Modelling patterns of polydrug use in the population of Great Britain: A latent class approach

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Table of Contents

List of tables

List of figures

List of Appendices

Acknowledgements

Note on access to contents

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Note on access to contents

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Abstract

Substance use and their consequences account for substantial public spending in Great Britain and Europe. However, alcohol and drug policy change is often based on the harms attributed to a single drug, when polydrug use (the use of more than one drug) is common and may increase associated harm. This research has employed advances in statistical analysis to create typologies of polydrug use including alcohol and illicit drugs at a general population level in the 2000 National Psychiatric Morbidity Survey to better inform risks associated with these substances. Alcohol and drug use patterns were determined separately and then in an integrated model using latent class analysis. The relationship between the classes, demographic, and psychological status was assessed through multinomial logistic regression. Three drug classes, wide range, moderate range and no drug use represented illicit polydrug use. Six alcohol classes were found, most of which followed a continuum of increased consumption relating to increased related problems, with one exception who experienced problems with low alcohol consumption. Any drug use elevated the risk for psychological conditions compared with the no drug use class, and increased levels of alcohol consumption were related to increased risk of generalised anxiety disorder and lifetime suicide attempts. Two integrated alcohol and illicit drug polydrug use models were proposed, one with eight and one with 18 classes. Further investigation of these models found two main conclusions. First, illicit polydrug classes change when measured with alcohol use, and the three classes were now ‘no drug’ use, ‘cannabis only’ and ‘polydrug users’. This in turn affected relationship with demographic variables and psychological status. Second, whilst alcohol use patterns do not change dramatically when measured in the presence of illicit drug use, there were

changes in relationships of alcohol with current psychological status as a consequence accounting for illicit drug use. Risk of poorer psychological health is elevated in heavier patterns of alcohol use who also consume illicit drugs compared to the same alcohol pattern without illicit drug use. In conclusion, latent class analysis is a useful way in which to model population level polydrug use. Through this methodology the consequences of separating alcohol and illicit drug use in research have been shown. Research into either alcohol or illicit drug use should consider modelling both in the same model. The presentation of polydrug use in this context may be able to show some of the ambiguities in the literature regarding demographic differences and risk relating to poorer psychological health.

1. Introduction

Research in this thesis will explore and measure patterns of polydrug use in the general population. It will also assess how these patterns relate to demographic criteria and current psychological status. To enable an understanding of polydrug use, this chapter will first outline the population prevalence of alcohol and illicit drugs in Europe, providing context for the dataset used throughout. Attention will then be drawn to polydrug use. The different definitions of polydrug use will be explored and a lexicon determined for this work. This will be followed by a discussion of the issues polydrug use raises in the drug field. This chapter will then discuss how polydrug use limits progress in drug and alcohol research, using examples from the ecstasy use literature.

1.1. Prevalence rates of illicit drug use in Europe

The data presented in this section refers to prevalence rates of drug use reported in Europe, to provide some context for the National Psychiatric Morbidity Survey (NPMS; Singleton, Bumpstead, O'Brien, Lee, & Meltzer, 2001a; 2001b), the dataset which will be used throughout this thesis. European data was sourced from the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) Annual report (EMCDDA, 2008). The EMCDDA is a Lisbon based, European Union de-centralised agency. It was founded in 1993 to provide drug related information of the countries in the European Union and Norway. It aims to provide policy makers, politicians, researchers and health professionals with a reliable, consistently measured evidence base on existing and emerging trends in European illicit drug use.

Information on the trends reported in this section is fed to the EMCDDA through the activities of ‘Reitox’ centres. These are national monitoring centres, present in 30 countries which provide requested information on illicit drug use and related information using similar methodologies. This ensures comparability in the Annual Report. All countries participating in this survey were randomly sampled whether simple, or multi-stage. In the former method every unit in a given population had the same probability of inclusion. Multi-stage random sampling is a method of random sampling between different units of measurement. For example, a participant in a study from the UK could be selected with a given probability from their Council area, postcode sector, household and from the residents living in the address. All participating countries also weighted their data to attempt to minimise response bias in their percentage estimates because of non-response.

The use of random sampling is important when estimating population trends. If we are interested in the characteristic of a given population, such as an opinion, we try to find out the parameter which represents the magnitude of that opinion. However, unless we ask questions of all members of the population, we can only make estimates as to what the ‘parameter’ or true value of that opinion might be. Instead, if a random sample of the population is taken we can find a statistic which approximates to the opinion of the sample. However, a given sample drawn randomly from the population of interest will vary in their opinion to another given sample. This is one of the causes of error in an estimate (other causes may arise from non-sampling related issues such as errors in data processing, ambiguous questions or differing interviewing circumstances).

In random sampling, estimations of this error can be derived. Random samples have a given probability of a unit (or individual) being selected. Thus inferences can be made as to the representative nature of the statistic in relation to the population parameter through 95% confidence intervals. This contrasts with opportunity samples. These are individuals selected by their availability and thus error can arise through considerable self-selection bias. It is also impossible to estimate the probability of a volunteer being selected into the sample. Inferences to the general (or otherwise) population are not possible. However, they can provide some context to findings. Opportunity sampling is common in illicit drug research due to the clustering of drug use in certain situations such as night clubs[1].

European countries sampled in this report varied in their data collection method. The majority used face to face computer-based interview techniques recommended by the EMCDDA, however, for reasons of cost some used telephone interviewing. This is a potential source of bias. Telephone surveys typically have lower estimates of illicit drug use and higher response of ‘don’t know’ (Aquilino, 1992; 1994). Another source of bias was inconsistency in data collection years but the majority of studies were collected in 2004-2006. Despite these methodological limitations, which might be expected of a survey of this kind, the Annual Report provides a useful indicator of European trends in illicit drug use.

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[1] These are often referred to as ‘dance drug’, ‘rave’, ‘nightclub’ or ‘party drug’ populations and may include those who attend both licensed and unlicensed venues for dancing and drug consumption. Attendees are traditionally more likely to consume illicit drugs than the general population (Deehan & Saville, 2003; Release, 1997). A common way to sample these populations are through ‘snowball’ techniques (Solowij, Hall & Lee, 1992), ‘privileged access interviewing’ (Griffiths, Gossop, Powis & Strang, 1993) or ‘purposive sampling’ (Topp, Hando, Dillon, Roche & Solowij, 1999). These are methods which use contacts known to the researchers, who then in turn refer their contacts to participate in the study. Whilst a common way in which to find illicit substance users, it introduces considerable response bias, in a similar way to opportunity sampling.

Cannabis is reported to have been used by 23 million adults in Europe in the past year (EMCDDA, 2008). As can be seen in Table 1, cannabis prevalence had the widest range between countries. The difference between the largest and smallest was 10.4%. The largest prevalence was in found in the general population of Italy (11.2% in the past year). The country with the least percentage of cannabis use was Malta with .8% of the population estimated to use this drug in the past year. The prevalence in the population of Great Britain was 8%. This is a greater percentage than 15 of the 18 studies illustrated in Table 1. Only prevalence rates of cannabis use in the Czech Republic, France and Italy were of greater magnitude. Prevalence of cannabis use in Great Britain is therefore high in the context of European trends.

Estimates of cocaine use in the NPMS were also high in comparison to other European countries. Great Britain had a prevalence of 1.5% for use of cocaine in the past 12 months. Only Italy and Ireland had a higher prevalence with 2.2% and 1.7% respectively. The lowest prevalence of cocaine use was found in a sample of the Greek population representing .1%. Note four million European adults are considered to have consumed cocaine in the past 12 months; a considerably lower estimate than cannabis. In addition, the range of prevalence rates were smaller (.1 to 3%)

The use of amphetamines in the past year ranged between .0 and 1.5%. Great Britain had the highest rate of consumption in Europe with 1.5%. Malta, which also had the lowest prevalence rate of cannabis use, had a prevalence rate of amphetamine use of less than .0. Norway and Latvia were the only countries using amphetamines with a prevalence of greater than 1%. Two million European citizens were considered to have used amphetamines in the last year.

The highest prevalence of ecstasy use in Europe was found in the Czech Republic. Of the surveyed sample, 3.5% were using ecstasy in the past year. Great Britain was the second most prevalent user of this drug with 1.6%, followed by Latvia and Norway with prevalence of 1.1%. Greece and Malta had the lowest prevalence of use in Europe. Approximately 2.6 million European citizens used ecstasy in the past year.

Finally, LSD had the lowest overall prevalence. No featured country had a prevalence of greater than .6%. The majority of countries had prevalence rates of .1% using this drug in the past year. As was for cannabis and cocaine use, Italy had the highest prevalence of LSD use in featured European countries (.6%). This was closely followed by Cyprus and Latvia. The populations of these countries had an estimated .5% prevalence of LSD use in the past year. Great Britain had a prevalence of .3% of LSD use in a 12 month period representing a modal position in the prevalences of Europe.

