Patterns of Alcohol Consumption and Related Behaviour in Great Britain: A Latent Class Analysis of the Alcohol Use Disorder Identification Test (AUDIT)

Gillian W. Smith[*] **and Mark Shevlin**

Psychology Research Institute, University of Ulster, Northland Road, Londonderry, BT48 7JL, UK

[*] Corresponding author: Psychology Research Institute, University of Ulster, Northland Road, Londonderry, BT48 7JL, UK. Tel.:+44-(0)-28-71-375619; E-mail: gillian.w.smith@gmail.com

Abstract:
Aims: Attempts have been made to develop typologies to classify different types of alcoholism. However, limited research has focused on classifications to describe general patterns of alcohol use in general population samples. **Methods:** Latent class analysis was used to create empirically derived behaviour clusters of alcohol consumption and related problems from the Alcohol Use Disorder Identification Test (AUDIT) based on data from a large stratified multi-stage random sample of the population of Great Britain. Multinomial logistic regression was performed to describe these resultant classes using both demographic variables and mental health outcomes. **Results:** Six classes' best described responses in the sample data. Three were heavy consumption groups, one with multiple negative consequences, one experiencing alcohol-related injury and social pressures to cut down and an additional class with memory loss. There was one moderate class with few negative consequences, and finally two mild consumption groups, one with alcohol-related injury and social pressure to cut down and one with no associated problems. **Conclusions:** Alcohol use in Great Britain can be hypothesized as reflecting six distinct classes, four of which follow a continuum of increased consumption leading to increased dependence and related problems and two that do not. Differences between alcohol use classes are apparent with reduced risk of depressive episode in moderate classes and an increased risk of anxiety disorders for the highest consumers of alcohol.

Introduction:
There have been theoretical and empirically developed typological schemes used to classify alcoholics. For example, Epstein *et al.* (2002) identified four prevailing alcohol typologies (binge, episodic, sporadic and steady) while Babor *et al.* (1992b) assessed the validity of five other classifications (primary versus secondary alcoholism, parental alcoholism, Jellinek'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 on 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 *et al.* (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 2000 French men. Six clusters included alcohol drinkers and were defined in terms of mean alcohol intake. The clusters were related to socio-economic and health-related variables.

Alternative typological techniques have also been employed. O'Connor and Colder (2005) 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 4000 American 16- to 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 hypothesized that the heterogeneity of alcohol-related behaviours could be described in distinct patterns based on both the consumption of alcohol and related alcohol use problems. In particular, latent class analysis was used to identify homogeneous classes, or groups, based on a standardized measure of alcohol consumption and related problems. The nature of the classes was further examined by examining associations with demographic variables and current mental health status.

Methods:
Participants and data
Analyses were performed on participants from the 'Psychiatric Morbidity Among Adults living in Private Households, 2000' survey accessed via the UK Economic and Social Research Council Data Archive (Singleton *et al.*, 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 (SD = 15.43). Over half (54.1%) of the respondents were females and 93% of the sample were 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; Saunders and Aasland, 1987; Babor *et al.*, 1992a), a widely used questionnaire measuring hazardous drinking. The scale comprises 10 items

referring to alcohol consumption and alcohol-related problems in the past 12 months. The AUDIT was originally designed to measure three conceptual domains: consumption (items 1 to 3), dependence (items 4 to 6) and alcohol-related consequences (items 7 to 10) (Saunders and Aasland, 1987). Scores on each item, for the purposes of these analyses, were collapsed in a dichotomy. The baseline category reflected the answers scoring zero on the scale, reflecting 'never' for questions 1, 3, 4, 5, 6, 7 and 8, '1 or 2 drinks' for question 2 and 'no' for questions 9 and 10. The second category represented all other responses for each of the 10 questions.

Demographic and mental health variables Depressive episode, generalized 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). All variables were coded as '1' present and '0' absent. Participants were also asked whether they had attempted suicide in their lifetime (0 = no; 1 = yes).

