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Mapping risk factors for substance use: Introducing the YouthMap12

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ABSTRACT

Background: In adolescence, psychological problems and regular use of alcohol, cigarettes, cannabis and other drugs (AOD) tend to cluster together, strongly indicating that certain groups of young people are at elevated risk of developing a problematic use of AOD. **Objective:** The aim of the present study was to develop an easy-to-implement screening instrument to identify subgroups of young people with different psychological problems at risk of problem use of AOD. **Method:** 3,589 randomly selected young Danes between 15-25 years, from a national survey (n=2,702) and a municipality survey (n=887), answered a 12-item questionnaire (YouthMap12) with 6 items identifying externalizing problems (EP6) and 6 items identifying internalizing problems (IP6). Latent class analysis (LCA) was used to characterize groups at risk, and associations were estimated between EP6 and IP6 and regular use of AOD, and between latent class membership and regular use of AOD. **Results:** LCA identified 6 classes with varying degree of externalizing and internalizing problems: 70% of youth were in the low problem score class, and the remaining 30% were at various levels of risk. Regular use of cigarettes, cannabis and alcohol was strongly associated with classes characterized by externalizing problems, while over-the-counter and prescription medicine was strongly associated with classes characterized by internalizing problems. **Conclusions:** Youth at risk of problem use of AOD can be identified using a simple and easily administered instrument.

Key words: adolescents; substance use; latent class analysis; externalizing; internalizing; integrative approaches.

1. INTRODUCTION

Risk-taking behaviors such as use of alcohol, cigarettes, cannabis and other drugs (AOD), risky sexual behavior and driving-related risks emerge in adolescence and tend to cluster together. This strongly indicates that certain groups of young people are at elevated risk of developing not only one, but several risk-taking behaviors (1).

While risk behaviors cluster, prevention is very often focused on category-by-category approaches, in which each individual health-related behavior is addressed independently. As Wiefferink et al. points out, such a category-by-category approach creates a risk that extra-curricular activities become overloaded (1). In addition, prevention programs rarely address specific risk groups, but usually target the general population (e.g. all pupils in secondary school). Within the health promotion sector there are thus increasing calls for an integrative approach to health-related behaviors. However, such a meaningful integrative approach will only be possible if there is some clustering, not only of the more direct risk-taking behaviors (e.g. drinking alcohol and smoking cigarettes), but also of the psychological and behavioral characteristics associated with or predictive of specific risk-taking behavior such as regular use of AOD.

Latent class analysis (LCA) has been used to identify different classes of alcohol and drug use patterns and psychosocial risk groups in clinical as well as general populations. LCA approaches can be divided into four types: The first approach, which is used in the majority of studies is that of AOD classification, in which classes of AOD patterns are first identified, and subsequently linked to different demographic, psychosocial and behavioral characteristics (e.g. 2). Another approach has been the mixed classification approach, which includes both the use of AOD and psychosocial factors associated with AOD use in the same LCA (e.g. 3). A third approach has been the psychosocial classification

approach, in which individuals are classified according to psychosocial characteristics and classes are subsequently characterized according to the use of AOD (e.g. 4) and finally a number of studies have used a longitudinal approach, in which respondents have been followed over time. These longitudinal studies can be based on AOD use as well as psychosocial classification approaches (e.g. 5, 6).

Studies that classify individuals based on AOD variables are helpful in clustering various type of AOD together, and may provide clues as to the pattern of substances being used by various groups in society. Classifying individuals based on their use of particular substances in a longitudinal design may inform researchers about substances that are typically used as entry drugs within a region or country and about transitions between types of drugs used. Studies using psychosocial variables, such as the present study, can be helpful in identifying subgroups at risk of initiating or escalating substance use, and in quantifying the number of individuals in a country or region who belong to a particular high-risk group.

Across methodologies, LCA studies converge in showing that high risk consumption of AOD is associated with both externalizing and internalizing problems, and that the strongest associations are with externalizing problems.

Associations between internalizing and externalizing problems and AOD use have also been reported in numerous studies using other methodologies. Some of the more robust findings have been associations between heavy use of alcohol and conduct problems, sensation seeking, poor well-being, and to some extent, internalizing problems (7-9). Tobacco smoking has been associated with both externalizing and internalizing problems (10-13). Cannabis use has been linked with externalizing problems, such as

attention deficit hyperactivity disorder (ADHD) and conduct disorder (14, 15), and with more general mental health and social problems (16-20).

Although numerous studies have found support for a two-factor, internalizing and externalizing, model, some studies have stressed the co-occurrence between externalizing and internalizing problems (21). Hence, in order to translate the associations between externalizing/internalizing problems and AOD use into policy, there is a need for strategies for classifying at-risk youth that are easy to understand and implement without reducing the psychosocial problems to a simple distinction between externalizing and internalizing problems.

The aim of the present cross-sectional study was to develop such an “easy-to-implement” method to identify different psychological subgroups of young people at high risk of developing problematic use of different types of drugs, including alcohol, cigarettes, cannabis, medicine for physical problems (over-the-counter: OTC, and prescription) and psychotropic medicine. Identification of subgroups at high risk is crucial in terms of directing prevention efforts at the most relevant groups and guiding integrative treatment approaches.

2. MATERIAL AND METHODS

2.1 Sample

Data were drawn from two separate Danish surveys conducted in the spring of 2015 and carried out by Centre for Alcohol and Drug Research, Aarhus University. In the first survey (the National YouthMap Survey), a sample of 4,853 persons between the 15-25 years of age, representing 806,577 young Danes, was randomly drawn from the central person registration numbers (CPR) by Statistics Denmark (the central authority on Danish

statistics, see <http://www.dst.dk/en>). Potential respondents were invited by postal letter to complete a web-based questionnaire. Telephone interviews were conducted with those individuals who had not responded after two reminders. The final sample consisted of 2,702 respondents representing a response rate of 56 %. The respondents were 50.9 % women (mean age 19.7) and 49.1 % men (mean age 19.5).

