

Population based latent class analysis of drinking behaviour and related psychological problems and cognitive impairment.

Mark Shevlin & Gillian W. Smith

Psychology Research Institute, University of Ulster

Corresponding Author:
Dr Mark Shevlin,
Psychology Research Institute, University of Ulster,
Northland Road, Londonderry, BT48 7JL
Email: m.shevlin@ulster.ac.uk
Telephone: +44 (0) 28 71 375619

There have been theoretical and empirically developed typological schemes used to classify alcoholics. For example, Epstein (2002) identified four prevailing alcohol typologies (binge, episodic, sporadic, and steady) while Babor (1992) assessed the validity of five other classifications (primary vs secondary alcoholism, parental alcoholism, Felling's gamma-delta distinction, gender, and subtypes derived from MMPI profiles). Although some of these typologies have been found to have predictive and clinical utility, they have been invariably derived from relatively small samples of alcoholics.

There have also been attempts to develop population based typologies of alcohol use, rather than focusing exclusively problematic alcohol consumption. Such studies have tended to focus on measures of consumption and frequency (includes graduated frequencies and averaging intake using these measures) and develop the typology based on cluster analytic techniques. Slater, Basil and Maibach (1999) used cluster analysis based on a sample of 2910 individuals representative of the American general population. They reported a five-cluster solution: non-drinkers, light drinkers, moderate drinkers, episodic drinkers and regular heavy drinkers. These clusters were found to be meaningfully associated with health and demographic variables. The nature of these clusters suggested a continuum of gradually increasing quantity and frequency. Rouillier et al (2004) identified seven clusters based on the amount and type of alcohol consumed using a sample of almost two thousand French men. Six clusters included alcohol drinkers and were defined in terms of mean alcohol intake. The clusters were related to socioeconomic and health related variables.

Alternative typological techniques have also been employed. O'Connor and Colder (1999) used latent profile analysis based on measures of quantity and frequency of consumption, and alcohol-related problems. Based on a sample of 533 first year American college students they reported five groups but concluded that no continual pattern of behaviour existed. Their profiles reflected light drinkers/abstainers with no problems, heavy occasional drinking without impairments, problematic/heavy occasional drinking with impairment, very heavy occasional drinking with impairment (averaging 10 drinks per occasion) and heavy frequency drinkers with impairment. Reboussin et al. (2006) employed latent class analysis to identify types of drinkers based on measures of drinking behaviours and alcohol-related problems in a sample of over four thousand American 16-20 year old current drinkers. The analysis indicated three classes: non-problem drinkers, risky drinkers, and regular problem drinkers.

This research aimed to develop a population based typology of alcohol drinking based on a large nationally representative sample of British participants. It was hypothesised that the heterogeneity of alcohol related behaviours could be described in distinct patterns based on both the consumption of alcohol use and related alcohol use problems. In particular, latent class analysis was used to identify homogeneous classes, or groups, based on a standardised measure of alcohol consumption and related problems. It was also predicted that class membership would predict current mental health status.

Methods

Participants and data

Analyses were performed on participants in the second "Psychiatric Morbidity Among Adults living in Private Households, 2000" survey (Singleton, Bumpstead, O'Brien, Lee

& Melzer, 2001). Interviews were successfully conducted with 8580 adults living in either England, Scotland or Wales using a stratified multi-stage random sampling strategy, however, after listwise deletion of missing data, the total effective sample size was N=7849. The mean age of the sample was 45 years old (SD= 15.43), with 54.1% of the respondents female and 93% of white ethnic origin. Further details of the survey methodology are detailed in Singleton et al. (2001).

Measures

Alcohol use

Alcohol use and related problems were assessed using the Alcohol Use Disorders Identification Test (AUDIT; Babor et al, 1992; Saunders & Aasland, 1987) a widely used questionnaire measuring hazardous drinking. The scale comprises of ten items referring to alcohol consumption and alcohol related problems in the past 12 months. Scores on each item, for the purposes of these analyses were collapsed into two categories, with '0' as the baseline 'never' for questions 1, 3-8, '1 or 2' for question 2 and 'no' for questions 9 and 10 with '1' representing all other responses for each question.