Demographic variables included respondent sex (0 = female; 1 = male), age (years), level of education (0 = educated beyond GCSE level; 1 = educated to GCSE or below) and economic activity (0 = active; 1 = inactive).

Analysis
Latent class models Patterns of drinking were generated using latent class analysis. This is a statistical modelling technique used to estimate the number of classes of an underlying categorical latent variable, which accounts for the relationships between categorical observed variables (Hagenaars and McCutcheon, 2002). This method creates subgroups of respondents who answer in a similar way on the observed variables of the AUDIT. The model parameters include class membership probabilities (or class prevalence estimates) and 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 Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Sample Size Adjusted Bayesian Information Criterion (SSABIC) were used to assess model fit, 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 (LRT) 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 probability value (P) is <0.05 the k model is superior and additional classes are added until the P value for the statistic is >0.05, at which point the previous model is accepted (Lo *et al.*, 2001). Entropy is a measure of the level that the latent classes are distinct from one another, where a number close to 1 indicates clear classification (Ramaswamy *et al.*, 1993).

Multinomial logistic regression Once the suitable latent class structure of alcohol use behaviour was determined 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 influence the formation of the latent classes). In this method, odds ratios (with 95% confidence intervals) are calculated which compare each of the additional classes to the baseline class.

Software Data were prepared for analysis using SPSS version 15.0 (SPSS Inc., 2006). Both the latent class analysis and the multinomial logistic regression were performed using the Mplus version 4.01 (Muthén and Muthén, 2005).

Results:

Table 1 shows the fit statistics for the latent class analysis of the 10 items of the AUDIT questionnaire. In terms of the LRT the optimal number of classes is 5. 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. Consequently, on inspection of the six-class solution in terms of conditional probabilities, it appears that the addition of another class does add a theoretically relevant pattern. On the basis of these issues the six-class solution is preferred.

The profile plot of the six-class solution is presented in Fig. 1. The most prevalent class is Class 4 (38.52%) and is characterized by a moderate probability of having more than three drinks on a typical session and a moderate likelihood of drinking six or more drinks on an occasion. This class has a very low probability of endorsing any of the indicators associated with dependence (items 4 to 6) or alcohol-related consequences (items 7 to 10). Class 3 is smaller (16.29%) and similar in profile to Class 4 although class members are more likely to drink six or more drinks or drink more than three drinks on a typical occasion and consequently experience memory loss related to this pattern of use. Members of Class 1 account for the smallest proportion of the sample (5.63%), but have the highest probability associated with consumption (items 1 to 3), dependence (items 4 to 6) and alcohol-related consequences (items 7 to 10). This class also has the highest probability associated with the indicator associated with drinking in the morning, which had a relatively low prevalence within the total sample of respondents. This profile of heavy use is mirrored in Class 2 (6.34%); however, this class has lower probabilities associated with the dependence and consequence indicators. The probabilities associated with the consumption indicators are relatively low for Class 5 (7.38%) but high for two indicators associated with negative consequences (items 9 and 10). Class 6 (25.84%) represented almost a quarter of the sample (25.84%) and had low probabilities on all items of the AUDIT and included some abstainers of alcohol.

The results of the multinomial logistic regression analysis are presented in Table 2. For all classes there is a significant increase in the likelihood of being male compared to the baseline, with the highest probabilities in the heavy drinking classes (Classes 1 and 2). Compared to Class 6, Classes 2, 3 and 4 had lower educational achievement (more likely to be educated to the GCSE level or below) and Classes 1 to 4 were more likely to be economically inactive. In terms of mental health outcomes, there appeared to be a protective effect of the moderate consumption patterns in relation to the baseline class with individuals in Classes 3 and 4 being significantly less likely to have a depressive episode. Given the consumption pattern of Class 3, it could be considered that this represents those who drink little and often. In contrast, the heavy consumers in Classes 1 and 2 appeared more likely to have generalized anxiety disorder than the baseline class, with Class 1 also being 1.66 times more likely to have mixed anxiety and depressive disorder. Classes 1, 2 and 3 had a higher probability of having attempted suicide in their lifetime. The results of the multinomial regression lend support to the external validity of the classes as distinct from each other, not only on the indicators of the latent variable, but also in terms of their relationship with covariates.