In the second survey (the Gentofte YouthMap Survey), the same procedure was applied. A sample of 1,530 persons between 15-25 years of age, representing 9,432 persons, was randomly drawn from the CPR by Statistics Denmark. The final sample consisted of 887 respondents (58 % response rate). The respondents were 50.4 % women (mean age 18.6) and 49.6 % men (mean age 18.8). Gentofte is the wealthiest municipality in Denmark. The mean total family income in 2014 was 115,093 EUR for a family in Gentofte versus 64,474 EUR for an average Danish family. In the present article, the Gentofte survey is used only to evaluate the reliability of the latent class model identified in the National YouthMap Survey. The demographic characteristics of the two surveys can be found in Table 1.

Table 1. Demographic characteristics of the two samples.

		Denmark n=2,702 Percent	Gentofte n=887 Percent
Sex	Women	50.93	49.61
	Men	49.07	50.39
Age	15-16 yr.	21.54	28.75
	17-19 yr.	29.64	36.08
	20-25 yr.	48.81	35.19
Educational Activities	Lower secondary	21.21	24.58
	Upper secondary	24.91	39.23
	Vocational	9.85	3.39
	Further ¹	9.33	5.53
	Further (long) ²	11.58	8.91
	Other	3.14	3.95
	None, employed	13.88	11.05
	None, not employed	6.11	3.38
Ethnicity	Immigrants	4.55	4.17
	Descendants	4.51	2.48
Living with	Parents	63.59	82.03
	Partner	4.50	2.82
	Alone, friends etc.	31.91	15.14

¹ e.g. nurse and school teacher ² master level

The Gentofte respondents were younger than the national respondents because most young people leave Gentofte after they have finished upper secondary education. This relocating can explain why fewer youth from Gentofte were enrolled in further educational activities than in the national survey. In the national survey, 245 (9.06%) of the respondents were either immigrants (123/4.55%) or descendants with non-Danish citizenship (122/4.51%; a descendant being a person where none of the parents were born in Denmark). The 245 immigrants/descendants represented a response rate of 35.9 %.

In order to compensate for differences between the studied population and the general Danish population of same age, analyses were performed using weighted data.

Weights were created by Statistics Denmark and are based on national distributions of age, sex, ethnicity, family structure and parents' education.

Participants in both surveys were informed of the purpose of the survey and the interviews were all carried out by trained interviewers from Statistic Denmark. Both studies were approved by the Danish Data Protection Agency and all confidentiality and privacy requirements were met.

2.2 Measures

YouthMap is a measure developed for the monitoring of psychosocial problems/strengths and substance use among youth and adolescents (22). It was developed through close dialogue with several public Danish substance abuse treatment centers whose primary target group is adolescents and younger adults. The treatment centers all expressed a need for a less time-demanding screening tool that is specifically designed for their target group. In addition to mapping the use of AOD, YouthMap includes questions about physical condition, nutrition/eating/sleep patterns, social relationships/family, academic skills/problems, stressful/traumatic experiences and psychological/behavioral problems.

The development of the YouthMap12 indicator took place over two phases. Due to the outcome expectations from the municipality administration, the treatment centers were interested in obtaining information about educational activities, school performance and school behavior and about psychological well-being (in addition to information about alcohol and drugs). Because the treatment providers stressed the importance of information about school behavior, school performance and psychological well-being, several items were added to the full YouthMap instrument to tap into these constructs. Items were initially selected from various widely used questionnaires such as the

European Adolescent Drug Abuse Diagnosis (23) and the European Addiction Severity Index (24). In our initial discussions with the treatment centers and the first very preliminary statistical analysis of clinical samples it became clear that information gained from questions about school problems and conflicts with social network (e.g. “expelled from school because of behavior” and “violent behavior”) was a strong indicator of present conflict-oriented behavior and use of illicit drugs. This association between school failure and use of illicit drugs has also been found in numerous other studies (25-27). In addition, the counsellors saw the internalizing/self-destructive psychological problems (e.g. experienced symptoms of depression and deliberate self-harm) as essential in order to better their understanding of rather distinct social and psychological functions. At the same time, we found strong associations between these psychological problems, psychiatric diagnoses, and the use of prescription medicine.

The second step was a small pilot study carried out by Statistics Denmark in 2014. Twenty persons from the same age group were randomly chosen by Statistics Denmark and interviewed (22). Findings from the pilot study showed that several questions were difficult for the respondents to understand (e.g. the phrase “experienced hallucinations” was misinterpreted by most adolescents) and there was a need to rephrase most questions to make them easier to understand for adolescents. Finally, 12 items were chosen for further analysis. The questions as they were used in the present two surveys can be found in Appendix 1. The complete YouthMap survey can be downloaded from www.crf.au.dk or by following the link from references (22).

Six measures of regular use of alcohol, cigarettes, cannabis, OTC medicine, prescription medicine for physical problems and psychotropic medicine were used as key dependent variables. The American National Institute of Alcohol and Alcoholism (NIAAA)

defines heavy drinking as drinking 5 or more drinks on the same occasion 5 or more days out of the past 30 days (28). In line with this, we defined regular use of alcohol as binge drinking at least once a week. Regular use of cigarettes, cannabis, OTC medicine, prescription drugs for general medical problems and psychotropic medicine was defined as four or more days in the past month. This cut-off was used to ensure comparability with the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA)'s division of AOD use in the past month into the following segments: 1-3 days, 4-9 days, 10-19 days and 20+ days (29, 30).

2.3 Statistical analysis

We conducted an exploratory factor analysis (EFA) of the YouthMap12 on half the sample to determine the number of factors, and then conducted a series of confirmatory factor analyses (CFA) on the remaining respondents. The aim of the CFA was to validate the findings from the EFA, and to determine whether the factors, should more than one be identified, should be considered correlated or uncorrelated.

Because of the different scales used to rate the items, all questions were dichotomized. The cut-off point for each question can be found in Appendix 1. The cut-off point for each question was found by using the following two criteria: 1) no more than 10 % would fulfill the criteria for "yes" or, 2) a clear increase in use of AOD above cut-off point. 10 questions met the 10 % criteria. Only loneliness in the last month (13.1 %) and violent behavior over the lifespan (24.6 %) included more than 10 %. The reason for setting the cutoff for violent behavior to "any over the lifespan" (item 6, appendix 1) was a strong increase in use of cigarettes and cannabis between the 'never' and 'almost never' answers in both the preliminary statistical analysis and the pilot survey.