In summary, Great Britain tends to have higher prevalence rates of cannabis, ecstasy, cocaine, amphetamines and LSD (in descending order of prevalence compared to most countries in the European Union (and Norway).

Table 1: Frequency of cannabis, cocaine, amphetamines, ecstasy and LSD use in Europe[2].

Country, year of survey, age range and sample size	Cannabis	Cocaine	Amphetamines	Ecstasy	LSD
Finland, 2006, 15-64 years, n=2802	3.6	.5	.6	.5	.1
Bulgaria, 2005, 18-60 years, n=1036	1.5	.3	.4	.5	.2
Czech Republic, 2004, 18-64 years, n=3526	9.3	.2	.7	3.5	.4
Denmark, 2005, 18-64 years, n=13310	5.2	1.0	.7	.3	.1
Germany, 2006, 18-64 years, n=7912	4.7	.6	.5	.4	.1
Ireland, 2006-2007, 15-64 years, n=4967	6.3	1.7	.4	1.2	.2
Greece, 2004, 15-64 years, n=4351	1.7	.1	.0	.2	.1
Norway, 2004, 15-64 years, n=2669	4.6	.8	1.1	.5	.2
France, 2005, 15-64 years, n=25879	8.6	.6	.1	.4	.1
Italy, 2005, 15-64 years, n=27995	11.2	2.2	.4	.5	.6
Cyprus, 2006, 15-64 years, n=3504	2.1	.6	.3	1	.5
Latvia, 2003, 15-64 years, n=4534	3.8	.2	1.1	.8	.5
Lithuania, 2004, 15-64 years, n=4207	2.2	.3	.3	.4	.1
Portugal, 2007, 15-64 years, n=12202	3.6	.6	.2	.4	.1
Poland, 2006, 15-64 years, n=2859	2.7	.2	.7	.3	.1
Austria, 2004, 15-64 years, n=3980	7.5	.9	.8	.9	.2
Netherlands, 2005, 15-64 years, n=4516	5.4	.6	.3	1.2	.1
Malta, 2001, 18-64 years, n=1755	.8	.3	0	.2	.1
Great Britain, 2000, 16-74 years, n=8580	**8.0**	**1.5**	**1.5**	**1.6**	**.3**

[2] Includes only those who had an estimate of prevalence of all five substances, or provided the number of respondents who took part in the survey. Total n=132,004 for studies in the EMCDDA Annual report (EMCDDA, 2008). Great Britain data from Singleton et al. (2001a; 2001b)

1.1.1. Drug use percentage: representative of the population?

UK prevalences provided to the EMCDDA for comparison are usually derived from the latest British Crime Survey- Drug Misuse Declared and these prevalences are notably absent from the comparisons in section 1.1. However, this section aims to assess the substance use in more depth to assess representativeness of the NPMS to prevalences at the time it was collected and the most recent survey. Therefore, Great Britain (NPMS) prevalences will be compared to those in the UK from 2000 and 2008. It is worth noting, given the legal status of many of the drugs included in this thesis, there are often concerns regarding representativeness and disclosure of illicit polydrug use behaviours (Anthony & Wagner, 2000). Adolescent studies have also illustrated that less socially desirable substances are more likely to be underestimated in prevalence rates (for example, Percy, McAlister, Higgins, McCrystal & Thornton, 2005).

As Figure 1 shows, frequencies of use of illicit drug use were similar to the British Crime Survey- Drug Misuse Declared at 2000 (DMD 2000; Ramsey, Baker, Goulden, Sharp & Sandhi, 2001), but most were closely related to British Crime Survey- Drug Misuse Declared 2007/8 (DMD 2007/8; Hoare & Flatley, 2008) figures. Yearly rates of cannabis use in the NPMS (Singleton et al. 2001a; 2001b) were around 8%, and this is mirrored in the percentage of the DMD 2007/8. This is less however than the DMD 2000 which finds the percentage yearly use at just over 10%. The use of cocaine amongst these three groups spans 1.5% in the NPMS to 2% in the DMD 2000 and 2.3% in DMD 2007/8, suggesting that the NPMS has the lowest reported use. In contrast, the percentage of sample respondents using ecstasy across all three studies is relatively similar. Other less prevalent drugs like magic mushrooms, heroin, methadone, anabolic steroids and glue also find broad similarities between the percentages of respondents using these items over the past year.

The use of LSD appears to be more frequent in the DMD 2000 survey than either of the other two studies illustrated. This trend is also found in the yearly prevalence of amphetamines. For both drugs, the NPMS shares a similar percentage with DMD 2007/8. Amyl nitrate use in the NPMS is considerably lower than that of either of the DMD studies. They had a similar percentage rate at 1.3% and 1.5% for the DMD 2000 and DMD 2007/8 respectively.

However, despite the similarities between this current survey and the DMD 2007/8, the latter has a slightly higher percentage of any drug used in the past year, with a percentage difference of .4%. Whilst this might seem small, it becomes more significant when extrapolated to numbers of individuals in the population of Great Britain. It is also worth noting that the DMD surveys were conducted in England and Wales only, whereas the survey used in this thesis contains data from England, Scotland and Wales.

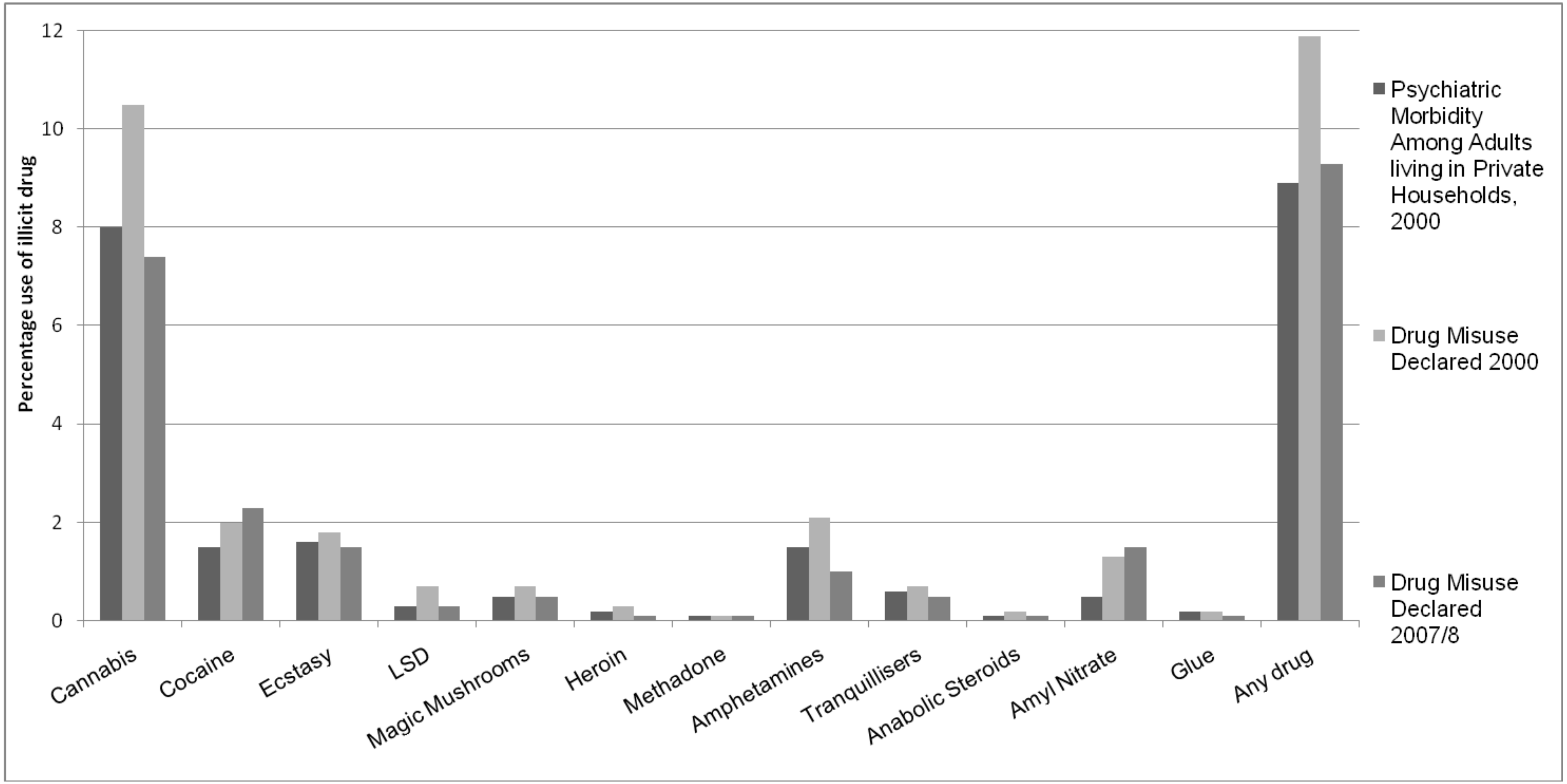

Figure 1: Graph illustrating percentage of illicit drug comparisons of respondents aged 16-59 with the Drug Misuse Declared in 2000 (Ramsey et al., 2001) and 2007/8 (Hoare & Flatley, 2008) and the NPMS (Singleton et al., 2001a; 2001b)

1.2. Prevalence rates of alcohol use in Europe

Data presented in this section is representative of a recent Eurobarometer study by the European Commission (EC) assessing attitudes to alcohol use in member states (EC, 2007). These have assessed trends in frequency in the past year, typical frequency and quantity in the past month and frequency of heavy drinking occasions. These are frequently asked questions to assess alcohol consumption (Dawson, 2003). They are also like those found in the commonly used Alcohol Use Disorder Identification Test (AUDIT: Saunders & Aasland, 1987) which features in the analyses presented in later chapters. Data from this survey will be reported in this section and compared with Great Britain estimates in section 1.3.

