HEALTH EDUCATION RESEARCH

Vol.36 no.3 2021
Pages 309–318
Advance Access published 12 January 2021

Testing risk and protective factor assumptions in the Icelandic model of adolescent substance use prevention

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Received on June 2020; editorial decision on December 2020; accepted on December 2020

Abstract

Iceland has witnessed a dramatic decline in adolescent substance use that may be partly the result of efforts related to the Icelandic prevention model (IPM). We sought to test risk and protective factor assumptions of the IPM using a prospective cohort study with 12 months separating baseline from follow-up. Participants were students in grades 8 and 9 in the national Icelandic school system enrolled in the spring of 2018 and 2019 (N=2165). Participants self-reported their experiences of cigarette smoking, alcohol consumption, and cannabis use and seven risk and protective factors. Analyses were conducted with generalized linear modeling with extension to general estimating equations with correlated outcomes data. Both individual main-effects models and collective models including all main-effects were tested. Out of 28 individual main-effects models, 23 produced findings consistent with study premises (P<0.05). Multiple main-effects models largely sustained the findings of the individual main-effects models. Findings support the assumption that the risk and protective factors commonly emphasized in the IPM are associated with the four different substance use outcomes in the hypothesized direction. Communities that plan to implement the IPM among adolescents might consider these factors in their work.

Introduction

During the last 20 years, Iceland has witnessed a dramatic decrease in the prevalence of adolescent substance use [1]. Between 1998 and 2018, the prevalence of daily tobacco smoking among 10th grade students went from 23% to 2%, drunkenness during last 30 days fell from 42% to 6%, and lifetime use of cannabis substances (marijuana and hashish) from 17% to 6%, evidenced by the local Youth in Iceland study series [2]. Although several European countries have reported downward trends in adolescent substance use in recent years, the decline in use among youth in Iceland has been steeper than elsewhere, even when compared with its neighboring Nordic countries [3, 4].

These pronounced changes in levels of adolescent substance use in Iceland have been at least partly

doi:10.1093/her/cyaa052

attributed to a nationwide implementation of a comprehensive, community-based primary prevention system called 'the Icelandic Model for Primary Prevention of Substance Use' (IPM) [5–7]. In principle, the IPM is a process-based dissemination and implementation system of collaboration where researchers, policymakers, administrative leaders and community practitioners join forces to annually assess needs and changes in both substance use outcomes and carefully defined risk and protective factors, which then leads to the selection of priorities, organization of strategies and allocation of necessary resources for prevention work at the national, municipal and local community levels [8].

The underlying pillars of the IPM were originally developed in the early 1990s via translation of classic theories of social deviance that originate in sociology and criminology [9–11], and not in traditional health behavior change theories [12]. The mutual viewpoint of those deviance theories is that most individuals are capable of initiating deviant acts, such as substance use but only under certain environmental and social circumstances will those acts become common patterns of behaviors among dominant groups of adolescents. Major reasons for the development of negative behavioral patterns include (i) lack of environmental sanctions by the social environment (e.g. parents and other adults), (ii) low individual and/or community investment in traditional and positive values (e.g. education) and (iii) lack of opportunities for participation in positive and prosocial development (e.g. organized recreational and extracurricular activities, such as sports, music, drama, after school clubs, etc.) [5]. Thus, the IPM emphasizes that the odds of substance use developing among adolescents is decreased by affirming parental and family-based support for positively valued behaviors, and sanctioning negatively valued behaviors by increasing parental monitoring, focusing on educational commitment and strengthening adolescent social capital via parental relationships with other parents and their children's friends [7, 8]. Further, the IPM seeks to improve access to and participation in organized and positive prosocial activities, such as organized sports and extracurricular activities, and the prevention of negative social behaviors, such as late and unorganized outside hours [7, 8].

The mechanisms that are assumed to drive down risk factors and strengthen protective factors may vary between communities. However, strong community collaboration between researchers, policy makers and administrative leaders and community practitioners lies at the heart of all local efforts, including quick and efficient dissemination and translation of local research findings, and goals and strategies decided by the local community [8]. In this respect, the IPM is not a program in the conventional sense but an ongoing effort to inform and mobilize society for the positive development of young people. At its core is the notion that substance use among youth is almost universally initiated as a social activity instigated via peer-group relations [13–15]. The younger adolescents are when substance use is initiated the more likely they are to develop from recreational use to problematic use, abuse and into dependence [16, 17]. Hence, three critical assumptions of the IPM are: (i), as potential substance users, adolescents are by and large products of the social environment; (ii) adolescent substance use is largely attributable to an unfavorable imbalance in the prevalence of ecologic risk and protective factors in their environment; and (iii) onset of use should be delayed as long as possible rather than awaiting individual service needs once the problem has manifested itself in routine behaviors [5]. The theoretical pillars underlying the model have been described by Sigfusdottir *et al.* [7] and the five underlying core principles of the IPM have been described by Kristjansson *et al.* [5].