Weighted least squares means and variance adjusted (WLSMV) estimator has been suggested as the best option for evaluating models of categorical data (31). To estimate goodness of fit for the models, we used the comparative fit index (CFI), Tucker–Lewis Index (TLI), and root mean square error of approximation (RMSEA). Good fit for the models would be indicated by CFI and TLI values of 0.95 or greater and an RMSEA value of 0.06 or lower (32). Note that the commonly used χ^2 value is not used in CFA models with the WLSMV estimator, because it is too conservative in this context (33, 34).

Cronbach's alpha was used to examine the internal consistency reliability, which represents the extent to which item responses correlate with each other and with total scale score. Test-retest reliability of the two factors was evaluated based on 310 YouthMap electronic answers 6 weeks after they had first answered the questions.

The 310 respondents were randomly selected among 2,085 from the national survey who agreed to participate in a follow-up study. To evaluate the correlation between the test and the retest scores, we used an Intraclass Correlation Coefficient (ICC). The ICC detects within-subject stability between measuring occasions, taking into consideration changes in the overall mean of the item. To interpret the reliability of clinical instruments using the ICC, the following ranges are recommended: less than .40 = poor; .40-.59 = fair; .60-.74 = good; and .75-1.00 = excellent (35).

LCA was used to uncover substantively meaningful psychological classes of people that were similar in their responses to the 12 binary questions. LCA assumes that the co-variation between observed indicators is due to the existence of different latent classes with different probabilities of occurrence. On the basis of these probabilities, respondents can be sorted into classes (36). LCA models were tested sequentially, beginning with a 2-class model. Models ranging from 2 to 9 classes were evaluated and compared using the

Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC) and the Adjusted Bayesian Information Criterion (ABIC). The AIC, BIC and ABIC are all criteria for relative fit, so when comparing models, minimal observed values of the information criteria is used to determine optimal model fit. The numbers in and by themselves are not informative, but the lower of two fits is always the better. The BIC and ABIC differ from the AIC in that the BIC and the ABIC both increase in value when more parameters are added to the model, so that they will favor more parsimonious models.

The Lo–Mendel-Rubin adjusted LRT was used to compare a k class solution to a $k-1$ class solution, where k is a given number of latent classes. If the p -value indicates significance for a model with $(k-1)$ classes ($p < .05$) and the p -value for the model with k classes indicates a lack of significance ($p > .05$), the decision is to retain $(k-1)$ latent classes (37). Additional classes are added until the p -value for the statistic is >0.05 , at which point the previous model is accepted.

Receiver operating characteristic (ROC) analysis was used to find the most appropriate and easy-to-practice paper and pencil method to identify the latent classes. In statistics, a ROC analysis (or ROC curve) is used to identify the true-positive rate, also known as sensitivity (i.e. the likelihood that a certain disease is identified by the test) and the false-positive rate, also known as specificity (i.e. the likelihood that a healthy person is diagnosed with the disease). The area below a ROC curve quantifies the overall ability of the test to discriminate between individuals with and without the disease. A rough guide for classifying the accuracy of a diagnostic test is: excellent (.90-1), good (.80-.90), fair (.70-.80), poor (.60-.70) and fail (.50-.60) (38).

We used binomial logistic regression analysis and odds ratios (OR) to estimate associations between EP6/IP6 and regular use of AOD and between the identified latent classes and regular use of AOD.

To test whether associations between internalizing and externalizing problems differed by age, we conducted a series of logistic regression analyses stratified by age in three age groups: 15-16, 17-19 and 20-25 years of age.

The statistical packages Mplus (39) were used to evaluate the latent factors (EFA and CFA) and to identify the latent classes (LCA). STATA 13.0 software package was used for all other statistics than EFA/CFA and LCA.

3. RESULTS

3.1 YouthMap12

An exploratory factor analysis (EFA) was conducted on the first half of the sample to determine the minimum number of factors that adequately describe the correlations among the 12 YouthMap questions. The best goodness of fit was found in a two factor model (RMSEA=0.02, CFI=.99 and TLI=.99). Factor loadings for the first factor, which was called externalizing problems/EP6 (see Appendix 1), were between .64 and .95. Factor loadings for the second factor, which was called internalizing problems/IP6, were between .56 and .89.

In order to test the two-factor model, confirmatory factor analyses (CFA) were conducted using the second half of the sample. First, a one-factor model was fitted for comparison, and then a two-factor model was fitted. For the one-factor model, all fit indices indicated a poor fit. The model χ^2 was 878.1, $p < 0.001$, $df = 54$, the RMSEA was 0.106, the CFI was 0.788, and the TLI was 0.741. Finally, the WRMR was 3.564.

Secondly, a two-factor model with uncorrelated factors was fitted. The model χ^2 was significant ($\chi^2 = 180.87$, $df = 54$, $p < 0.001$), the RMSEA was 0.042, the CFI was 0.967, and the TLI was 0.970. Finally, the WRMR was 1.669. Thus, while a two-factor model with uncorrelated factors was an improvement over the one-factor model, fit remained unacceptable as indicted by the $WRMR > 1.0$.

For a correlated two-factor model, the model χ^2 was 83.328, $df = 53$, $p = 0.005$. The RMSEA was 0.021, the CFI was 0.992, and the TLI was 0.990. Finally, the WRMR was 0.931. Thus, except for the significant χ^2 value, all indices were in the acceptable range. The item loadings are shown in Figure 1 and the tetrachoric relations between each item are presented in Table 2.

Figure 1. Factor loadings of the 2-factor model for YouthMap12.

Internalization (IP6): 6 items measuring internalizing problems. Externalization (EP6): 6 items measuring externalizing problems. The 6 items measuring internalization targeted last month (e.g. feeling lonely last month). Externalizing items related to school, included experiences from primary and lower secondary school.

Table 2. Tetrachoric correlations between YouthMap 12 items.