Data reported was collected in October and November 2006 by the market research company 'TNS Opinion and Social'. It was uniformly sampled using multi-stage random probability techniques. Weighting was also applied according to national statistics from a surveyed country to improve representativeness of collected data. All surveys were conducted using Computer Assisted Personal Interviewing (CAPI) techniques face to face with the respondent. There were 25 countries included in the total EU estimate (these will be commonly referred to in the text as EU 25). The total number of European citizens sampled were 28,584. Of this total, 1375 were from the UK. Whilst this survey assesses information relating to the use of alcohol in certain demographic groups for EU 25, no significance tests were performed. Thus any reference to demographic trends must be interpreted with caution.

The first question relates to any alcohol consumption in the past year. The majority of European citizens had consumed alcohol in this time frame (75%).

Highest abstention rates were found in Italy (40%) and the lowest were in Denmark (7%). The UK prevalence rate of abstention was 19% in the year prior to data collection. Abstention was more common in females living in Europe; 32% of females had not consumed alcohol in the past year compared with 16% of males. Alcohol consumption in the past year was also broadly associated with higher educational attainment and managerial employment status.

Those who had consumed alcohol in the past year were then asked their frequency of drinking in the past month. The majority of those who drank in the past year also drank at least once in the past month (87% in the EU; 86% in the UK). Prevalence rates representing the frequency of consumption in the past month are presented below in Table 2.

Table 2: Frequency of alcohol consumption in the past month in the EU and UK

	Once a month	2 – 3 times per month	Once a week	2 - 3 times per week	4 – 5 times per week	Daily use
EU 25	13	17	25	23	8	13
UK	9	14	26	33	9	8

The most frequent consumption patterns in the past month represent consumption either once, twice or three times per week. The European prevalence estimate for daily use was higher than the UK, but this does not infer the quantity per occasion. Portugal had the highest percentage of daily drinking in the European Union (47%), with the least frequent in Latvia (1%). UK drinkers were more likely to drink alcohol two to three times per week compared with the EU estimate. They were also less likely to drink once, twice or three times per month.

Typical amounts consumed on occasion are presented in Table 3. Residents of the UK consume more than four drinks on a typical consumption occasion more frequently than EU estimates. However, the majority of European and UK citizens drink one or two drinks in a typical occasion. This would suggest that predominantly, consumers in both samples had a moderate typical intake. Ireland had the highest typical quantity of the European Union; 34% of the sample typically consumed more than four drinks and 36% typically drank three or four drinks. By contrast, Bulgaria had the lowest typical consumption. Of their sample 1% drank four or more drinks on occasion, and 8% drank three or four drinks on a typical occasion.

Table 3: Typical quantities of alcohol consumed on an occasion in the EU and UK

	Less than one standard drink	One to two drinks	Three to four drinks	Five or more drinks
EU 25	11	49	29	10
UK	4	46	25	24

There were also some demographic trends reported in European use. Lower educational attainment (educated up to 15 years) was associated with the lowest typical consumption. By contrast, students and unemployed persons were most likely to consume three or more drinks on a typical occasion (42% each). Those least likely to drink three or more drinks on a typical occasion were homemakers and retired persons with 16% and 17%. Males were more likely to consume three or more drinks per sitting. Younger age was also associated with heavier typical amounts. Of 15 to 24 year olds, 44% were drinking above three or more drinks on a typical occasion compared with only 17% of retired persons.

The frequency of 'binge drinking' conceptualised as drinking more than five drinks on occasion in the past year is presented in Table 4. Most European residents drink this quantity infrequently. Prevalence rates for drinking less than once a month or never were 55% for EU25. Rates for the UK are similar at 53%. The highest prevalence of drinking five or more drinks, several times per week was found in Estonia (28%). This is considerably more than EU25 and UK estimates at 13% and 12% respectively. Residents in Ireland were most likely to consume five or more drinks on occasion once a week (37%). Highest rates of 'never' drinking this amount were found in Portugal (55%). 'Never' drinking five or more drinks was also more common in females (41%) than males (22%) and in older adults (44%) compared to younger adults (20%). Homemakers and retired persons were unlikely to drink five or more drinks on occasion (41% and 46% respectively stated they would never drink this amount on a drinking occasion).

Table 4: Frequency of drinking five or more drinks on occasion in the EU and UK

	Never	Less than once a month	Once a month	Once a week	Two or more times a week
EU 25	31	24	16	15	13
UK	29	24	16	19	12

1.3. Alcohol use in Europe: Comparisons with the NPMS

The questions asked in this European survey were similar to the AUDIT questions asked in the NPMS dataset analysed in this thesis (Singleton et al., 2001a; 2001b). This section will compare trends found in EU 25, and the specific estimates for GB with the NPMS data.

The first question of the AUDIT questionnaire refers to how often an individual has consumed alcohol in the past year (how often; see Appendix 1). This relates to two questions in the Eurobarometer study (EU, 2007). The first of these asks whether an individual has consumed alcohol in the past year. The second inquired as to the frequency of use in the past month (for those who had consumed alcohol in the past year). Response options presented in Table 2 have some comparable ranges to those in the ‘how often’ question in the AUDIT questionnaire, but cannot be directly compared. The percentage responses in the Eurobarometer study are for those who have said they consume alcohol at least monthly. In the NPMS a response to the how often question reflects full year patterns, which may include past year abstainers.

The second main question in the Eurobarometer study concerns typical amount consumed on an occasion. The first response category is less than one typical drink which is not included on the AUDIT questionnaire. Given the prevalence of this in the EU and UK, it is not possible to directly compare the frequencies. In an attempt to compare these, it could be suggested that a percentage of those endorsing one or two drinks on the AUDIT must also be drinking less than one drink. A collapsed category of less than one drink and one to two drinks could be considered equivalent to the one or two drink response category in the AUDIT. However, the categories of three or four, and five or more can be directly compared between studies. They are presented in Table 5 below. There were few differences between the UK sample in the Eurobarometer study and the population of Great Britain. There were a higher percentage of five or more drinks as a typical consumption pattern in the GB sample, differences representing 3% of the total population.

Table 5: Comparisons of typical consumption frequencies between the Eurobarometer study and NPMS

	Two or fewer drinks	Three to four drinks	Five or more drinks
EU 25	60	29	10
UK	50	25	24
NPMS (Singleton et al., 2001a)	49	24	27

The final main question in the Eurobarometer study examines the frequency of drinking five or more drinks on a single occasion in the past year conceptualised as ‘binge drinking’. The AUDIT question which is comparable asks about consumption of six or more drinks in the past year. Despite this, the response categories are directly comparable between studies, and are presented in Table 6 below.

Table 6: Comparison of frequencies of drinking five or more drinks (Eurobarometer) and six or more drinks on the NPMS

	Never	Less than once a month	Once a month	Once a week	Two or more times a week
EU 25	31	24	16	15	13
UK	29	24	16	19	12
NPMS	43	27	14	17	2

Differences were more pronounced between samples for binge drinking on occasion. The Great Britain (GB) sample had a higher percentage of those not binge drinking on occasion in the past year compared to the UK and EU estimate. They also had the lowest frequency of binge drinking twice or more per week. This variation may be due to the conceptualisation of binge drinking as five (Eurobarometer) or six drinks (NPMS). However, the difference between five and six drinks per occasion is only one standard drink. Therefore, the GB percentage for never drinking five or more drinks on occasion is likely to be lower than in Table 6. However, there was still a considerable percentage difference between the EU and UK figure, and thus the differences may still be relevant.