Despite Iceland's success in reducing youth substance use during the last 20 years, the assumed core risk and protective factor main-effects have never been tested using a longitudinal research design, although both trend analyses [1, 18] and quasi-experimental, group-based comparisons over time [19] have been published. The absence of an appropriate longitudinal test of the relations between risk and protective factors and outcomes of the model largely stem from three main reasons. First, within the model, all data collection processes, analyses,

dissemination of results and micro and mezzo level translation with policy makers and practitioners, have been conducted with practice-based needs in mind [5, 8]. Because the IPM focuses on the environmental imbalance in risk and protective factors as the primary reasoning for adolescent substance use initiation and development, the data that are used to evaluate and support action items at the local community level have been generated via repeated cross-sectional surveys rather than in longitudinal designs. Second, because the model is not an intervention in the classical sense, the IPM does not easily lend itself to typical random allocation designs, such as the RCT. In fact, in an assessment of the premises and transferability of the IPM for potential adaptation and implementation in Ontario in Canada, Bajwa [20] stated that the model would most likely better be suited to be tested longitudinally in a cohort design rather than as a randomized trial. Third, for a holistic and longstanding preventive community impact, the IPM relies heavily on the accumulation of effects stemming from several risk and protective factors that mutually affect the risks of alcohol, tobacco and other drug (ATOD) use initiation and progression among youth in local communities. Hence, an appropriate test of the model assumptions should simultaneously include an assessment of core parental, community, school and leisure time factors that have been identified by the model as critical for the initiation and progression of substance use among adolescents [6, 8, 19]. Thus, the aim of this study was to test the relations between core risk and protective factors, identified by the IPM, and several substance use outcomes in a longitudinal cohort design.

Materials and methods

Sample and participants

Data for this report are based on two waves of school-based surveys from the LIFECOURSE study of risk and protective factors for healthy adolescent development. LIFECOURSE is a developmental cohort study that covers the early lifespan of the 2004 birth cohort of children in Iceland from before birth to the age of 15/16. The theoretical framework for the study has been described elsewhere [21]. Of the 3914 individuals that were approached for participation, 2373 (60.6%) provided informed parental consent and student assent, with 2278 (96.0%) responding to the baseline survey of consented participants (girls =51.1%). The study was reviewed and approved by the National Bioethics Committee of Iceland (equivalent to a national IRB) and the study has been registered and acknowledged by the Personal Protection Authority.

Procedure

The school-based surveys were conducted by ICSRA in February in 2018 (T1) and 2019 (T2) in all upper secondary schools in Iceland using procedures developed by ICSRA in collaboration with the Icelandic Ministry of Education, Science and Culture over a 20-year period [22]. First, contact information for the sample was acquired through the National Statistical Bureau and sister agencies. A non-traceable, unique research identification number was created for each participant. Teachers at individual school sites supervised participation of students in the classroom and administered the survey questionnaire using a double-envelope system to identify students while distributing the surveys in classroom settings, omitting their identification post-survey completion (non-traceable ID printed on each individual questionnaire for scanning and data processing). Students were instructed not to write their names, social security numbers or any other identifying information anywhere on the questionnaire. Upon survey completion, students were asked to place their completed questionnaire in a blank and pre-sealed envelope provided to them before returning it to the supervising teacher. A key that links individual names and contact information to research IDs is maintained by a third party at the Primary Health Care Clinics of the Capital Area and is not accessible to the research team.

Measures

Measures in the LIFECOURSE study have been adapted from international studies, such as

monitoring the future [23], ESPAD [3] and the 25-year long running Youth in Iceland study series [7].

Dependent variables

Four dependent variables were employed in this study at Times 1 and 2, respectively, headed with the statement: how often in your lifetime have you smoked cigarettes/used e-cigarettes or vaped/consumed alcohol of any kind/used hashish or marijuana? Response categories ranged from 0='Never' to 7='40 times or more'. For the purposes of these analyses, responses were collapsed to 0='Never' and 1='Once or more'.