	Lone- liness	Depres- sion	Anxiety	Contempla- te suicide	Eating disorder	Self- harm	Trouble- maker	Conflict teachers	Disruptive behavior	Truant	Expel- led	Violence
Loneliness	-	0.79	0.63	0.67	0.47	0.55	0.18	0.20	0.10	0.21	0.04	0.12
Depression	0.79	-	0.71	0.78	0.54	0.61	0.18	0.19	0.07	0.25	0.09	0.23
Anxiety	0.63	0.71	-	0.64	0.49	0.53	0.18	0.18	0.05	0.26	0.04	0.19
Contemplate suicide	0.67	0.78	0.64	-	0.50	0.71	0.10	0.19	0.06	0.21	0.07	0.27
Eating disorder	0.47	0.54	0.49	0.50	-	0.47	0.15	0.13	0.03	0.23	-0.07	0.08
Self-harm	0.55	0.61	0.53	0.71	0.47	-	0.20	0.09	0.11	0.16	0.10	0.21
Troublemaker	0.18	0.18	0.18	0.10	0.15	0.20	-	0.78	0.77	0.48	0.63	0.52
Conflict w. teachers	0.20	0.19	0.18	0.19	0.13	0.09	0.78	-	0.81	0.57	0.64	0.51
Disruptive behavior	0.10	0.07	0.05	0.06	0.03	0.11	0.77	0.81	-	0.45	0.66	0.51
Truant	0.21	0.25	0.26	0.21	0.23	0.16	0.48	0.57	0.45	-	0.52	0.36
Expelled	0.04	0.09	0.04	0.07	-0.07	0.10	0.63	0.64	0.66	0.52	-	0.48
Violence	0.12	0.23	0.19	0.27	0.08	0.21	0.52	0.51	0.51	0.36	0.48	-

Internal consistency reliability (Cronbach's alpha) and stability (test-retest) is presented in Table 3.

Table 3. Cronbach alpha and test-retest for YouthMap12.

	National survey	6 week test-retest	
	Cronbach Alpha	Cronbach Alpha	ICC ¹
	n=2,702	n=310	n=310
Externalization (EP6)	0.71	0.75	0.74
Internalization (IP6)	0.72	0.80	0.75

¹ ICC = Intra Class Correlation. Statistics are unweighted.

3.2 Externalizing and internalizing problems and regular use of AOD

Results from the regression analyses of associations between regular use of AOD and scores in externalizing problems (EP6) and internalizing problems (IP6) are presented in Table 4 (divided into men and women). All associations between EP6 score and AOD

were controlled for age and IP6 score, while all associations between IP6 score and AOD were controlled for age and EP6 score.

Table 4. Externalizing and internalizing problems and regular use of AOD.

			Externalizing problems (EP6)		Internalizing problems (IP6)	
Percen			AOR	95 % CI	AOR	95 % CI
Regular use	t					
women, n=1,376						
Cigarettes	4+ days/mo.	23.00	1.82***	1.57 - 2.10	1.14*	1.02 - 1.27
Cannabis	4+ days/mo.	2.46	1.70***	1.42 - 2.05	1.33**	1.12 - 1.58
Alcohol binge drinking	1+ days/week	8.63	1.23**	1.07 - 1.42	1.13*	1.00 - 1.27
OTC medicine	4+ days/mo.	17.35	1.11	0.97 - 1.26	1.42***	1.28 - 1.58
Prescription physical	4+ days/mo.	11.98	1.17*	1.01 - 1.35	1.32***	1.18 - 1.48
Psychotropic medicine	4+ days/mo.	4.47	1.08	0.88 - 1.32	2.27***	1.92 - 2.69
Men, n=1.326						
Cigarettes	4+ days/mo.	26.78	1.54***	1.40 - 1.70	0.87	0.73 - 1.02
Cannabis	4+ days/mo.	6.84	1.61***	1.42 - 1.82	1.14	1.06 - 1.23
Alcohol binge drinking	1+ days/week	16.19	1.15**	1.03 - 1.27	0.80*	0.65 - 1.98
OTC medicine	4+ days/mo.	7.54	1.08	0.94 - 1.23	1.35**	1.12 - 1.64
Prescription physical	4+ days/mo.	8.53	1.01	0.87 - 1.17	1.39***	1.16 - 1.66
Psychotropic medicine	4+ days/mo.	2.58	1.35**	1.09 - 1.67	1.80***	1.45 - 2.23

AOR: Adjusted odds ratio. CI: Confidence interval. OTC: Over-the-counter. Prescription physical: Prescription medicine for physical problems. Psychotropic medicine: Medicine for mental problems. All Ns are unweighted, all percentages and AOR are weighted, and all AOR are adjusted for difference in age. All AORs for externalizing problems are adjusted for internalizing problems, and all AORs for internalizing problems are adjusted for externalizing problems. * p<.05, ** p<.01, ***p<.001.

For men, no associations between IP6 and regular use of cigarettes or cannabis were found, but a strong positive association was found between IP6 and use of OTC medicine, prescription medicine for physical problems and psychotropic medicine. For women we found a similar pattern, but unlike what was the case for men, we also found positive

associations between IP6 and use of cigarettes and cannabis. Regular binge drinking was related to EP6 for both men and women. For men we found a modest negative association and for women a modest positive association between IP6 and binge drinking.

Considering that some associations between regular use of AOD and age can be expected, and that this age dependence could influence the associations between regular use of AOD and externalizing/internalizing problems, we conducted a separate analysis stratified by age (Table 5), to ensure the transparency of the results presented in Table 4. Results generally indicated that associations between externalizing problems and AOD were strongest in the youngest group.

Table 5. Prevalence of regular AOD use for three age groups and its association with externalizing and internalizing problems.