Measures of Mental Health

Depressive episode, generalised anxiety disorder and mixed anxiety and depressive disorder were measured using the Clinical Interview Schedule Revised (CIS-R; Lewis and Pelosi, 1990). Diagnoses of disorders are obtained through the application of algorithms reflecting the ICD-10 diagnostic criteria for research (Lewis et al, 1992). Probable psychosis was measured using the Psychosis Screening Questionnaire (PSQ, Bebbington & Nayani, 1995). This measures psychotic symptoms in the past 12 months with five main questions on mania, thought insertion, paranoia, strange experiences and

hallucinations. An individual scoring two or more in this test was deemed to have probable psychosis. Participants were also asked whether they had attempted suicide in the past year and whether they had seen their General Practitioner (GP) for either a physical or medical complaint in the past year.

Demographic variables

Demographic variables were respondent sex, age, level of education- defined as educated beyond GCSE level or not, employment status, and whether they were currently in a couple or had children. IQ was measured by the National Adult Reading Test (NART; Nelson & O'Connell, 1978) and using algorithms recommended in the NART test manual converted into WAIS-R verbal IQ scores (Nelson & Willison, 1991).

Latent class models

Patterns of drinking were generated using latent class analysis. This is a statistical modelling technique which is used to estimate the number of classes of an underlying categorical latent variable which accounts for the relationships between categorical observed variables (Hagenaars & McCutcheon, 2002). This method creates subgroups of respondents who answer in a similar way on the observed variables of the Alcohol Use Disorder Identification Test. The model parameters include (1) class membership probabilities (or class prevalence estimates) and (2) class-specific symptom endorsement probabilities. Assignment of individuals to classes was based on a probabilistic method not the most likely latent class (Clogg, 1995).

Model Fit

Information criteria such as the AIC, BIC and Sample size adjusted BIC will be assessed with the lowest values of these criterion indicating superior model fit (i.e. the model which best balances the number of parameters and the information from those parameters). In addition, the Lo-Mendel-Rubin likelihood ratio test compares a k class solution to $k-1$ class solution where k is a given number of latent classes. This method tests the hypothesis that the null model ($k-1$) is acceptable. If the p value is less than .05 the k model is superior and the process must be continued, through running models with successive numbers of classes until the p value for the statistic is greater than 0.05, where the null model is the best explanation of the heterogeneity of the data. Entropy is a measure to the level of which the latent classes are distinct from one another, where a number close to 1 indicates clear classification (Ramaswamy, DeSarbo, Reibstein & Robinson, 1993).

Latent class regression models

Once the suitable latent class structure of alcohol use behaviour has been determined using the fit criteria, the latent class model parameters are fixed and conditional probabilities of individuals are regressed on demographic and health related criteria (thus the covariates do not affect the formation of the latent classes). In this method, odds ratios (with 95% confidence intervals) are calculated which compare the classes to the baseline class. The 2 times loglikelihood difference test is used to reduce the number of estimated parameters in the latent class regression model to maximise parsimony.

Software

Data was prepared for analysis using SPSS version 11.0 (SPSS Inc., 2001). Latent class regression models were performed using the Mplus Version 4.00 (Muthen & Muthen, 2005).

Results

Table 1 shows the results for the latent class analysis of the ten items of the AUDIT questionnaire. In terms of the Lo-Mendel-Rubin adjusted likelihood ratio test (LMR) the optimal number of classes is five. However the information criteria appear to suggest a six class structure. In particular the BIC and SSABIC appear to reach a minimum at six classes and begin to increase for the seven class model. On the basis of this the six class solution is preferred.