Independent variables

Consistent with previous descriptions of the IPM [5–8], the following seven independent variables were used in these analyses: outside hours after midnight, organized sport participation, organized recreational/extracurricular activities, parental monitoring, time spent with parents, social capital and low school engagement.

'Outside hours after midnight' were assessed with the question: if you think about the last 7 days, how often did the following apply to you? 'I went outside in the evening and returned home after midnight'. Reponses ranged from 1= 'Never' to 8='7 times'. Responses were collapsed to 0= 'Never' and 1= 'Once or more'.

'Organized sport participation' was assessed with the question: how often do you practice sports with a club or a team? Responses ranged from 1= 'Almost never' to 6= 'Almost every day'. Responses were dichotomized with 0='2 times per week or less' and 1= '3 times per week or more'.

Participation in 'organized recreational and/or extracurricular activities' was assessed with the question: how often do you participate in organized recreational or extracurricular activities? Responses ranged from 1= 'Almost never' to 6= 'Almost every day'. Responses were dichotomized with 0= 'Almost never' to 1= 'Once per week or more'.

'Parental monitoring' was assessed with two questions headed with: how do the following statements apply to you? (i) 'My parents follow whom I am with in the evenings', and (ii) 'My parents know where I am in the evenings'. Reponses to both questions ranged from 1= 'Applies very badly to me' to 4= 'Applies very well to me'. Scores were summed to form a scale with a range from 2 to 8.

'Time spent with parents' was assessed with two questions headed with: how do the following statements apply to you? (i) 'I spend time with my parent(s) outside school hours on working days', and (ii), 'I spend time with my parents during weekends'. Responses ranged from 1= 'Almost never' to 5= 'All the time'. Scores were summed to form a scale with a range from 2 to 10.

'Social capital' was assessed with two questions headed with: how do the following statements apply to you? (i) 'My parents know my friends' and (ii) 'My parents know my friends' parents'. Reponses to both questions ranged from 1= 'Applies very badly to me' to 4= 'Applies very well to me'. Scores were summed to form a scale with a range from 2 to 8.

'Low school engagement' was assessed with four items headed with: how well do the following statements apply to you? (i) 'I find the school studies pointless', (ii) 'I am bored with the studies', (iii) 'I am badly prepared for classes' and (iv) 'I feel like I don't put enough effort into my studies'. Responses ranged from 1= 'Applies almost never to me' to 5= 'Applies almost always to me'. Scores were summed to form a scale with a range from 4 to 20.

Control variables

Three control variables were dichotomized and employed in all analyses: (i) gender (girls =1), (ii) family structure (lives with both parents =1) and (iii) mother's education (college degree or higher =1).

Statistical analyses and handling of missing data

Participants who reported having ever engaged in one of the outcome risk behaviors at Time 1, and then reversing their response at Time 2 were dropped (n=113) for a final sample size of N=2165. Missing values within individual variables ranged from 0 to 20.8%. Multiple imputations (MI) were conducted using IVEware 0.3 [24] with SAS

Srclib. Imputations were run using the sequential regression method, with bounds set on ordinal and continuous data, and a minimum marginal R^2 value set to 0.01. Consistent with IVEware recommendations [24], 10 iteration cycles were run with 100 datasets imputed. Sensitivity analysis of the final imputed models against the original un-imputed dataset suggested fairly stable estimates with improved power for detecting model effects.

All analyses were conducted in SAS 9.4 [25]. Ordinal data with sufficient variability were treated as continuous predictors; distributional properties were assessed, and Skew and Kurtosis determined to be within 1.0 in most cases and <2.0 in all cases. All other variables were treated as categorical. The primary analysis technique was generalized linear modeling with extension to general estimating equations (GEE) with correlated outcomes data, using a binomial distribution and logit link and repeated subject set as the participant ID [26]. Correlation structure were selected based on best fitting Quasi-likelihood under the Independence Model Criterion with AR(1) determined as most suitable for our analyses. Demographic covariates (consistent across all models) were also selected during this model-fitting phase. Once the best fitting models were selected, final model results were reported by running the models by each MI, and then outputting the GEE parameter estimates with empirical standard errors, parameter indices and GEE covariance matrix to appropriately account for the repeated measures in the data. MI analyzes then summarized the model effects of the intercept and predictors (including covariates of gender, mother education and family structure for all models). Models were run for all four outcomes with both single and multiple main-effects. Parameter estimates were exponentiated and reported as Odds Ratios (OR); 95% CI of the parameter estimates (also exponentiated and reported as ORs) and *P*-values are also reported.