		N	Regular use Prevalence	Externalizing problems		Internalizing problems	
				AOR	95 % CI	AOR	95 % CI
Cigarettes	15-16 yr.	582	10.53	***2.15	1.67 - 2.79	1.18	0.98 - 1.44
4+ days/month	17-19 yr.	801	22.90	***1.51	1.32 - 1.73	1.10	0.93 - 1.30
	20-25 yr.	1,319	30.42	***1.62	1.46 - 1.80	0.98	0.87 - 1.10
Cannabis	15-16 yr.	582	2.48	***2.45	1.75 - 3.44	1.10	0.85 - 1.41
4+ days/month	17-19 yr.	801	3.77	***1.69	1.39 - 2.06	**1.47	1.13 - 1.90
	20-25 yr.	1,319	5.81	***1.55	1.36 - 1.77	1.13	0.93 - 1.38
Alcohol binge	15-16 yr.	582	8.95	***1.71	1.34 - 2.18	1.05	0.87 - 1.27
4+ days/month	17-19 yr.	801	14.10	*1.18	1.02 - 1.37	1.04	0.85 - 1.26
	20-25 yr.	1,319	12.82	1.08	0.96 - 1.22	0.92	0.77 - 1.09
OTC medicine	15-16 yr.	582	11.84	*1.26	1.01- 1.57	***1.44	1.20 - 1.72
4+ days/month	17-19 yr.	801	12.38	1.09	0.91 - 1.30	*1.21	1.01 - 1.45
	20-25 yr.	1,319	12.40	1.08	0.96 - 1.23	***1.45	1.28 - 1.64
Prescription physical	15-16 yr.	582	9.45	**1.35	1.08 - 1.68	*1.20	1.00 - 1.44
4+ days/month	17-19 yr.	801	7.22	1.18	0.97 - 1.42	**1.38	1.13 - 1.69
	20-25 yr.	1,319	11.79	1.00	0.86 - 1.16	***1.37	1.20 - 1.56
Psychotropic medicine	15-16 yr.	582	2.04	1.36	0.95 - 1.94	*1.58	1.06 - 2.35
4+ days/month	17-19 yr.	801	2.10	1.32	0.98 - 1.78	***1.86	1.43 - 2.43
	20-25 yr.	1,319	4.64	1.15	0.93 - 1.42	***2.20	1.87 - 2.59

AOR: Adjusted odds ratio. CI: Confidence interval. All Ns are unweighted, all percentages and AOR are weighted, and all AOR are adjusted for difference in sex. All AORs for externalizing problems are adjusted

for internalizing problems, and all AORs for internalizing problems are adjusted for externalizing problems. * $p < .05$, ** $p < .01$, *** $p < .001$.

For internalizing problems, the only significant association was that the effect of internalizing problems increases for older respondents concerning use of prescribed psychotropic medication (Table 5). To further test the associations, a series of logistic regressions with an interaction term between externalizing/internalizing problems and age were carried out. These tests showed similar results, in which the effect of externalizing problems were attenuated for older respondents. It was, however, only for prescription medicine for physical problems that the interaction term was significant.

3. 3 Identifying psychological classes

To determine different psychologically meaningful classes, we ran an LCA including the 12 binary questions from YouthMap12. Among the three tested LCA models (AIC, BIC and ABIC) the best fit ranged from 4-7 classes depending on the criterion used: according to the AIC the best fit was a 7-class model, according to the BIC a 4-class model, and according to the ABIC the best fit was a 6-class model (Table 6).

Table 6. Determining the number of latent classes

	Class-3	Class-4	Class-5	Class-6	Class-7	Class-8
Akaike Information Criterion (AIC)	17430	17281	17217	17168	17159	17177
Bayesian Information Criterion (BIC)	17654	17582	17595	17623	17690	17785
Adjusted BIC (ABIC)	17434	17420	17392	17378	17404	17457
Lo-Mendel Rubin	$p < 0.0000$	$p < 0.0000$	$p < 0.0078$	$p = 0.0042$	$p = 0.42$	$p = 0.61$

The intermediate position of the ABIC is in line with previous findings (40, 41). According to simulation studies, BIC and ABIC are superior to AIC, and ABIC in particular performs

well when the sample size is large (41). The certainty of a classification can also be demonstrated by the Lo-Mendel-Rubin test that showed a significant improvement by using 6 classes rather than 5 ($p=0.0042$) and no significant improvement by using 7 classes rather than 6 ($p=0.42$). In sum, the model did not benefit from including a 7th class, and the Lo-Mendel-Rubin test showed that a 4-class model, as suggested by the BIC, could be improved by including up to 6 classes (Table 6).

Aside from the purely statistical criteria of model fit, it is also important to consider the interpretability of the model (42). Here the 6-class model offers an additional advantage in that it differentiates between youths with moderate problems and youths with more severe problems. Hence, the 6-class model was chosen for the present study.

The majority of respondents (about 70%) belong to a class characterized by low levels of internalizing and externalizing problems, labelled LOW. The remaining respondents belong to one of 5 classes characterized by moderate to severe internalizing and/or externalizing problems, which are labelled accordingly: Moderate Internalizing Problems (MIP), Severe Internalizing Problems (SIP), Severe Externalizing and Internalizing Problems (SEIP), Moderate Externalizing Problems (MEP), and Severe Externalizing Problems (SEP). In Table 7 the percentages of respondents fulfilling the criteria for each of the 12 items and the mean score for IP6 and IP6 is presented for each of the 6 classes.

Table 7. Percentages of respondents fulfilling the criteria for each item and the mean score for IP6/EP6 divided into the 6 classes.

	LOW	MIP	SIP	SEIP	SEP	MEP
N	1885	257	78	54	112	316
Percent	69.76	9.51	2.89	2.00	4.15	11.70
Loneliness	4.08	61.09	73.08	92.59	0.89	4.11
Depression	0.00	61.09	87.18	61.11	2.68	0.63
Anxiety	2.71	40.47	64.10	57.41	2.68	1.90
Contemplate suicide	0.64	27.24	100.00	40.74	0.00	6.33
Eating disorder	3.93	27.24	52.56	42.59	2.68	5.70
Deliberate self-harm	0.74	9.34	60.26	22.22	2.68	0.95
Mean score IP6	0.12	2.26	4.37	3.17	0.12	0.20
Troublemaker at school	0.00	7.00	12.82	74.07	93.75	40.19
Conflict with teacher	0.00	5.84	5.13	85.19	93.75	31.65
Disruptive classroom	0.00	2.33	0.00	64.81	90.18	31.96
Truant from school	2.07	10.89	12.82	42.59	40.18	18.67
Expelled from school	1.64	0.00	14.10	33.33	64.29	26.27
Violent behavior	14.96	22.96	55.13	59.26	77.68	51.27
Mean score EP6	0.18	0.48	0.96	3.48	4.51	1.98

All statistics are unweighted. LOW = Low problem score. MIP = Moderate internalizing problems. SIP = Severe internalizing problems. SEIP = Severe externalizing and internalizing problems. SEP = Severe externalizing problems. MEP = Moderate externalizing problems. IP6 (6 questions identifying internalization problems), EP6 (6 questions identifying externalization problems).