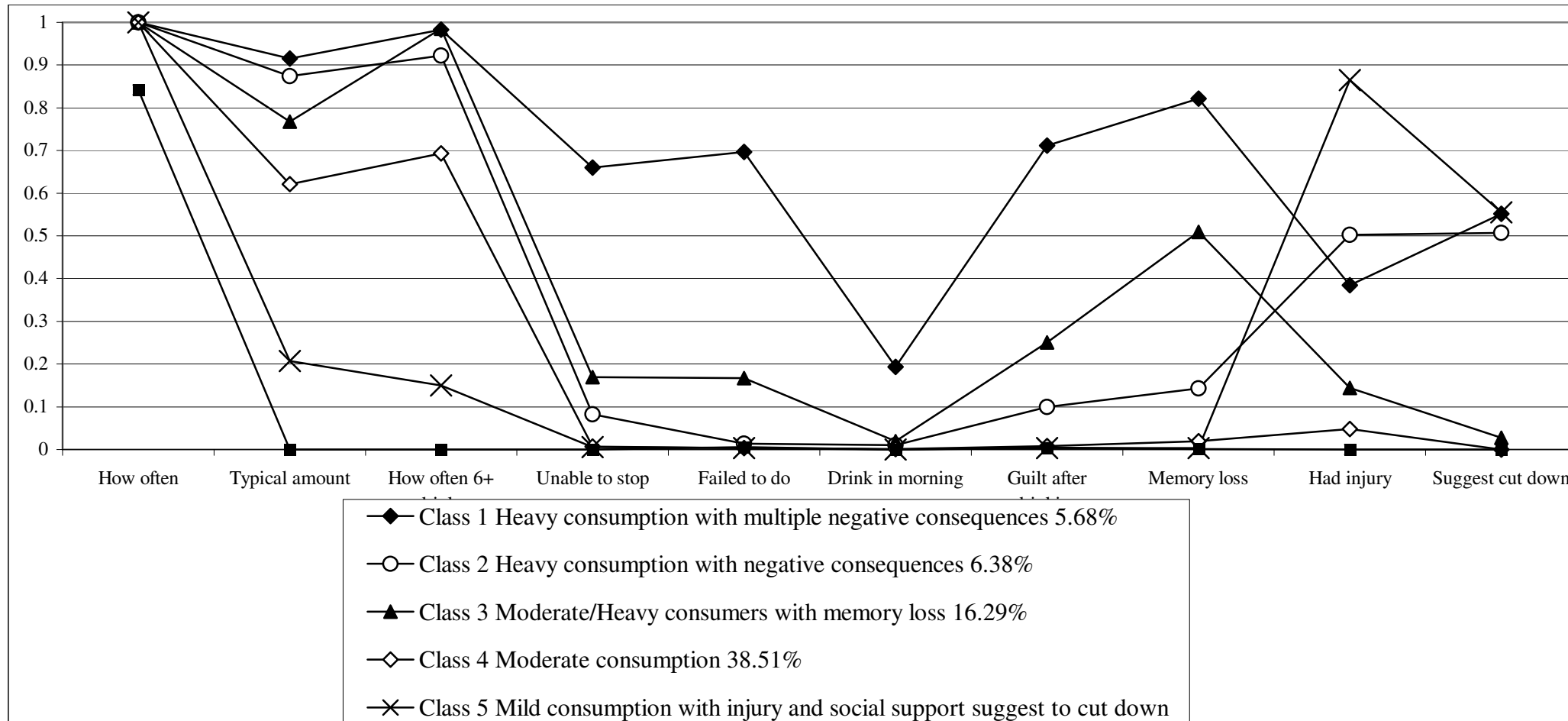
Table 1. Fit indices for the latent class analysis of the AUDIT.

	LRT	<i>p</i> value	AIC	BIC	SSABIC	Entropy
2 class	6455.41	.00	51000.25	51146.58	51079.85	.73
3 class	1932.62	.00	49070.04	49293.02	49191.33	.82
4 class	1184.12	.00	47895.91	48195.54	48058.90	.83
5 class	257.60	.00	47657.70	48033.98	47862.38	.74
6 class	123.46	.08	47554.99	48007.92	47801.37	.73
7 class	57.95	.01	47518.46	48048.04	47806.52	.74

LRT: Likelihood Ratio Test; AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; SSABIC: Sample size adjusted Bayesian Information Criteria

The profile plot of the classes is presented in Figure 1 below.

Figure 1: Graph showing probability of endorsing each question on the AUDIT.