Results

Table I includes descriptive statistics for all non-imputed study variables, including the prevalence of each outcome variable at T1 and T2, respectively. As expected, the proportion of respondents reporting ever using any of the four substances grows steadily with age. For example, ever cigarette smoking increased from 3.1% at T1 to 7.2% at T2, and ever alcohol use increased from 13.6% at T1 to 24.9% at T2. We also assessed the bivariate correlation between the independent and dependent variables at Times 1 and 2. This analysis revealed relationships strength from non-significant to r=0.64 (see Appendix tables; Supplementary data are available at *HEAL* online).

Table I. *Descriptive statistics (non-imputed results), N=2165*

Categorical variables (%)	Time 1	Time 2
Ever cigarette smoking	3.1	7.2
Ever e-cigarette use	14.2	27.2
Ever alcohol use	13.6	24.9
Ever marijuana use	0.8	4.5
Outside after midnight	7.2	14.4
Sport participation 3+	59.6	53.3
Organized recreational/ extracurricular activities 1+	37.2	38.3
Girls	51.1	n/a
Family structure (lives with both parents)	75.0	n/a
Mother education (college degree)	43.7	n/a
Continuous variables (mean SD)		
Parental monitoring	6.3 (1.71)	6.4 (1.65)
Time spent with parents	7.6 (1.84)	7.4 (1.91)
Social capital	6.9 (1.27)	6.7 (1.34)
Low school engagement	9.2 (3.18)	9.9 (3.30)

Table II shows the results for all single main-effects models while controlling for gender, family structure and mother's education. Each of the seven model blocks includes four models, one for each outcome, for a total of 28 models. Within all model blocks, the time variable is statistically significant in all instances, which reflects the natural progression in odds of any form of substance use as participants grow older between T1 and T2. A summary of the main-effects models shows 23 of 28 relationships to be statistically significant in the expected direction in all instances. For example, for the first model in model Block 1, predicting cigarette smoking, each increase in score on the parental monitoring measure is related to the decrease in odds of

Table II. *Single main-effects models (controlling for gender, mother education, family structure)*

Main-effects:	DV: ever smoking			DV: ever e-cigarette			DV: ever alcohol			DV: ever cannabis		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Model block 1												
Time	2.18	1.65–2.88	<0.01	2.00	1.74–2.30	<0.01	1.89	1.63–2.18	<0.01	4.06	2.37–6.93	<0.01
Parental monitoring	0.81	0.74–0.89	<0.01	0.89	0.85–0.94	<0.01	0.87	0.82–0.92	<0.01	0.74	0.65–0.84	<0.01
Model block 2												
Time	2.02	1.51–2.69	<0.01	1.93	1.67–2.22	<0.01	1.81	1.56–2.09	<0.01	3.65	2.13–6.27	<0.01
Time spent with parents	0.74	0.68–0.81	<0.01	0.81	0.77–0.85	<0.01	0.87	0.83–0.91	<0.01	0.67	0.60–0.76	<0.01
Model block 3												
Time	1.98	1.49–2.63	<0.01	1.92	1.66–2.21	<0.01	1.79	1.54–2.07	<0.01	3.69	2.13–6.39	<0.01
Social capital	0.67	0.60–0.75	<0.01	0.77	0.72–0.83	<0.01	0.78	0.72–0.83	<0.01	0.54	0.47–0.62	<0.01
Model block 4												
Time	1.94	1.46–2.58	<0.01	1.86	1.61–2.15	<0.01	1.75	1.51–2.02	<0.01	3.52	2.05–6.06	<0.01
Low school engagement	1.19	1.13–1.26	<0.01	1.17	1.13–1.20	<0.01	1.12	1.08–1.15	<.01	1.24	1.15–1.33	<0.01
Model block 5												
Time	1.99	1.49–2.65	<0.01	1.89	1.63–2.19	<0.01	1.80	1.56–2.07	<0.01	3.66	2.15–6.23	<0.01
Outside after midnight	2.25	1.02–4.81	0.04	1.89	1.02–3.49	0.04	1.60	0.86–2.97	0.14	3.19	1.42–7.13	<0.01
Model block 6												
Time	2.05	1.56–2.70	<.01	1.92	1.68–2.21	<0.01	1.82	1.57–2.10	<0.01	3.81	2.24–6.46	<0.01
Sport participation	0.57	0.39–0.82	<0.01	0.65	0.48–0.86	<0.01	0.71	0.54–0.93	0.01	0.48	0.30–0.79	<0.01
Model block 7												
Time	2.13	1.61–2.79	<0.01	1.96	1.71–2.26	<0.01	1.85	1.62–2.13	<0.01	3.99	2.39–6.68	<0.01
Organized rec. activities	1.36	0.96–1.92	0.09	1.15	0.86–1.54	0.35	1.06	0.83–1.37	0.63	1.19	0.76–1.87	0.45