1.4. Perceived harm and availability of alcohol and illicit drugs

As has been illustrated above, the prevalence of alcohol and illicit drugs in Europe, UK and Great Britain, varied considerably according to the drug. Alcohol was the most commonly used substance, followed by cannabis, ecstasy, cocaine, amphetamines and LSD. In part, the reasons for this difference may be attributed to perceived harm, benefits and availability of drugs (White et al., 2006; Nordentoft & Hjortoj, 2007). This section will primarily draw upon a study conducted in May 2008 as part of the Flash Eurobarometer survey series (EC, 2008) on attitudes of young people to drug use in 27 EU countries. Like the other surveys reported in this section to date, the information is based on a multi-stage random sample of the population of Europe which has been weighted to better represent the population from which it was sampled. It was conducted by the Gallup polling organisation through telephone interviews. The total sample size was 12312; the sample size of the UK component was 500 persons.

The risk to health perceived by European youth and UK youth are presented in Table 7. Very few respondents considered alcohol, cannabis, cocaine, ecstasy, or heroin use to be risk free. Cannabis and alcohol were the most likely to be perceived as low risk, with higher percentages for UK youth compared with the European average (EU 27). Alcohol use was broadly considered to be moderately risky by European youth. However, there were some differences between EU and UK youth estimates in terms of risk attributed to cannabis use. Approximately equal percentages considered cannabis to be moderate or high risk at around 40%. Cannabis was considered high risk by more European young people than those in the UK (40% compared with 28%). This is indicative of higher cannabis use frequency for the UK compared with the European average (see section 1.1).

Of the sampled European youth, 85% and 80% considered cocaine and ecstasy use to be high risk. In the sampled UK youth, lower percentages were found for these two substances; for both drugs, 76% of the sample considered them high risk. Lower percentages of high risk were found for UK youth for these two drugs. By far, heroin was considered the most high risk of all the drugs surveyed with neither EU youth, nor the UK subsample considering heroin risk below moderate. Slightly higher UK youth reported heroin use to be high risk compared to EU youth.

This is reflective of prevalence trends (see section 1.1). Firstly, Great Britain estimates were higher than majority of the EMCDDA countries reported in Table 1. Second, it is indicative of slight prevalence differences between cocaine and ecstasy use in the past year.

Table 7: Perceived health risk attributed to the consumption of alcohol and illicit drugs

		No Risk	Low Risk	Moderate risk	High risk
Alcohol	EU 27	1	15	59	24
	UK	1	22	59	18
Cannabis	EU 27	1	14	42	40
	UK	2	26	44	28
Cocaine	EU 27	0	1	12	85
	UK	0	3	20	76
Ecstasy	EU 27	0	2	16	80
	UK	1	6	17	76
Heroin	EU 27	0	0	4	94
	UK	0	0	2	97

Note: Row percentages to not sum to 100% due to 'don't know' responses

Demographic trends were also reported for EU 27 estimates. Young females considered drug use to be generally more risky than young males in Europe. Cannabis was considered high risk by 46% of females compared to 35% of males. Conversely, 10% of females considered cannabis to be low risk compared with 18% of males. More young males considered alcohol to be low risk compared to young females (19% compared with 11%). Older youth were more likely to choose high risk compared to the moderate risk for drug use compared those who were younger. This would suggest that prevalence rates might be higher in young males. However, the relationship with education varied. Those with lower educational attainment attributed a higher risk to cannabis but not other drugs.

In the Eurobarometer study, risk perception was related to availability of drugs. Attributing a high risk to a given drug was associated with greater difficulty in accessing the drug. Alcohol was the easiest to obtain for both EU and UK youth. This was followed by cannabis, cocaine, ecstasy and finally heroin use.

Attribution of risk was assessed through a general question: “To what extent do you think the following drugs may pose a risk to a person’s health? Does *named drug* pose a high, medium, low or no risk?” (p.21; EC, 2008). Therefore, it was difficult to estimate how risk was conceptualised by individuals. Recent research by White et al. (2006) explored (any) risk perception of ‘party drug’ use in a sample of 273 regular ecstasy users in Australia. The majority of respondents’ considered the use of ecstasy and amphetamines were risky (90% and 84% respectively). Lower percentages attributed risk with cocaine (55%). These would appear to be conservative estimates compared to European youth figures (no risk versus any risk from Table 7). However, they also assessed what the perceived risks might be. Addiction or dependence was more of a risk for cocaine (44%) followed by amphetamine (21%) and ecstasy use (7%). Risk of depression was more likely to be attributed to ecstasy use (13%) compared with amphetamine (9%) and cocaine use (4%). This was reflected in perceived neurological harm risk. Again, ecstasy was most likely to be associated with this harm (12%) compared to 8% and 3% of amphetamine and cocaine users respectively. They did not estimate risks for heroin or cannabis use in this sample given the low percentages of this use in their study.

In conclusion, risk is generally viewed as highest for heroin, followed by cocaine, ecstasy, cannabis and alcohol. Broadly, this reflects prevalence trends for these drugs. However, estimates of perceived harms in European youth did not describe what these harms might be. Recent research has suggested that this perceived harm may be most likely to be concerns regarding neurological damage, depression or addiction (White et al., 2006).

1.5. Polydrug use

Polydrug use has been considered “the most important confound in drug research” (Gouzoulis-Mayfrank and Daumann, 2006b, p.45) and there are five main reasons why this may be the case. The first concerns the lack of isolation in a single drug focus. Any relationships with the single drug of focus are weakened in an unknown way by other drugs used with the drug of interest. Second, given the number of licit and illicit drugs available, there are vast numbers of possible combinations of drugs available. Third, methods used to measure illicit drugs whether statistical or descriptive are not consistent across studies. Fourth, the impact of polydrug use is also affected by the number and range of drugs included. Some studies focus exclusively on specific drugs, however, may not account for their high association with other drug use which has not been include. Finally, conceptualisation of drug use can vary between studies, and across time points.

This first section will explore definitions of polydrug use and attempts to overcome inconsistent conceptualisation by creation of a lexicon to be used throughout this thesis. The second section will explore frequencies in polydrug use. Frequencies will be described in the context of caveats relating to possible combinations, lack of isolation and the drugs included in percentage estimates. The problems arising from measurement will be discussed in chapter two.

1.5.1. Definitions of polydrug use

Definitions of polydrug use in the literature have typically varied between studies (Brecht, Huang, Evans, & Hser, 2008; Schensul, Convey & Burkholder, 2005). This is potentially caused by the drugs included, whether specific or general, the time frame of usage, and as a function of the effects. Each of these will be assessed in turn in arising with the universal definitions in this thesis.

Johnston (1975) suggested that polydrug use was the use of more than one drug by an individual. This broad definition was also adopted by Collins, Ellickson and Bell (1998). Whilst this description could encompass both licit and illicit drug use, Johnston stated that alcohol should be included. An EMCDDA report (EMCDDA, 2001) stated all illicit drug users are at the very least ‘lifetime’ polydrug users. Despite this, the term polydrug has more connotations with illicit drug use, than perhaps licit drugs (World Health Organisation [WHO], 2009). Martin (2008) used a broader drug definition of alcohol users who used other psychoactive drugs, for example tobacco, cannabis, pharmaceuticals, or other illicit drugs. Thus the defining characteristic of this definition was alcohol use (in the presence of other drugs). Other classifications based on drugs selected particular polydrug use combinations. These included pairings such as ‘alcohol and cannabis’ (e.g. Midanik, Tam & Weisner, 2007; Riley & Hayward, 2004) or more general ‘alcohol and drugs’ (e.g. Falk, Hsaio-Ye and Hiller-Sturmhofel, 2008; Feigelman, Gorman & Lee, 1998). Advantages to this approach may be the minimisation of other confounding patterns of use. However, patterns of a specific pair are typically both hard to find and have low frequencies in the population. Broad patterns, for example illicit drugs and alcohol whilst easier to find encompasses a multitude of heterogeneity within a group.

Other approaches have considered timing in their polydrug definitions. Johnston (1975) proposed three classifications in this regard. The first concerns any use of more than one drug by an individual in the past (‘ever use’). The second, was the use of more than one drug by an individual in the past year (‘recent use’). The final classification was on occasion, defined as any consumption where the mind-altering effects overlap (‘overlapping use’). There is some degree of overlap between these categories. ‘Recent use’ and ‘overlapping use’ classifications are included in ‘ever use’ polydrug patterns. ‘Overlapping use’ is a specific case of ‘recent use’ polydrug consumption. The ‘recent use’ classification is also common in those studies focussing on particular pairings of licit and illicit drug use such as Falk et al. (2008) or Midanik et al. (2007). The definitions offered by Johnston have been developed into two more commonly used terms; simultaneous and concurrent polydrug use. The first of these is like the ‘overlapping use’. Simultaneous polydrug use is therefore defined as the combination of drugs on a single occasion. As illustrated above, Johnston (1975) described this as when effects overlap, however, some researchers have put time frames to illustrate close effects. For example, Boys, Lenton and Norcross (1997) suggested a four-hour time frame was appropriate. Other researchers were broader in their definition, stating that simultaneous use was the use of two or more drugs in combination at either the same time or in “close temporal proximity” (Martin, 2008; p.96). This type of polydrug combination is a special case of concurrent polydrug use which reflects Johnston’s ‘recent use’ pattern. Essentially, this is the combination of two or more drugs in a specified time period, commonly one year.