Externalizing classes (MEP, SEP and SEIP) were strongly associated with regular use of cigarettes and cannabis and modestly associated with regular binge drinking with stronger associations for men than for women (Table 8). The internalizing classes (MIP, SIP and SEIP) were strongly associated with regular use of prescription medicine for physical problems and psychotropic medicine with stronger associations for women than for men. Women belonging to the SEIP class were in high risk of using all types of drugs, including alcohol, on a regular basis. Men from the SEP class were in high risk of regular use of all types of drugs except regular use of medicine for physical problems. The MIP class was specifically likely to report regular use of psychotropic medicine and for women also regular use of medications for physical problems.

Table 8. Regular use of alcohol and other drugs among 6 classes of Danish women and men between the ages of 15-25.

			LOW	MIP	SIP	SEIP	SEP	MEP
Women N			1003	174	56	30	19	94
% of women			72.89	12.65	4.07	2.18	1.38	6.83
Mean age			19.61	19.28	18.75	20.53	20.89	19.23
Cigarettes	4+ days/last mo.	Percent	17.55	23.17	37.06	54.81	69.82	47.15
		AOR	1	1.35	**3.62	*** 9.42	***13.23	*** 7.55
Cannabis	4+ days/last mo.	Percent	1.63	0.79	1.98	29.25	5.12	3.94
		AOR	1	0.48	1.21	***25.22	3.29	2.47
Binge drinking	1+ days/week	Percent	7.68	9.62	6.46	25.51	5.26	12.34
		AOR	1	1.25	0.79	**4.28	0.69	1.66
OTC medicine	4+ days/week	Percent	12.58	33.42	38.93	35.69	12.78	19.7
		AOR	1	***3.49	***4.43	**3.86	1.02	1.70
Prescription medicine	4+ days/week	Percent	9.36	19.3	23.96	26.03	19.31	12.19
		AOR	1	***2.39	**3.21	**3.34	2.26	1.38
Psychotropic	4+ days/last mo.	Percent	1.1	14.22	32.18	13.81	0	4.02
		AOR	1	***17.17	***56.09	***15.51	empty	* 4.13
Men N			882	83	22	24	93	222
% of men			66.52	6.26	1.66	1.81	7.01	16.74
Mean age			19.53	20.26	19.54	20.21	20.23	19.69
Cigarettes	4+ days/last mo.	Percent	20.13	21.17	28.1	23.37	61.61	39.38
		AOR	1	0.96	1.64	1.16	***6.37	***2.62
Cannabis	4+ days/last mo.	Percent	3.47	7.76	11.85	17.06	19.98	11.94
		AOR	1	1.03	*2.03	**3.62	***6.18	***3.70
Binge drinking	1+ days/week	Percent	14.55	15.4	3.97	6.39	26.15	20.78
		AOR	1	1.04	0.25	0.39	**2.04	*1.54
OTC medicine	4+ days/week	Percent	5.94	9.44	23.96	9.00	6.86	11.46
		AOR	1	1.64	**5.02	1.56	1.16	**2.05

Prescription	4+ days/week	Percent	7.53	10.81	19.81	21.12	6.78	9.61
Medicine		AOR	1	1.44	3.09	*3.22	0.88	1.3
Psychotropic	4+ days/last mo.	Percent	0.83	7.17	14.9	13.72	5.56	3.65
		AOR	1	***9.05	***21.06	***18.74	**6.94	**4.50

All Ns are unweighted, percentages of men and women are unweighted, other percentages and AOR are weighted. LOW = Low problem score. MIP = Moderate internalizing problems. SIP = Severe internalizing problems. SEIP = Severe externalizing and internalizing problems. SEP = Severe externalizing problems. MEP = Moderate externalizing problems. * p<.05, ** p<.01, ***p<.001.

3.4 Manual identification of the 6 classes: A practical demonstration

In order to reproduce the same 6 classes, the same method and a similar national survey is required. If the same 12 questions are used in e.g. a school-based survey, in a clinical population or in a local community survey, other latent classes and probably also different numbers of latent classes are likely to be uncovered. Therefore, the present national classification represents an important starting point by providing a useful national comparison for subsequent classifications of young people from different organizations or communities.

The manual classification serves two overall purposes: 1) to help local communities or organizations such as schools or treatment facilities to identify young people with different psychological needs in serious risk of developing regular use of AOD and 2) to enable a comparison between the number of young people in need of help in local communities, schools, etc. with a national standard.

A ROC analysis was used to identify a similar division into classes as the present LCA uncovered. The objective was to find an acceptable balance between sensitivity and specificity indicated by area below the ROC. In Table 9 the inclusion criteria, sensitivity, specificity and area below the curve are presented for each class. Importantly, no cases were left unclassified.

Table 9. Spreadsheet based translation of the 6 classes in the national survey

	N	N				Area under
	LCA	Manual	Criteria	Sensitivity	Specificity	ROC curve
LOW	1,885	1,927	EP6+IP6<2 (EP6=0/1 & IP6=2/3) and/or	97.8%	89.8%	0.94
MIP	257	212	(EP6=2+IP6=2=2)	77.4%	99.5%	0.88
SIP	78	79	EP6=02 & IP6=4-6	78.2%	99.3%	0.89
SEIP	54	61	(EP6+IP6>5) and/or (EP6=2/3+IP6=2/3=5)	90.7%	94.8%	0.93
SEP	112	105	EP6=4-6 & IP6=0/1	84.8%	99.6%	0.92
MEP	316	318	EP6=1-3 & IP6=0/1	94.2%	83.7%	0.89
	2,702	2,702				

EP6: score in 6 items measuring externalizing problems. IP6: score in 6 items measuring internalizing problems. By applying the above criteria, three extra classes were identified: LOW+MEP renamed to LOW, SIP+SEIP renamed to SIP and SEP+SEIP renamed to SEP. The spreadsheet can be sent by request.

To ensure reliability of the associations between the manually identified class memberships and risk of using AOD on a regular basis, two separate surveys were compared: The National YouthMap Survey and the Gentofte YouthMap Survey. In Table 10 the percentages of people belonging to each class and the associations between class and regular use of AOD for the two surveys are presented.

Table 10. The associations between classes and regular use of AOD in two Danish surveys.