Discussion:

The findings reported in this paper have described a British population typology that attempts to profile alcohol use based on a standardized measure of alcohol consumption, dependence and negative alcohol-related consequences. A six-class solution was found to be the best description of the sample data. Classes 1, 3, 4 and 6 tended to differ quantitatively rather than qualitatively. This suggests that alcohol consumption, dependence and negative alcohol-related consequences lie along a continuum although it is skewed particularly in relation to the dependence items (4 to 6). In addition, higher levels of consumption were associated with higher levels of dependence and consequences.

Two classes deviated from the general continuum pattern. The pattern of probabilities associated with Class 5 (mild consumption and negative consequences) indicates that this relationship is not always expressed. It could be suggested that this class represents a group of individuals who do not drink a lot, but drink excessively in certain situations (Medina-Mora *et al.*, 1998). Indeed Cherpitel *et al.* (1995) found that those who drink heavily on rare occasions have a elevated risk for injury, suggesting that the quantity on occasion could be a key factor in risk. Class 2 had similar consumption probabilities compared to Classes 1 and 3. However, the probabilities associated with the traditional dependence indicators (items 4 to 6)

were relatively low and the probabilities associated with two negative consequences indicators were relatively high (experienced alcohol-related injury and asked to cut-down alcohol consumption). For this group there is a positive association between consumption and consequences without the expected level of dependence. The issue of the validity of the self-reported dependency is pertinent in determining the robustness of this class, as there is evidence of under-reporting of behavioural indicators of dependence among heavy alcohol users (Maisto and Connors, 1992).

The results from the multinomial logistic regression using the demographic variables indicated that heavier drinking classes (Classes 1, 2 and 3) were more likely to be males, young, of low educational achievement and economically inactive (compared to Class 6). The results based on the psychological variables indicated that generalized anxiety disorder, mixed anxiety and depression and suicide attempts are only associated with Classes 1 and 2, characterized by high consumption. This is consistent with the research literature that has identified negative psychological consequences of excessive consumption (e.g. Rodgers *et al.*, (2000)). However, in the context of this study, where three clusters of indicators were modelled (consumption, dependence and consequences) the psychological outcomes may also be attributable to related affective states (guilt), injuries or poor social relations (being asked to reduce consumption). Depressive episodes were less likely for those moderate drinkers in Classes 3 and 4. This indicates that there may be some protective component associated with limiting alcohol consumption to moderate levels or sustained but moderate quantities of alcohol use. However, this may be due to the social nature of such consumption rather than a psychopharmacological mechanism. Overall, there appeared to be a dose-response type pattern of effects, with the odds ratios associated with the mental health variables generally decreasing from Class 1 through 5. This is indicative of an underlying continuum of alcohol consumption, dependence and negative consequences at the population level. However, such an interpretation warrants extreme caution, as not all effects were statistically significant.

In conclusion, this study found support for a population typology of alcohol-related behaviour that implied, for the most part, an underlying continuum of consumption, dependence and negative consequences. Two qualitatively different classes were also found. The classes associated with high consumption were more likely to have poorer psychological status, and there was some evidence of a protective effect for more moderate consumption classes. It is clear that research that aims to identify homogeneous groups of people based on alcohol consumption and related behaviours and identifies resultant psychological and/or physical problems would be useful in focusing preventative measures and educational programmes. However, this research did have its limitations. Future research could provide (1) a more detailed measure of consumption levels and frequency, (2) include more outcomes associated with social functioning problems or (3) examine geographical influence such as indices of deprivation or urban/rural differences.