The final consideration in defining polydrug use often relates to the function of drug combinations. Merchant and Macdonald (1994) describe how those involved in the 1990’s rave scene had considerable knowledge about drugs used, and the product of their combinations. Friends and associates who used drugs were often able to elucidate pleasurable combinations with specific effects, for example complimenting, increasing or neutralising the effects of another drug. Primarily the mixing process is intentional on the part of the user (Schensul et al., 2005). However, Johnston (1975) and Martin (2008) caution that haphazard patterns are also plausible based on need and availability. Decisions are made relative to current or expected effects of consumed drugs, their predicted duration, choices of what could be taken next, resultant effects and potential for harm.

To summarise combinations of polydrug use tend to occur for the following reasons. First, combinations may intensify an existing effect. For example, the combination of amphetamines and ecstasy may be consumed to increase the stimulant high for a more intense experience. The second reason could be to suppress an effect, for example, alcohol and cocaine polydrug use to curb feelings associated with acute cocaine withdrawal. Third, drugs may be combined in a polydrug use pattern to counteract an effect (Parker & Williams, 2003). For example cannabis may be used when at home after a night out to counteract or neutralise the stimulant effects of ecstasy or amphetamines. Fourth, drugs could be combined to create a new psychoactive drug. Alcohol and cocaine use together create a metabolite cocaethylene (Jatlow et al., 1991) which can enhance and sustain the 'high' experience.

However, whilst the combination of drugs may be intentional, unpredictable and unpleasant effects can still occur (EMCDDA, 2001; Merchant & Macdonald, 1994). This may be partly explained by the impurity of drugs (Green, Mechan, Elliott, O'Shea and Colado, 2003). Levels of purity of ecstasy have decreased over time (Cole, Bailey, Sumnall, Wagstaff & King, 2002) and there is evidence to suggest that quality of other illicit drugs is also variable (Caulkins, 2007). Notably, the duration and severity of both the pleasant and unpleasant, expected and unexpected effects will be affected by the half life of the ingested drugs, synergistic compounds or psychoactive metabolites (Smit, Monshouwer & Verdurmen, 2002).

In linking these concepts together, it might be suggested that polydrug use should be defined from the following three components. The first is the widest range of different drugs. The second is a specific time frame (in this case 1 year) and the third is the intention (less relevant in concurrent polydrug use). Given the differences presented above 'polydrug' use is defined below in Table 8. This will enable clear definitions between terms within chapters, with easier comparisons to be made between frequencies.

Table 8: Operational definitions for polydrug use in this thesis

Term	Definition
Polydrug use	The concurrent use of two or more drugs (whether illicit or alcohol use) in the past year.
Illicit polydrug use	The concurrent use of two or more illicit drugs in the past year

1.6. Frequencies of polydrug use

The frequencies of polydrug use will now be discussed, firstly presenting lifetime, yearly and more frequent patterns of concurrent use. Following this, the frequencies of simultaneous polydrug use will be reported. A summary table of rates is provided in Table 9.

In a time space random sample of 400 Manhattan nightclub attendees, Kelly and Parsons (2008) found the mean number of illicit drugs used during the lifetime to be 3.57. A further random sample of 3274 male army conscripts from Piedmont, Italy measured a variant on the mean number of drugs used to estimate illicit polydrug use (Siliquini et al., 2001). With a focus on specific drugs, users of heroin were found to have the greatest mean substances used per drug, closely followed by LSD users. In contrast, cannabis users had the least number of mean substances used per drug (1.6). In total, 30% of those comprising this sample were polydrug users.

Opportunistic samples which have estimated lifetime illicit polydrug use rates include Webb, Ashton, Kelly and Kamali (1996). They surveyed 3,699 university undergraduates from a range of faculties and found 34% of their sample had used two or more illicit drugs, and 19% had used four or more illicit drugs (they did not provide the percentage for three or more illicit drugs). White et al. (2006) in a sample of 372 regular ecstasy users in Australia found a higher percentage of lifetime illicit polydrug use. The bivariate combination of ecstasy and amphetamines was found in 91% of their sample. The combination of ecstasy and cocaine was found in 55% of their sample. Wibberley and Price (2000) in a study of 71 opportunistically sampled lifetime illicit drug users found that of those who used amphetamines, cocaine, ecstasy or LSD six or more times in their lifetime, 100% had used alcohol and 67.6% had used cannabis. Topp, Hando, Dillon, Roche & Solowij, (1999) found in their sample of 329 ecstasy users in Australian cities that the mean number of drugs tried by the sample (including licit and illicit drugs) was 10. Adolescent studies such as Sutherland and Shepherd (2001) found considerably lower rates. Of their 9742 adolescents surveyed in Northern England, 12.8% used alcohol and tobacco, 3.7% used alcohol and illicit drugs, and 11.7% used all three. Lifetime rates of polydrug use were provided for specific polydrug combinations from 12th Graders from the West Coast of the US as part of the Rand Adolescent Panel study (Collins et al., 1998). The authors found 2.3% of the sample had used alcohol and sedatives, 6.7% had used alcohol and stimulants and 5.3% had used both cocaine and other drugs. Overall, they found a lifetime concurrent polydrug use rate of 36.9%, which included both alcohol and drugs. Smit et al. (2002) found slightly lower rates of polydrug use in their sample of adolescents. Including abstainers, 23.7% of this sample had used at least once in their lifetime, however, if abstainers were excluded this increased to 41.8%.

There were considerably more estimates of polydrug use at a yearly level. Falk et al. (2008) found a percentage polydrug rate of 5.6% for the US population (illicit drug use and alcohol consumption in the past year). This is like the percentage use found in Wadsworth, Moss, Simpson and Smith (2004). These authors found that 7.7% of the surveyed adults living in two Welsh communities used alcohol and illicit drugs. However, they did find differences when taking tobacco into account. For example, the most frequent illicit drug use pattern reflected use of tobacco, alcohol use within recommended weekly limits and any illicit drug use (3.5%). In contrast, they found their least prevalent group to be those not using alcohol or tobacco, but using illicit drugs (.4%). This demonstrates how common polydrug use is amongst illicit drug users. Midanik et al. (2007) further subdivided this into specific drug combinations. They found that alcohol and cannabis use were the most frequent yearly concurrent combination, used by 3.3% of the US population. This percentage was like the use of other drugs with alcohol in this sample (also 3.3%). They also note that 1.7% used painkillers with alcohol in the past year.

Hopper et al. (2006) found in a small sample of 22 ecstasy users, that all had used alcohol and cannabis. This was a sample opportunistically selected to include ecstasy users who had used at least once per month in the past year, so it may have limited applicability to general population estimates. High percentages were also found between other drugs suggesting further polydrug use involvement. Of these individuals, 81.8% had used cocaine, 72.7% had used hallucinogens and 54.5% of the sample had used other stimulants (than ecstasy). Other drugs were also used by the sample including sedatives and opiates, but these were used by comparatively less in the past year.

Ecstasy users, comprising 3% of Pedersen and Skrondal’s (1999) sample of 10,812 Norwegian adolescents also had a high proportion of polydrug use. Specifically, this was most likely to involve cannabis use (65.8%), amphetamine use (56.0%) or heroin use (31.5%). They also reported an overall sample percentage rate of amphetamine and ecstasy illicit polydrug use (1.6%) although concede that the majority of their polydrug users also used cannabis. A study by McCrystal, Percy, Higgins, and Thornton (2003) assessed specific combinations of substances in the past year of adolescent post-primary school children in Northern Ireland. During the past year alcohol and cannabis use was reported by 22% and alcohol and solvents were used by 16% of the sample. Current ecstasy use and the relationship with other drugs was the focus of a paper by Keyes, Martins and Hasin (2008). They concluded that this group were almost certainly using alcohol (98.4%) but had lower probabilities of polydrug use including cocaine (38.1%), opioids (33.8%), tranquillisers (34.2%) and sedatives (95.4%). They also assessed the polydrug use behaviours of other drug users. These individuals were also highly likely to use alcohol (90.3%) but had a lower probability of other drug use such as cocaine (29.1%), opioids (11.1%), tranquillisers (4.6%) and sedatives (5.2%). This suggests that ecstasy users are more likely to be polydrug users. A study by Topp, Barker and Degenhardt (2004) found opportunistically sampled regular ecstasy users were likely to have used alcohol (79%), cannabis (82%), amphetamines (85%) and to a lesser extent cocaine (44%). Only 4% of these users stated that they had used none of these drugs. The mean number of drugs used in the past year was 5.1 for this group. This was similar to the yearly mean number of drugs used found by Riley, James, Gregory, Dingle and Cadger (2001). In their sample of 122 Scottish ‘rave’ attendees, the average number of drugs used concurrently within a year was 4.16. They also reported that 92.6% of their sample had used more than one drug in the past year. Similarly, Scheier, Abdallah, Inciardi, Copeland and Cottler (2008) found 629 of their ecstasy users from had used 4.28 drugs in the past year (excluding ecstasy). This was predominantly comprised of non-club drugs, for which the mean number of drugs used in the past year were 3.93. Unusually, the mean number of club drugs used was .27 by this group. This would not appear to be supported by research reported above, as club drugs appear to be used together in a polydrug pattern.