	Percent of respondents		Cannabis 4+/month.		Binge drinking 4+/month		Psychotropic 4+/month.	
	Manual calculation		AOR		AOR		AOR	
	National	Gentofte	National	Gentofte	National	Gentofte	National	Gentofte
LOW	70.03	72.79	1	1	1	1	1	1
MIP	8.09	8.61	1.47	2.77	1.23	1.22	***14.77	***5.85
SIP	2.84	1.82	0.93	Empty	0.42	0.19	***29.62	***14.99
SEIP	2.55	1.93	***13.75	***15.59	1.49	0.99	***20.75	***16.77
SEP	4.45	3.06	***7.05	***18.01	*1.82	*2.67	*4.36	Empty
MEP	12.04	11.79	***3.91	**4.99	*1.53	**2.35	***4.04	2.61
	n=2,702	n=887						

All Ns are unweighted, all percentages and AOR are weighted and all AOR are adjusted for difference in sex and age. * p<.05, ** p<.01, ***p<.001.

As seen in Table 10 the associations among classes and regular use of AOD are almost identical in the two surveys.

Compared to the Gentofte Survey, significantly more people from the national survey were classified in the severe classes (SIP, SEIP and SEP), 9.84 % versus 6.81 %, OR=1.50, p<.05, 95% CI 1.06 to 2.10 (weighted). This was in line with the general assumption that youth from Gentofte have less severe psychological and social problems when compared with youth from the rest of the country. To some extent the sample characteristics (Table 1) justify this assumption. In the national survey 11 % of youth age 20+ were not enrolled in any kind of educational activities or employed when interviewed (Gentofte 8 %). Fifty percent of youth age 16-19 from the national survey were enrolled in some kind of upper secondary education (Gentofte 72 %) and 61 % of youth between 15-20 years of age from the national survey were living with both parents (Gentofte 69 %). In

sum youth from Gentofte seemed to experience a more stable educational, occupational and family structure.

4. DISCUSSION

The purpose of the present study was to develop an easy-to-implement instrument to identify subgroups of young people with different psychological problems at elevated risk of developing early regular use of AOD. First, we developed a short 12-item questionnaire (YouthMap12) based on 6 questions identifying externalizing problems (EP6) and 6 questions identifying internalizing problems (IP6). The two scales were weakly correlated with each other and internal consistence and test-retest stability were above 0.70.

Secondly, we tested YouthMap 12 in two samples of Danish youth (age 15-25): a national survey with 2,702 respondents and a municipality survey with 887 respondents. The EP6 scale was strongly associated with regular use of cigarettes, cannabis and to some extent binge drinking, while IP6 was associated with regular use of medicine for physical problems (both prescription and OTC) and regular use of psychotropic medicine.

The strong association between externalizing behavior and regular use of cigarettes and cannabis is in line with findings from previous longitudinal studies showing that this type of behavior is associated with the risk of problematic drug use (7, 13, 14, 19). The association between internalizing problems and regular use of prescription medicine and OTC is less studied, and due to our cross-sectional design we cannot make inferences about causality, i.e. whether internalizing problems are a risk factor, or whether it could be the opposite way around. E.g. a young person with diabetes using insulin every day could be at risk of developing internalizing problems.

Since substance use increases dramatically during youth, we were specifically interested in testing whether links between externalizing or internalizing problems varied with age. We found that adjusted odds ratio (AOR) decreased by age for cigarettes, cannabis and in particular for alcohol. Denmark is characterized as having a wet alcohol drinking culture (43, 44) and binge drinking among youth is widely normalized. A highly significant association between externalizing problems and regular binge drinking was found in the youngest group, but was weaker and not significant in the oldest group, indicating that binge-drinking is not normalized for the youngest age group, where it is associated with externalizing problems. Although we found a decrease in AOR for each age group for regular use of cigarettes and cannabis and its association with externalizing problems, it remained significant for all age groups.

Externalizing problems were strongly associated with regular use of cigarettes, cannabis and to some extent alcohol (depending on age) for both women and men. But in contrast to men, we also found significant associations between internalizing problems and use of cigarettes and cannabis among women (Table 4).

Based on the self-reported answers to the 12 questions, an LCA led to 6 well-defined groups of young people with different types of difficulties. As would be expected in a general population sample, the majority were in the class with low indicators of risk, with slightly more women than men being in the low-risk group. Consistent with previous research, LCA led to a very clear division of externalization and internalization related problems. Furthermore, the latent classes could be characterized by different levels of severity. A small group of respondents, (2.5%), reported a large number of both externalizing and internalizing problems, and may represent a sub-population at very high risk of a range of adverse outcomes. This finding indicates that although confirmatory

factor analysis pointed to two weakly interdependent factors, a significant subgroup of young people has both externalizing and internalizing problems to a significant degree.

Classes characterized by externalization problems (MEP, SEP and SEIP) were strongly associated with regular use of cigarettes and cannabis and modestly associated with regular binge drinking, while internalizing classes (MIP, SIP and SEIP) were strongly associated with regular use of prescription medicine for physical problems and psychotropic medicine. As expected, use of AOD was more pronounced in the severe classes: women belonging to the SEIP class were in high risk of using all types of drugs, including alcohol, on a regular basis, and men from the SEP class were in high risk of regular use of all types of drugs except regular use of medicine for physical problems (OTC and prescribed).

The classes identified in the LCA were manually reproduced and a simple spreadsheet was developed to translate the 6 LCA-classes to 6 manually produced classes. Areas below the ROC curve were between .88 and .94 which can be defined roughly as between good and excellent. Finally, the reliability of the model was illustrated by comparing the National YouthMap Survey with a similar, but distinct YouthMap survey from the wealthiest municipality in Denmark (Gentofte). In these two surveys we found comparable distributions of the manually produced classes and similar associations between classes and regular use of AOD.

An improved and easy-to-implement characterization of which groups of young people are at high risk of developing regular use of AOD is crucial in terms of directing prevention efforts and tailoring individual and integrative treatment programs, as well as being used in local and national decision and policy-making. YouthMap12 has been used in several school based surveys in Denmark and one in Norway (the municipality of

Stavanger). We have identified great differences in severity profiles between school classes and different educational tracks. These results have been used e.g. by school managers to discuss need for more resources with local politicians and administrators; by schools to discuss strategies for preventing drop-out (e.g. among high school and college students) and by teachers to design different teaching strategies for specific groups of students (45).