The most prevalent class, in the Great British population, class four, drinks more than three drinks on a typical session and are likely to drinks six or more drinks on occasion, however, do not have any associated problems. Class three is similar, however, although they have a slightly higher probability of drinking six or more drinks, drinking more than three drinks on a typical occasion, and also may experience memory loss. Class one, the lowest proportion in the population, appear to be the largest consumers of alcohol and much more likely to experience multiple problems due to this drinking pattern. They were also more likely to take a drink in the morning, although it must be recognised that this item is of a relatively low frequency in the total population. This profile of heavy use is mirrored in class two, however, in terms of their related problems, they are only likely to have a friend/family member suggest that they cut down on their use and to have experienced an alcohol related injury. In contrast class five, are mild users who are likely to experience both of the alcohol related problems endorsed in class two.

The results of the logistic regression analysis is presented in Tables 2 and 3. In terms of mental health outcomes, there appeared to be a protective effect of mild and moderate consumption patterns in relation to the baseline class with individuals in classes two through five being significantly less liable to have a depressive episode. Those in class one, exhibiting heavy consumption with negative consequences are significantly more likely to have either generalised anxiety disorder or mixed anxiety or depressive disorder. None of the classes were significantly more or less likely to have probable psychosis. Classes one, two and three had a higher probability of having attempted suicide in their lifetime. None of the classes were more likely to report a mental health complaint to their General Practitioner, however, classes one, two, three and five were less likely to report a physical health complaint than the baseline class.

Looking at the profiles of these classes in terms of their demographic criteria, all of the classes were more likely to be male compared to the baseline, with the highest probabilities in the heavy drinking profiles. Classes one to four were more likely to be educated up to sixteen years old (GCSE level or below) and were more likely to be employed. The heavy drinking with multiple negative consequences profile were of a higher probability of being in a couple and having a higher IQ. It is of note that those individuals who had a lower probability of having children compared to the baseline class were most commonly found in classes one, two, three and five.

Table 2: Logistic regression of latent classes and mental health outcomes

Mental Health Predictors (0= absent; 1= present)	Odds Ratio (95% confidence intervals)					
	Class 1 Heavy consumption with multiple negative consequences	Class 2 Heavy consumption with injury and suggestion to cut down	Class 3 Moderate consumption with memory loss	Class 4 Moderate consumption	Class 5 Mild consumption with injury and suggestion to cut down	Class 6 Baseline Mild consumption
Depressive episode	1.43(.88 - 2.34)	.72(.53 - .98)*	.72(.53 - .98)*	.72(.53 - .98)*	.72(.53 - .98)*	-
Generalised Anxiety Disorder	2.46(1.68 - 3.61)*	1.68(1.19 - 2.39)*	1.06(.83 - 1.36)	1.06(.83 - 1.36)	1.06(.83 - 1.36)	-
Mixed Anxiety and Depressive Disorder	1.65(1.23 - 2.21)*	.92(.77 - 1.08)	1.11(.90 - 1.37)	.92(.77 - 1.08)	.92(.77 - 1.08)	-
Probable Psychosis	.81(.45 - 1.45)	.81(.45 - 1.45)	.81(.45 - 1.45)	.81(.45 - 1.45)	2.00(.86 - 4.66)	-
Suicide Attempt in the past year	3.24(2.24 - 4.67)*	1.86(1.40 - 2.48)*	1.86(1.40 - 2.48)*	1.14(.87 - 1.49)	1.10(.71 - 1.72)	-
Physical Health GP complaint	.73(.66 - .80)*	.73(.66 - .80)*	.73(.66 - .80)*	.73(.66 - .80)*	1.04(.87 - 1.23)	-
Mental Health GP complaint	.96 (.83 - 1.11)	.96(.83 - 1.11)	.96(.83 - 1.11)	.96(.83 - 1.11)	.96(.83 - 1.11)	-

