing Databases

	Age						
	11	12	13	14	15	16	17
Boys	.856	.881	.877	.883	.847	.881	.833
Girls	.795	.875	.903	.893	.903	.858	.863
Average	.826	.878	.890	.888	.875	.870	.848

Table 4

Point Biserial Correlations between Attitude and Four Substance Use Behaviours *

	Alcohol	Drunkenness	Cigarettes	Cannabis
Total Sample	−0.555	−0.517	−0.552	−0.476
Boys	−0.567	−0.528	−0.523	−0.487
Girls	−0.536	−0.499	−0.585	−0.455

* All correlations are significant beyond $p = .0001$

Table 5

Observed Attitude Scores *

Age	Combined Sample		Boys		Girls	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
11	8.558	1.274	8.420	1.370	8.696	1.164
12	8.048	1.551	7.884	1.607	8.211	1.481
13	7.487	1.790	7.357	1.837	7.616	1.738
14	6.981	1.923	6.830	1.923	7.131	1.913
15	6.763	2.024	6.544	2.046	6.981	1.981
16	6.401	1.896	6.007	1.753	6.795	1.990
17	6.254	2.109	5.933	2.140	6.574	2.023
Overall	7.213		6.997		7.429	

* Attitude scores range from 0 to 10 with 10 being theoretically the most desirable.

Table 6

Results of Logistic Regression with Substance Behaviours as Dependent Variables.

Behaviour	Gender	Statistic	Attitude	Age	Attitude × Age	Intercept	Nagelkerke R ²
Alcohol	Girl	B	-0.415	0.401	-0.021	-1.331	0.394
		Wald χ^2	14.886	45.878	7.092	2.696	
		<i>p</i>	0.000	0.000	0.008	0.101	
		Odds ratio	0.564	1.076	0.986	15.197	
	Boy	B	0.088	0.693	-0.061	-5.030	0.447
		Wald χ^2	0.691	151.680	58.123	43.872	
		<i>p</i>	0.406	0.000	0.000	0.000	
		Odds ratio	1.092	2.001	0.941	0.007	
Drunkenness*	Girl	B	0.338	0.451	-0.060	-3.738	0.249
		Wald χ^2	4.409	37.591	26.513	13.109	
		<i>p</i>	0.036	0.000	0.000	0.000	
		Odds ratio	0.456	1.196	0.992	11.003	
	Boy	B	0.774	0.582	-0.098	-5.115	0.276
		Wald χ^2	26.959	77.957	79.107	31.342	
		<i>p</i>	0.000	0.000	0.000	0.000	
		Odds ratio	2.168	1.789	0.907	0.006	
Cigarettes	Girl	B	-0.785	0.179	-0.008	2.398	0.464
		Wald χ^2	38.558	7.822	0.824	7.370	
		<i>p</i>	0.000	0.005	0.364	0.007	
		Odds ratio	0.948	1.445	0.945	0.126	
	Boy	B	-0.572	0.073	-0.014	2.721	0.378
		Wald χ^2	29.789	2.139	3.451	15.475	
		<i>p</i>	0.000	0.144	0.063	0.000	
		Odds ratio	0.938	1.628	0.948	0.036	
Cannabis	Girl	B	-0.053	0.368	-0.057	-2.073	0.403

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Behaviour	Gender	Statistic	Attitude	Age	Attitude × Age	Intercept	Nagelkerke R ²
		Wald χ^2	0.167	43.252	34.364	7.093	
		<i>p</i>	0.682	0.000	0.000	0.008	
		Odds ratio	0.955	1.611	0.942	0.024	
Boy		B	−0.046	0.477	−0.059	−3.727	0.416
		Wald χ^2	0.081	46.546	25.049	14.609	
		<i>p</i>	0.776	0.000	0.000	0.000	
		Odds ratio	0.625	1.405	0.978	0.221	

* Calculated using only data from those who had reported alcohol use.