It should be noted that because of the language used in the test, YouthMap12 is not recommended for young people below the age of 15. In addition, students still enrolled in elementary school (9th grade students and younger) seem to have difficulties answering the questions about school/education. This could be one of the reasons we found a significant increase in the externalization score between the three age groups, $F(2, 2699) = 6.15, p < 0.01$, age 15-16 ($M=0.55, SD=0.97$), age 17-19 ($M=0.68, SD=1.25$) and age 20+ ($M=0.76, SD=1.27$). It is likely, that it is easier to evaluate one's behavior in retrospect. We found no association between score in internalization problems and age.

It must also be emphasized that YouthMap12 is a brief screening tool and not a diagnostic instrument. The internalization questions cannot be used to identify clinical depression or anxiety, severe eating disorder, etc. The internalizing scale represents a broad proclivity to emotional pain, rather than specific mental disorders.

In combination with other significant factors measuring e.g. attention, impulsivity, negative life events, social support and AOD use among friends, which are included in the complete YouthMap, it has been used as a screening instrument in different treatment settings (46), and as such it is highly helpful when combined with a professional clinical interview.

Although regular use of AOD is also seen among young people without identifiable psychosocial problems, young people with severe psychosocial problems are at highest risk of developing a persistent and harmful use of AOD. These vulnerable groups of young people are also at high risk of developing a wide range of other problems such as dropout from educational activities, health problems (including nutritional problems), early sexual debut, criminal behavior, etc. In order to prevent these high risk youths from representing a substantial public health burden in the near future, there is a need to develop an integrative approach in which regular use of AOD is understood in the light of the user's psychological and social problems. A one-sided focus on alcohol or other drugs without focusing on the psychosocial life of these vulnerable youth is probably of limited relevance.

Limitations

Some additional limitations of the present study must be noted. The moderate response rate of 56 % (national survey) and 58 % (municipality of Gentofte) makes it difficult to argue that the samples represent Danish youth. In order to compensate for the differences between the studied population and the general Danish population, we used weighted data. We are well aware that this strategy probably does not solve the problem of representativeness entirely. However, this is the best we were able to do in Denmark at present.

Our questions concerning regular use of medicine were based on short questionnaire items, and may represent a wide range of drugs, ranging from drugs that are essential for survival and health, to drugs that are used to treat minor ailments, such as a mild headache. Unfortunately, no information about the non-proprietary name of the medicine was available. This would have been very helpful.

Finally, defining regular use by only one threshold (4+ days last month) for AOD is a rather simple strategy. It could be argued that different thresholds for different age groups and for men and women would be preferable.

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ressources, use/abuse of AOD and well-being among 15-25 year old Danes).
(Aarhus University, Centre for Alcohol and Drug Research).

APPENDIX 1

YouthMap12

With filter questions (Survey version)

Externalizing problems (EP6)					
1. To what extent were you/are you and your friends troublemakers?	1	2	3	4	5
2. To what extent have you had/do you have conflicts with your teachers?	1	2	3	4	5
3. To what extent were you/are you disruptive in class?	1	2	3	4	5
4. To what extent did you/do you skip classes in primary and lower secondary school?	1	2	3	4	5
5. Have you ever been expelled from school due to your behavior?	No			Yes	
6. Have you ever directly physically harmed other people e.g. been in a fight, assaulted other people or similar acts (play or accident do not count)?	N	AN	S	O	NA
Internalizing problems (IP6)					
7.1. Have you had a period in life where you were affected by depression?	N	AN, S, O, NA answer 7.2.			
7.2. How affected have you been by depressive symptoms in the past 30 days?	Not	Lit	Som	Lot	VM
8.1. Have you had a period in life where you experienced <u>anxiety</u> ?	N	AN, S, O, NA answer 8.2.			
8.2. How affected have you been by anxiety in the past 30 days	Not	Lit	Som	Lot	VM
9.1. Have you had a period in life where you had suicidal thoughts?	N	AN, S, O, NA answer 9.2.			
9.2. How affected have you been by suicidal thoughts in the past 30 days?	Not	Lit	Som	Lot	VM
10.1. Have you had a period in life where you felt <u>lonely</u> ?	N	AN, S, O, NA answer 10.2.			
10.2. Have you been affected by this loneliness in the past 30 days?	Not	Lit	Som	Lot	VM
11.1. Have you ever purposely <u>hurt yourself</u> e.g. cut or burned yourself or the like?	N				
11.2. How many times have you purposely hurt yourself the past 30 days?	Not	Lit	Som	Lot	VM
12.1. Have you had a period in life where you had an eating disorder e.g. avoided eating food or purposely vomited?	N	AN, S, O, NA answer 12.2.			
12.2. How affected have you been by an eating disorder in the past 30 days?	Not	Lit	Som	Lot	VM

1=Not at all, 2=to a lesser degree, 3=to some degree, 4=To a high degree, 5=to a very high degree

N=Never, AN=Almost Never, S=Sometimes, O=Often, NA=Nearly Always, Not=Not at all, Lit=A little, Som=Somewhat, Lot=A lot, VM=Very much.

7.1., 8.1., 9.1., 10.1., 11.1. and 12.1 are filter questions.

1, 2, 3, 4, 5, 6, 7.2., 8.2., 9.2., 10.2., 11.2. and 12.2. = YouthMap12.

Dichotomization: All white cell's = 0 point, all black cell's = 1 point.

APPENDIX 2

The questions used to assess use of alcohol, drugs and medicine.

1. How often do you drink 5 or more units on one occasion?
 1. Never
 2. Once a month or less
 3. 2-3 times a month
 4. Once a week
 5. Twice a week
 6. 3-4 times a week
 7. 5 or more times a week
 8. Do not want to answer
2. Number of days where you have used cannabis (e.g. hash, pot, skunk or other kinds of cannabis) in the past 30 days?
3. Number of days where you have smoked cigarettes in the past 30 days?
4. Number of days where you have used over-the-counter pain-relieving medication, such as Panodil, kodimagnyl, Ipren, Ibuprofen or other non-prescription drugs the past 30 days?
5. Number of days where you have used medicine for physical problems (prescribed by a physician) the past 30 days?
6. Have you ever been on medication for mental problems? 1. Yes 2. No (filter question)
- 6b. Number of days where you have taken the medication for mental problems in the past 30 days?