Table 3: Logistic regression of latent classes and demographic criteria

Demographic predictors	Odds Ratio (95% confidence intervals)					
	Class 1 Heavy consumption with multiple negative consequences	Class 2 Heavy consumption with injury and suggestion to cut down	Class 3 Moderate consumption with memory loss	Class 4 Moderate consumption	Class 5 Mild consumption with injury and suggestion to cut down	Class 6 Baseline Mild consumption
Sex (0=female; 1=male)	5.33(4.31 - 6.52)*	4.03(3.44 - 4.73)*	3.25(2.84 - 3.72)*	2.16(1.94 - 2.41)*	1.35(1.13 - 1.61)*	-
Age (continuous)	.92(.91 - .92)*	.95(.94 - .96)*	.93(.92 - .93)*	.97(.96 - .97)*	1.00(.99 - 1.01)	-
Education (0=beyond GCSE; 1=GCSE or below)	1.22(1.08 - 1.37)*	1.22(1.08 - 1.37)*	1.22(1.08 - 1.37)*	1.22(1.08 - 1.37)*	.93(.77 - 1.12)	-
Employment status (Economically: 0= inactive; 1= active)	1.23(1.04 - 1.46)*	1.23(1.04 - 1.46)*	1.75(1.50 - 2.03)*	1.40(1.25 - 1.58)*	1.03(.84 - 1.25)	-
Has Children (0=One or more ; 1=None)	1.36(1.17 - 1.57)*	1.36(1.17 - 1.57)*	1.36(1.17 - 1.57)*	1.10(.97 - 1.26)	1.36(1.17 - 1.57) *	-
In a couple (0= not; 1= in a couple)	1.71(1.39 - 2.10)*	1.15(.98 - 1.35)	1.10(.96 - 1.26)	.97(.87 - 1.08)	.97(.87 - 1.08)	-
Verbal IQ (Continuous)	1.01(1.00 - 1.02)*	1.00(1.00 - 1.01)	1.00(1.00 - 1.01)	1.00(1.00 - 1.01)	1.00(1.00 - 1.01)	-

Conclusion

As considered, the majority of adults are consumers of alcohol in the general population. This study has generated heterogenous groups of individuals in the population based on patterns of drinking. These classes have demonstrated that there are differences in average volume, or patterns within the sample. Patterns of endorsement of the first three items of the AUDIT, widely believed to measure consumption suggest that quantity and frequency are related, but not exactly so to six or more drinks on occasion, and the patterns reflect this. Like Reboussin (2006) suggests, also the concept of average volume over a period of time tells us less about the hazards of drinking than patterns.

Looking at the classes, it is clear that mild consumption and consequences seem to suggest that the relationship between consumption and problems can be complicated, i.e. not just a linear relationship where increased consumption leads to an increase in problems. It could be suggested that this represents a group of individuals who don't drink a lot but drink excessively in certain situations (Medina-Mora et al. 1998).

As Cherpitel (1995) suggested, the risk of injury is positively related to average consumption of alcohol including risk at low levels of volume, suggesting that for some individuals in the population who only drink heavily very occasionally are putting themselves at greater risk of injury. Looking at health, there appear to be better health outcomes for regular drinkers when number of drinks, and number of occasions drinking six or more are low, thus suggesting that frequency plays a minor role compared to how many drinks are being consumed per occasion.

Heavy consumption and multiple negative consequences are more likely to have mixed anxiety or depression or anxiety disorder than depression whereas all other classes appeared to be less likely to have depression than the control group. This would suggest that even total abstinence is not without problems, and may be associated with negative health outcomes. This is a link not necessarily predicted by the distribution of consumption model.

In class four, moderate consumption and memory loss is prevalent. The relationship between memory loss and alcohol use at a moderate level has/has not been well documented and possibly warrants further investigation (put in something about memory loss and alcohol here). This is suggesting that there is a sustained pattern of alcohol use which is likely to produce these effects.

It is noteworthy that no-one was more likely to report a mental health problem. This is particularly important for class one the heavy consumers with negative consequences who would be less likely to see their GP about a physical complaint than those in the baseline category. The class with the highest probability of injury, class four were also less likely to visit their GP for either a physical or mental health complaint. Social support may also play a role; class one were more likely to be in a couple compared with the baseline category. This may raise issues of co-dependence, or a lifestyle where heavy drinking is supported by both parties in the couple.