Fewer studies reported rates of concurrent polydrug use in a shorter time frame than one year. Kelly and Parsons (2008) in their Manhattan night club sample found the mean drugs being used during the past four months were 2.07 (includes illicit drugs only). Sterk, Theall and Elifson (2007) reported polydrug estimates in the past 90 days, finding that 98.1% of current ecstasy users were polydrug users (including both illicit drugs and alcohol). Topp et al. (2004) used a wider time frame. They found the majority of their regular ecstasy users from the National Drug Strategy Household Survey had used alcohol (73%), cannabis (62%), amphetamines (52%) or cocaine (26%) in the past six months. Only 12% of this group used none of these. The mean number of drugs used within this time frame was 5.4. In contrast, recent ecstasy users (who used ecstasy but not monthly in the past six months) from the same study had somewhat lower percentages of other drug use. They also had a lower mean number of drugs used in the past six months (4.4). Earleywine and Newcomb (1997) also assessed polydrug use within the six month time frame. They concluded, in the past six months, alcohol and cannabis were used by 31%, alcohol and other drugs by 28% and cannabis and other drugs by 22% of the sample.

A recently published study in Ireland using a weighted, multi-stage random sample of the populations of Ireland and Northern Ireland found in the past month 1.93% of the population of Ireland and 2.11% of the population of Northern Ireland were likely to combine any illicit drug with alcohol and tobacco (NACD & DAIRU, 2007). Polydrug rates for the specific combination of tranquillisers, antidepressants or sedatives and alcohol were 1.37% for Ireland

and 2.90% for Northern Ireland. Additionally, of all past month cannabis users 90% and 92% also used alcohol in Ireland and Northern Ireland.

In summary, concurrent polydrug use varies widely in the time frames illustrated. Lifetime polydrug use rates are generally higher than those with a more recent time frame. Furthermore, differences in measurement are also apparent. Some estimates include alcohol use in their estimations, and some do not. In addition, some specify polydrug combinations, whilst others describe any illicit drug use. Percentages of polydrug use are most commonly reported, whether referring to any illicit drug use or specific combinations of use, although mean numbers of drugs used are also reported for some studies.

Simultaneous use frequencies also vary in measurement, however, are most commonly reported as use ‘before, during or after’ or on a ‘single occasion’. Fendrich, Wislar, Johnson & Hubbell (2003) in their random sample of young adults from Chicago, assessed polydrug use during the last use of a club drug. They found that just over one quarter used a club drug solely. However, 73% used at least one drug from alcohol, cannabis, cocaine, heroin, PCP, hallucinogens, stimulants, tranquillisers or sedatives. Degenhardt, Barker and Topp (2004) in a random sample of the Australian population assessed percentages of named drug combinations with a focus on ecstasy. Of those who had used ecstasy, alcohol was used by 26.8%, cannabis by 61.6%, amphetamines by 52.5% and cocaine by 18.7%. They defined the simultaneous occasion within the yearly time frame, assessing whether an individual had used at the same time at least once in the past year. Calafat et al. (1992) in a dance drug survey of young adults in Europe found the most common simultaneous polydrug use pattern to be alcohol and cannabis (50.6%). Of the more traditional club drugs, the most common patterns were alcohol and ecstasy (11.1%) and alcohol, cannabis and ecstasy (10.4%). This suggests a strong involvement of illicit substances with alcohol. Earleywine and Newcomb (1997) in their adolescent study found simultaneous polydrug use rates of 28% for alcohol and cannabis, 16% for alcohol and other drugs and 11% for cannabis and other drug use.

Respondents in the 2000 National Alcohol Survey (Midanik et al., 2007) reported simultaneous polydrug use rates which were exclusive of concurrent use. Occurrence of cannabis and alcohol use represented the most widespread simultaneous polydrug use combination (7.0%). Those using illicit drugs (but not cannabis) and alcohol were the next most common simultaneous polydrug use combination reported (1.7%).

Deehan and Saville (2003) in their survey of 760 nightclub attendees in South East England found that on a given night, 29% of their opportunity sample consumed alcohol with illicit drugs. This was notably lower than the occurrences reported by Riley et al. (2001). Their estimates of simultaneous polydrug use only included illicit drugs and found 66.3% mixed illicit drugs on a single occasion. Of this, 69.1% used two drugs, 24.7% used three drugs and 26.2% used four or more drugs. Of these, specific patterns were more common than others. Ecstasy and amphetamine polydrug use was most frequently reported at 63%. Other reported combinations were ecstasy, amphetamines and other (LSD, magic mushrooms or cocaine) at 27% and ecstasy and others (excluding amphetamines) at 8.6%.

Forsyth (1996) assessed simultaneous polydrug use in ‘before, during and after’ ecstasy use patterns. Of those using ecstasy on a given occasion, 3.3% consumed alcohol before ecstasy, 4.2% used during the use of ecstasy and 1.7% used alcohol after. This suggests a lower percentage rate than other studies. Cannabis use was the most commonly consumed drug after ecstasy use with 4.3%. Typically 2.7% used cannabis during the ecstasy consumption and .9% consumed before ecstasy use. However, the most common combinations with ecstasy ‘before’ were cocaine use (11.4%) and amphetamine use (19.6%). The most commonly reported ‘during’ were cocaine (11.4%), amphetamines (12.6%), LSD (16.2%) and amyl nitrate (37.5%). Amphetamine use ‘after’ ecstasy ingestion was the only drug with a higher occurrence than cannabis (6.3%). Topp et al. (1999) assessed ‘during’ and ‘after’ time frames. ‘During’ ecstasy use the most common combinations included cannabis (45%), amphetamines (43%) and alcohol (40%). However, ‘after’ ecstasy use cannabis (64%), alcohol (21%) and benzodiazepines (17%) were more commonly used. This shows some differences with Forsyth (1996) study.

Two studies took a slightly different approach. Verheyden, Henry and Curran (2003) in their sample of 466 regular ecstasy users in Manchester and London assessed the proportion of ecstasy users who always mixed their ecstasy with another drug (including alcohol). They found 59% of ecstasy users were always simultaneous polydrug users. Finally, Sterk et al. (2007) assessed simultaneous use on the first occasion ever. Of their sample, 47.9% had used ecstasy alone, 28.4% had used it with another illicit drug and 10.3% had mixed it with alcohol and other illicit drugs.

As illustrated in concurrent rates of polydrug use, there is some variability in measurement of simultaneous polydrug use. Whilst the time frame is less of a factor in this case than perhaps concurrent estimates, there is still ambiguity around definitions of a simultaneous occasion. In addition, the trend for some studies to report particular combinations and others to be broader, it is difficult for researchers to determine trends.

Table 9: Frequency of polydrug use summary table.

		Concurrent use			Simultaneous use		Drug*
Authors	Sample (Sampling strategy)	Lifetime	Yearly	Six months to more frequent	How measured?	Frequency	
Calafat et al.,1999	2,662 'dance drug individuals from European cities				Same occasion	Alcohol and cannabis 50.6% Alcohol and ecstasy 11.1% Alcohol, cannabis and ecstasy 10.4% Cannabis and ecstasy 8.4% Alcohol and cocaine 7.8% Alcohol, cannabis, ecstasy and cocaine 7.8% Alcohol, cannabis and cocaine. 2%	B
Deehan & Saville, 2003	760 night club attendees in South East England (Opportunistic)				On a night	29% consumed alcohol with illicit drugs 11% drank 10 units or more with illicit drugs	IA
Degenhardt et al., 2004	22,649 Australia National Drug Strategy Household Survey (Random)				Using at same time at least once in past year	Ecstasy and alcohol 26.8% Ecstasy and cannabis 61.6% Ecstasy and amphetamines 52.5% Ecstasy and cocaine 18.7%	I
Earleywine & Newcomb, 1997	1364 adolescents in 7th, 8th and 9th grade (School sample)			Past six months Alcohol and cannabis 31% Alcohol and other drugs 28% Cannabis and other drugs 22%	Single occasion	Alcohol and cannabis 28% Alcohol and other drugs 16% Cannabis and other drugs 11%	B