DV= dependent variable.

smoking by 19%. Similarly, the fourth model in model Block 5, predicting cannabis use, shows that spending time outside after midnight once or more is related to the increase in odds of ever using cannabis substances by over 3-fold. Five models revealed non-significant main-effects. Only outside hours after midnight predicting alcohol use and all four models for organized recreational activities were not significant in our analyses.

Table III includes the results for the four multiple main-effects models while controlling for gender, family structure and mother education. Each model includes all seven independent variables. As before, the time variable is significant in all instances reflecting increased odds in all forms of ever ATOD use as participants grow older. In Model 1, predicting smoking, significant main-effects were observed for time spent with parents, social capital, low school engagement, outside hours after midnight and marginal relations for parental monitoring (P=0.09) and sport participation (P=0.07). Similar findings were observed in the remaining three models with four significant main-effects (P<0.05) and further 1–2 main-effects marginally significant. Similar to the single main-effects models, only participation in organized recreational/extracurricular activities remained non-significant in all instances.

Discussion

The findings suggest that the underlying risk and protective factor assumptions of the IPM hold in a longitudinal design. Within the single main-effects models, six out of seven independent variables (all except weekly participation in organized

Table III. *Multiple main-effects models*

Main-effects:	DV: ever smoking			DV: ever e-cigarette			DV: ever alcohol			DV: ever cannabis		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Time	1.77	1.27–1.87	<0.01	1.77	1.52–2.07	<0.01	1.70	1.45–1.98	<0.01	3.16	1.79–5.58	<0.01
Parental monitoring	0.92	0.83–1.01	0.09	0.97	0.92–1.04	0.41	0.93	0.87–0.98	0.01	0.89	0.78–1.02	0.09
Time spent with parents	0.83	0.76–0.91	<0.01	0.86	0.81–.90	<0.01	0.92	0.87–0.97	<0.01	0.79	0.70–0.90	<0.01
Social capital	0.80	0.70–0.90	<0.01	0.86	0.79–0.93	<0.01	0.84	0.79–0.91	<0.01	0.67	0.57–0.79	<0.01
Low school engagement	1.12	1.05–1.18	<0.01	1.12	1.09–1.16	<0.01	1.08	1.05–1.12	<0.01	1.12	1.04–1.21	<0.01
Outside after midnight	1.83	1.04–3.20	0.03	1.55	0.90–2.68	0.12	1.33	0.78–2.27	0.30	2.29	1.27–4.12	<0.01
Sport participation	0.69	0.46–1.03	0.07	0.71	0.55–0.92	<0.01	0.78	0.60–1.02	0.07	0.60	0.35–1.03	0.06
Organized rec. activities	1.17	0.76–1.80	0.47	1.02	0.77–1.34	0.89	0.96	0.74–1.25	0.77	0.90	0.52–1.57	0.71

DV= dependent variable.

recreational and extracurricular activities) revealed a statistically significant over-time main-effects on the outcomes in 23 out of 24 models. Spending time outside after midnight was not significantly related to increased odds in ever using alcohol (P=0.14). Weekly participation in recreational and/or extracurricular activities was non-related to the outcomes in all four instances. Despite a presumed and considerable overlap between several independent variables, the multiple main-effects models largely sustained the individual main-effects model findings with four out of seven main-effects variables significant (P<0.05) in all instances, and further 1–2 main-effects marginally significant (P-values ranging from 0.06 to 0.12).