This research has also illuminated a higher likelihood of heavier drinking for males and younger people, suggesting that the focus of interventions is important here.

The research has also demonstrated that the suicide risk is much elevated in those who have heavy drinking patterns and many negative consequences. This presents a serious health consideration, in what is a rare occurrence but with a potentially fatal outcome.

References

- Babor T.F., Dolinsky, Z.S., Meyer, R.E., Hesselbrock, M., Hofmann, M., & Tennen, H. (1992). Types of alcoholics: concurrent and predictive validity of some common classification schemes. *British Journal of Addiction*, 10, 1415-31.
- Babor, T.F., de la Fuente, J.R., Saunders, J. & Grant, M. (1992) *AUDIT: The Alcohol Use Disorders Identification Test: Guidelines for use on primary health care*. Geneva: World Health Organisation.
- Bebbington, P.E. & Nayani, T. (1995) The psychosis screening questionnaire. *International Journal of Methods in Psychiatric Research* 5, 11-19.
- Epstein, E.E, Labouvie, E., McCrady, B.S., Jensen, N.K. & Hayaki, J. (2002) A multi-site study of alcohol subtypes: classification and overlap of unidimensional and multi-dimensional typologies. *Addiction*, 97: 1041-1053.
- Haagenars J.A. & McCutcheon, A.L. (Eds.) (2002) *Applied Latent Class Analysis*. UK: Cambridge University Press.
- Lewis, G., & Pelosi, A. (1990) *Manual of the revised clinical interview schedule (CIS-R)*, Institute of Psychiatry: London
- Lewis, G., Pelosi, A.J., Araya, R., & Dunn, G. (1992) Measuring psychiatric disorder in the community: a standardized assessment for use by lay interviewers. *Psychological Medicine* 22,465–86.
- Medina-Mora, E., Carreño, S. & De la Fuente, J.R. (1998) Experiences with the Alcohol Use Disorders Identification Test (AUDIT) in Mexico. In *Recent Developments in Alcoholism, Vol. 14, The consequences of Alcoholism*. Galanter, M. ed., 383-396. Plenum Press: New York.
- Muthen, B.O. & Muthen L.C. (2005) *Mplus version 4.00*. Los Angeles, CA: Muthen & Muthen.
- Nelson, H.E. & O'Connell, A. (1978) Dementia. The estimation of pre-morbid intelligence levels using the New Adult Reading Test. *Cortex* 14, 234-244.
- Nelson, H.E. & Willison, J. (1991) *National Adult Reading Test (NART) Test Manual*, NFER- Nelson: Windsor, England.
- O'Connor, R.M., & Colder, C.R. (2005). Predicting Alcohol Patterns In First-Year College Students Through Motivational Systems And Reasons For Drinking Source: *Psychology of Addictive Behaviors*, 19, 10-20.
- Reboussin, B.A., Song, E.Y., Shrestha, A., Lohman, K.K., & Wolfson, M. (2006). A Latent Class Analysis of Underage Problem Drinking: Evidence From A Community Sample Of 16-20 Year Olds. *Drug and Alcohol Dependence*, 83, 199-209.

Saunders, J. B., & Aasland, O.G. (1987) *WHO Collaborative Project on Identification and Treatment of Persons with Harmful Alcohol Consumption*. WHO/MNH/DAT 86.3. World Health Organization: Geneva.

Saunders, J.B., Aasland, O.G., Babor, T.F., de la Fuente, J.R. & Grant, M. (1993) Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on early detection of Persons with Harmful Alcohol Consumption –II. *Addiction* **88**,791-804.

Singleton, N., Bumpstead, R., O'Brien, M., Lee, A., Meltzer, H. (2001) *Psychiatric Morbidity among adults living in private households, 2000*. London: Stationery Office

Slater, M.D., Basil, M.D., & Maibach, E.W. (1999). A Cluster Analysis of Alcohol-Related Attitudes and Behaviors in the General Population. *Journal of Studies on Alcohol*, 60, 667-674.

SPSS Inc. (2001) SPSS for Windows release 12.0.0. SPSS Inc: Chicago.