Falk et al., 2008	43,093 adults in US population NESARC (Random)		59.8% of alcohol users did not use with illicit drugs 5.6% of the population were illicit and alcohol polydrug users				B
Fendrich et al., 2003	627 young adults aged 18-40 from Chicago, (Random)				Last time used a club drug (ecstasy, ketamine, rohypnol, GHB, LSD, or speed)	27.2% used it alone 73% used at least one other drug from alcohol, cannabis, cocaine, heroin, PCP, hallucinogens, stimulants, tranquillisers or sedatives	B
Forsyth, 1996	135 Glasgow rave attendees (Opportunistic)				Before, during and after	Ecstasy and alcohol 3.3% before 4.2% during 1.7% after Ecstasy and cannabis .9% before 2.6% during 4.3% after Ecstasy and cocaine 11.4% before 11.4% during 2.2% after Ecstasy and amphetamines 19.6% before 12.5% during 6.3% after Ecstasy and LSD .9% before, 16.2% during, 0% after Ecstasy and magic mushrooms 2.0% before, 4.1% during, 1.0% after Ecstasy and amyl nitrate 1.0% before, 37.5% during, 1.9% after	B

Hopper et al., 2006	22 ecstasy users (at least once per month) (Opportunistic)		All used ecstasy, alcohol and cannabis. 81.8% cocaine 54.5% stimulants 72.7% hallucinogens 27.3% sedatives 36.3% opiates		B
Kelly & Parsons, 2008	400 night club attendees in Manhattan, (Time-space)	Mean number of drugs used in lifetime 3.57		During the past four months Mean number of drugs used were 2.07	I
Keyes et al., 2008	8,666 from NESARC former and current ecstasy users and users of other illicit drugs (selected sample from an original random sample)		Current ecstasy users and alcohol 98.4% cocaine 38.1% opioids 33.8% tranquillisers 34.2% sedatives 23.5% Former ecstasy users and alcohol 95.4% cocaine 10.1% opioids 21.9% tranquillisers 10.0% sedatives 16.0% Users of other illicit drugs alcohol 90.3% cocaine 29.1% opioids 11.1% tranquillisers 4.6% sedatives 5.2%		B

McCrystal et al., 2003	3844/4308 adolescent post-primary children in Northern Ireland (School Sample)		Alcohol and solvents 16% Alcohol and cannabis 22%				B
Midanik et al., 2007	7,612 National Alcohol Survey (2000) US (Random)		3.3% cannabis and alcohol use .8% cocaine/crack and alcohol .7% hallucinogens and alcohol .8% uppers and alcohol 1.7% pain killers and alcohol 3.3% other drugs (not cannabis) with alcohol		‘at the same time’ but exclusive of concurrent use	7% cannabis and alcohol use .9% cocaine and crack .5% hallucinogens and alcohol .5% uppers and alcohol .2% painkillers and alcohol 1.7% other drugs (not cannabis) with alcohol	B
NACD & DAIRU, 2007	4918 and 3516 adults from Ireland and Northern Ireland (Random)			Alcohol, tobacco and any illicit drug 1.93% Ireland; 2.11% Northern Ireland Alcohol, tranquillisers, antidepressants and sedatives 1.37% Ireland; 2.90% Northern Ireland			B
Pedersen & Skrondal, 1999	10,812 adolescents in Oslo, Norway (School sample)		Ecstasy users (3% of total sample) 65.8% cannabis use, 56% amphetamines 31.5%				I

Pedersen & Skrondal, 1999 cont.			heroin 1.6% using amphetamines and ecstasy				
Riley et al., 2001	122 Scottish rave attendees (Opportunistic)		92.6% used more than one drug in the past year. Mean number used 4.18 drugs		'mixed on occasion'	66.3% mixed on occasion 69.1% 2 drugs 24.7% 3 drugs 26.2% 4+ Specifically Ecstasy and amphetamines 63% Ecstasy, amphetamines and other of LSD/mushrooms/cocaine 27% Ecstasy and others excluding amphetamines 8.6%	I
Scheier et al.,2008	629 ecstasy users from Miami, St Louis and Sydney (Opportunistic)		Mean number of club drugs used .27 Mean number of other non club drugs used 3.93 Mean number of drugs used except ecstasy 4.28				I
Siliquini et al., 2001)	3274 male army conscripts from Piedmont, Italy (Random)	Mean number of drugs used per drug Heroin 4.2 LSD 4,0 Ecstasy 3.7 Cocaine 3.6 Inhalants 3.1 Cannabis 1.6 30% of the sample were polydrug users					I

Sterk et al., 2007	261 ecstasy users from Atlanta, Georgia (Opportunistic)			In the past 90 days, 98.1% of ecstasy users polydrug used.	Past occasion First ecstasy use ever	Median number of illicit drugs used was 3 Alone 47.89% With another illicit 28.35% Alcohol and other illicit drugs 10.34%	B
Sutherland & Shepherd, 2001	9742 adolescents in Northern England (Opportunistic)	12.8% alcohol and tobacco 3.7% alcohol and illicit drugs 11.7% alcohol, tobacco and illicit drugs					B
Topp et al., 2004	48 regular and 199 recent ecstasy users from the NDSHS (Selection from random sample) and 163 regular ecstasy users (Opportunistic)		Regular ecstasy users opportunistically sampled In the past year 79% used alcohol 82% used cannabis 85% used amphetamines 44% used cocaine 4% used none of these Mean number of drugs used in the past year 5.1	In past six months Regular ecstasy users NDSHS 73% used alcohol 62% used cannabis 52% used amphetamines 26% used cocaine 12% used none of these Mean number of drugs used in past year 5.4 Recent ecstasy users from NDSHS 56% used alcohol 34% used cannabis 42% used amphetamines 7% used cocaine 8% used none of these Mean number of drugs used in the past year 4.4			B

Topp, et al., 1999	329 ecstasy users in Sydney, Melbourne and Brisbane (Opportunistic)	Mean 10 drugs tried		During	Ecstasy and cannabis 45% Ecstasy and amphetamines (43%) Ecstasy and alcohol (40%) Ecstasy and LSD 13% Ecstasy and amyl nitrate 12%	B
				After	Ecstasy and cannabis 64% Ecstasy and amphetamines (7%) Ecstasy and alcohol (21%) Ecstasy and benzodiazepines 17%	
Verheyden, Henry, et al., 2003	466 regular ecstasy users in Manchester and London (Opportunistic)			'always mix'	59% of ecstasy users always mix their ecstasy use with another drug (including alcohol)	B
Wadsworth, Simpson et al., 2004	7979 adults living in Merthyr Tydfil or Cardiff (Random)		No drugs 16.8% No tobacco, alcohol above recommended limits (alcohol above), no illicit drugs (illicits) 16.4% Tobacco, alcohol within limits (alcohol normal), no illicits 6.6% Tobacco, alcohol above, no illicits 3.7% No tobacco, alcohol normal, no illicits 40.2% Tobacco, alcohol above, no illicits 3.5% Tobacco, alcohol			B

			normal, illicits 3.2% No tobacco, alcohol normal, illicit 2.5% Tobacco, alcohol normal, illicits 2.0% Tobacco, no alcohol, illicits .7% No tobacco, no alcohol illicits .4%		
Webb et al., 1996	3,699 Second year university students (Opportunistic)	34% two or more illegal drugs 19% four or more illegal drugs			I
White et al. (2006)	372 regular ecstasy users Australia (Opportunistic)	Ecstasy and amphetamines 91% Ecstasy and cocaine 55%		Past six months Ecstasy and amphetamines 74% Ecstasy and cocaine 20%	I
Wibberley & Price, 2000	71 drug users (Opportunistic)	Of those who used amphetamines , cocaine, ecstasy or LSD six or more times in lifetime 100% used alcohol 67.6% had used cannabis			B

*** I= Illicit drugs only B=Both illicit drugs and alcohol**

1.6.1. The example of ecstasy

"it is really difficult... to find people who had ever consumed, in their lifetime, only ecstasy" (p.90, Schifano, Di Furia, Forza, Minicuci & Bricolo 1998)

This section will examine selected studies addressing the effects of ecstasy use. It is intended to illustrate some of the difficulties the occurrence of polydrug use can present when assessing risk of harm to individuals using ecstasy. Cohen (1980) describes two cases of suicide that implicate ecstasy as the cause. In particular, the first of these two cases, states that no other drugs were implicated except alcohol and long-term cannabis use. Notably, the person had been using alprazolam, paroxetine, lithium, carbamazepine and lorazepam which are all psychoactive licit drugs (if taken upon a doctor's recommendation). In addition, by the time they had committed suicide the ecstasy use had ceased. However, despite the lack of isolation spanning not just psychoactive licit and illicit drugs but also psychoactive prescription drugs, ecstasy use was implicated as the cause. It is more likely that a complex aetiology was responsible, and notable that there was no record of whether the other drugs used, preceded or anteceded the condition.