An important aspect of the IPM is its non-prescriptive approach to community-based prevention. Consistent with Livingood *et al.* [27] recommendations labeled 'a toolkit approach' to health promotion, the model assumes that risk and protective factors will vary in both volume and intensity between communities, and that the selection of factors to focus on in prevention will depend on several functions, such as regular survey assessment, present assets and capabilities of the local community to strengthen protective factors and drive down risk factors and both present and future resource allocation to support prevention work. Practically, the IPM assumes that many risk and protective factors overlap at the community level. For example, strengthening parental monitoring at the individual level will presumably bear implications for less frequent late outside hours [5, 6]. Likewise, the IPM assumes that communities differ widely in their readiness and capacities to engage in prevention work, which renders a careful selection of factors to focus on at any given time a crucial part of the model [8]. In this respect, the single main-effects tests demonstrate that prevention work around a given factor may have important implications for one or more other factors over time. The multiple main-effects models further demonstrate that, in statistical terms, the overlap is minimal, although the implications for change in any single risk and/or protective factor may be substantial at a practical level.

All main-effects variables tested in our analyses have been individually studied in other settings although a holistic assessment into several of the core risk and protective factors identified by the IPM have not been tested simultaneously before. Previous studies have found that increased time spent with parents [28], levels of parental monitoring [29] and social capital [30, 31] serve to decrease the odds of substance use and delinquency among youth. Multiple studies have shown that low school engagement signifies a likely path to delinquency [32, 33], and findings from leisure studies have long

shown participation in organized and structured activities, such as sports, music and drama to be important for healthy development [34, 35]. It is therefore particularly noteworthy that we did not find any significant main-effects for participation in organized recreational and/or extracurricular activities, neither in individual or multiple main-effects models. This calls for special attention. Several scholars have pointed out that the main element in the positive impact of leisure activities on youth development is to be found in the structure, organization and exposure to healthy adult role models rather than the specific content of the activity [36, 37]. In this study, however, measurement of organized recreational and/or extracurricular activities was conducted with a single survey item that presumably does not detect a suitable difference between organization, structure and adult involvement noted in previous studies as important elements. Further, studies in adolescent leisure activities have found that both perceived availability and levels of engagement are important to determine the impact of recreational and extracurricular activities on adolescents ATOD use [36, 38–40]. It is thus possible that the limited range in assessment of organized recreational and extracurricular activities led to the non-significant findings of these main-effects.

This study has some limitations. First, our selection of variables to be included in our tests of assumptions by the IPM was made with a mixture of convenience and prior knowledge and experience of the model. This of course does not rule out other factors that may be important for primary prevention. Second, because our assessment is about risk and protective factor assumptions in the IPM for primary community-based prevention and not to test relationship differences across different outcomes, we did not adjust the *P*-values for multiple tests as would be more appropriate in basic research. Third, three of seven independent variable measures were employed with single-item questions. Although some of these measures follow a count distribution, we recommend that future assessments of the IPM prioritize use of validated scales to the extent possible. Fourth, our study sample was limited to Iceland. Despite several previous studies have shown adolescents in Iceland to be largely similar to youth in other advanced economies, some ecologic and structural factors, e.g. the nature and organization of sport participation, may differentiate Iceland from other places [37]. Fifth, our longitudinal assessment only included two time points. Future studies would benefit from using growth-curve techniques to assess change over a longer period with larger number of data points. Finally, this study sought to test assumptions about the applicability of risk and protective factors designated as important by the IPM. However, we did not perform any tests into which mechanisms may prove most useful in driving down those risk factors and/or strengthening protective factors. Future studies that include rigorous process data are needed for such examination.

Notwithstanding these limitations, this study has several notable strengths. First, the cohort design and state-of-the-art analyses utilized give us considerably more confidence in the findings than analyses conducted solely with cross-sectional data could. Second, the study sample was sufficiently large to determine the unique contribution of several related risk and protective factors, such as both time spent with parents and parental monitoring, despite their apparent overlap. Third, instead of merging several types of ATOD use to a single and general outcome measure, we were able to assess the main-effects for four distinct outcomes.

In conclusion, the findings of this study support the assumption that the risk and protective factors commonly emphasized in the IPM are related to the four different substance use outcomes in the hypothesized direction. This holds true for both individual risk and protective factors, as well as in the collective statistical assessment. Communities that plan to implement the IPM for alcohol, tobacco and other drug use prevention among adolescents might consider these factors in their work. Future studies into the premises of the IPM should incorporate other mechanisms into the assessment, such as a finer breakdown of leisure time activities and a more elaborate measure of school-based factors.

Supplementary data

Supplementary data are available at *HEAL* online.

Funding

This work was supported by the European Research Council (ERC) award ERC-CoG-2014-647860 and by the National Institute of General Medical Sciences of the National Institutes of Health (NIH) award 2U54GM104942-02.

Conflict of interest statement

None declared.

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