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

Model	LRT	P	AIC	BIC	SSABIC	Entropy
2 class	6455.41	0.00	51,000.25	51,146.58	51,079.85	0.73
3 class	1932.62	0.00	49,070.04	49,293.02	49,191.33	0.82
4 class	1184.12	0.00	47,895.91	48,195.54	48,058.90	0.83
5 class	257.60	0.00	47,657.70	48,033.98	47,862.38	0.74
6 class	123.46	0.08	47,554.99	48,007.92	47,801.37	0.73
7 class	57.95	0.01	47,518.46	48,048.04	47,806.52	0.74

Note: LRT: Lo-Mendel-Rubin likelihood ratio test; AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; SSABIC: sample size adjusted Bayesian Information Criteria.

Table 2 Estimates from the multinomial logistic regression of latent classes and demographic and mental health variables

Predictors	Odds ratio (95% confidence intervals)				
	Class 1	Class 2	Class 3	Class 4	Class 5
	Heavy consumption with multiple negative consequences	Heavy consumption with injury and suggestion to cut down	Heavy consumption with memory loss	Moderate consumption	Mild consumption with injury and suggestion to cut down
Sex	5.86 (4.76–7.20)*	4.10 (3.51–4.80)*	3.32 (2.91–3.78)*	2.11 (1.90–2.35)*	1.32 (1.11–1.58)*
Age	0.92 (0.92–0.93)*	0.96 (0.95–0.96)*	0.93 (0.94–0.94)*	0.97 (0.96–0.97)*	1.01 (1.00–1.01)
Education	1.02 (0.83–1.25)	1.25 (1.07–1.47)*	1.24 (1.08–1.42)*	1.34 (1.20–1.48)*	0.94 (0.08–1.12)
Employment status	1.30 (1.03–1.65)*	1.34 (1.12–1.60)*	1.83 (1.57–2.12)*	1.42 (1.27–1.59)*	1.04 (0.86–1.26)
Depressive episode	1.29 (0.74–2.27)	0.65 (0.04–1.08)	0.61 (0.39–0.95)*	0.67 (0.49–0.93)*	0.90 (0.53–1.52)
Generalized anxiety disorder	2.86 (1.88–4.35)*	1.85 (1.28–2.65)*	1.17 (0.83–1.65)	1.13 (0.87–1.46)	1.09 (0.71–1.66)
Mixed anxiety and depressive disorder	1.66 (1.22–2.25)*	1.12 (0.86–1.45)	1.08 (.86–1.34)	0.86 (0.72–1.03)	0.87 (0.64–1.12)
Suicide attempt in lifetime	2.86 (1.90–4.30)*	1.73 (1.19–2.50)*	1.69 (1.23–2.32)*	1.03 (0.78–1.35)	1.20 (0.77–1.86)

Note: all estimates compared to baseline mild consumption group (Class 6) where * denotes significance at the 0.05 level.
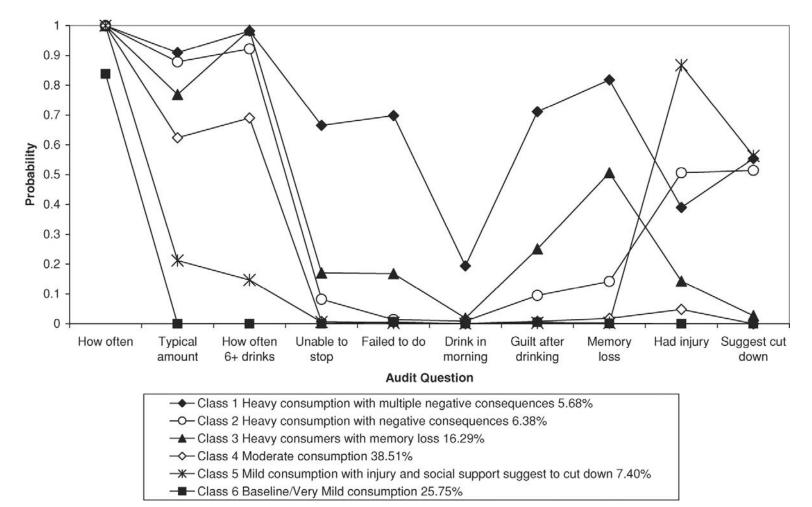
Fig. 1 Profile plot showing class-based probability of endorsing each item on the AUDIT