Cohen (1995) in a later paper reports on the subjective reports of the effects of ecstasy by users noting "interestingly many users experienced depression both immediately following the termination of the drugs' effects and months and even years later" (p.1142). Again, the lack of isolation, and additional explanatory factors were neither presented in the article nor explored. The self-report which may be based on clinician advice or expectancy effects associated with education on the effects of the drug may well have contributed to the self-report given.

McGuire and Fahy (1991) again attributed the cause of paranoid psychosis to ecstasy. This was despite reported polydrug use. The ecstasy users were reported to have used occasional cocaine and amphetamines, and they stopped taking all drugs approximately six weeks before admission. There had also been a history of transient paranoid psychosis. Another of their reported cases had used cocaine, LSD and cannabis with nightly use of ecstasy. However, on admission to hospital, urine screens were negative for all drugs except for cannabis. Even though the authors state polydrug use was present; “both our patients developed chronic paranoid psychoses after prolonged misuse of ecstasy although they had also misused other drugs on occasion” (p.697), ecstasy is described as key to the aetiology. In these studies, whilst ecstasy could plausibly play a role, it could also have been a consequence of any of the other psychoactive drugs or combinations of drugs in either a concurrent or simultaneous way.

However, problems faced by researchers in accounting for polydrug use are not exclusively found in case studies. The need to find ways to describe heterogeneity forces arbitrary cut points. This affects two aspects of polydrug use, the plethora of patterns of use, and the different ways to measure drug use. For example, a recent study by Dafters, Hoshi and Talbot (2004) assessing the cognitive effects of ecstasy use comprised four groups for comparison, no (illicit) drug using controls, cannabis only, cannabis and ecstasy light use (<50 tablets in lifetime) and cannabis and ecstasy heavy users (50+ tablets lifetime). The groups have a number of mean differences between use levels of alcohol, amphetamine, cocaine, heroin and LSD, none of which are assessed as contributors to models for deficits. Thus, the lack of isolation of the drugs in these researcher chosen categories, make it difficult to draw conclusions about the groups. A number of studies examining elevated levels of depression in ecstasy users also fail to consider that the findings found could be equally plausibly related to some of the other drugs used in a polydrug way (Fox, Parrott & Turner, 2001; Gamma, Buck, Berthold & Vollenweider, 2001; Verkes et al., 2001). Fox et al. (2001) examined four groups of ecstasy users, non-use, low, medium and high users finding significant differences in relation to cognitive deficits. As an example, the percentage of use of amphetamines across all four groups was 55%, 93%, 100% and 100% respectively. Given that alcohol, nicotine, amphetamines and other drugs can have as dramatic an effect in ecstasy polydrug users as the ecstasy itself, it is difficult to attribute the effects to ecstasy (Parrott, 2006)

In a more recent study into ecstasy use and depression, Guillot and Greenway (2006) did not find a significant difference between their ecstasy naive controls and ecstasy users. Equally plausibly, the ecstasy naive controls could have been called “amphetamine, LSD, mushroom, ketamine, cocaine and opiate naive controls” versus the “users of a range of these drugs”. The issue of nomenclature is a fundamental problem in the field. Sumnall, Wagstaff and Cole (2004) suggest that studies should avoid placing individuals in artificial categories such as ‘an amphetamine user’ and let the data illustrate its own categories. Simon and Mattick (2003) support this stating that “researcher driven, unvalidated categories” will certainly provide variance in groupings not accounted for by the choice of group title. For example, calling a group amphetamine user, will semantically attribute any effects to amphetamines rather than other possible drugs used.

A similar study, Roiser, Cook, Cooper, Rubinsztein and Sahakian (2005) examined susceptibility to emotional and cognitive effects of ecstasy use. They concluded that heavy ecstasy use contributed to deficits. However, they concede that it is difficult to ascribe to ecstasy as the users used a range of other drugs. Considering that polydrug use is common, even in ‘novice’ ecstasy users (Schuster, Lieb, Lamertz & Wittchen, 1998), researchers have found difficulties in accounting for this important issue. The potential influence of other drugs is not limited to just illicit polydrug use. Curran and Travill (1997) found in a study of 12 ecstasy users versus 12 alcohol users a significant relationship with mood and cognitive tests in the ecstasy users. They concede that the amount of alcohol taken by some of the ecstasy users was small, but could not discount that it may have had some impact on the outcomes of the study.

However, other methods used to reduce the effect of confounds are not always appropriate for illicit polydrug research. As Dafters et al. (2004) state, for ethical reasons, double blind placebo controlled repeated dose clinical trials cannot be used in illicit drug research. Gouzoulis-Mayfrank and Daumann (2006b) call on the use of prospective designs following young children into adulthood, however, note that these often entail considerable cost and a difficulty in maintaining high response rates. Despite this, there have been some notable prospective studies in the area such as Dunedin Multidisciplinary Study (Silva, 1978) and Belfast Youth Development Study (Percy, McCrystal, Higgins & McSherry, 2002). The use of animal models to assess harm related to polydrug use can only allude to part of the picture. There is a lack of complexity in these studies to translate from laboratory into real life, controlling for dose, and importantly polydrug use (Green et al., 2003). There are also a number of additional problems, consumption quantities for illicit drugs are difficult to standardise as in the way of alcohol use and deciding on control groups with which to compare use to can be problematic. Control groups of polydrug users who do not use ecstasy may display a more moderated pattern of drug use than ecstasy polydrug users (Gouzoulis-Mayfrank & Daumann, 2006b).

Despite these methodological differences, ecstasy has been the second most frequently used drug for the majority of the 1990’s to the present day, with evidence to suggest it has been recently superseded by cocaine (EMCDDA, 2008). There is a need to research potential positive and negative effects of this and other drugs to try and minimise harm. It is usually difficult to find users of just one drug, in the night club literature cannabis, ecstasy, amphetamines, and amyl nitrate predominate. In Hammersley, Ditton, Smith and Short (1999), none of their ecstasy users had consumed it alone with a more recent study by Verheyden, Henry, et al. (2003) illustrating that 59% of ecstasy users in their sample always used this drug with other licit and illicit drugs.

In conclusion, the findings described as a result of ecstasy use when polydrug use is apparent, fail to account for what cannot just be described as a limitation of the research. Problems with lack of isolation, the wide range of patterns, drugs and ways to measure this concept make it difficult for research to move forward. Furthermore, it is evident that polydrug use is fundamental to both the description and conclusions drawn from the results.

1.7. Summary and aims of this thesis

This introduction has described the prevalence of alcohol and illicit drug use in general population samples. However, research into either illicit drug or alcohol use may not account for, or adequately describe the occurrence of polydrug use. Previous research has found it difficult to account for this polydrug use for a number of reasons. These include unclear definitions of polydrug use, the lack of isolation with other drugs, the large range of possible patterns, different drugs included in the analysis and different ways to account for polydrug use through measurement.

To address the issues arising from polydrug use, the following research questions will be addressed:

1. Can the variability in illicit and alcohol polydrug use patterns be accounted for?
2. Are these valid in relationships with demographic variables?
3. How does polydrug use relate to psychological status?

To answer (1), latent class analysis will be utilised which will account for the lack of isolation between drugs, the wide variety of patterns found in the data and include the largest number of drugs possible. Chapter three will assess the patterns of illicit polydrug use in the general population of Great Britain using the NPMS (Singleton et al., 2001a; 2001b). It will therefore create homogeneous typologies which account for a wide pattern of illicit drug behaviour. Chapter four is a validation chapter which will assess the validity of these classifications of illicit polydrug use through assessment of quantity of illicit drug use in the lifetime. Yearly use may reflect either extensive or occasional use and given the way in which drug use is measured it will be important to establish both patterns and extent of illicit polydrug use. Variations in patterns of alcohol use and related behaviours will be presented in chapter six. Given the strong relationship between illicit drugs and alcohol use, it is important to understand variations in alcohol use and related behaviours, first before assessing polydrug use. Finally, chapter seven aims to create a unified model of polydrug use, encompassing both alcohol and illicit drugs.

To address (2), patterns of polydrug use will be regressed on demographic criteria which have been shown to be associated with alcohol and illicit drug use. This will be included in analyses in chapters three, six and seven. Chapter three will validate the latent classes of illicit polydrug use, chapter six will validate the alcohol use typologies and chapter seven will validate the integrated polydrug use typologies.

The relationship between polydrug use and psychological status will be assessed in chapters five, six and seven to achieve aim (3). Chapter three will assess the relationship between illicit polydrug use profiles and key, common neurotic disorders including generalised anxiety disorder, depressive episode and suicidality. Chapter six will assess the relationship of these disorders with the alcohol use typologies. The relationship between psychological health and polydrug use will compare the relationships found when these drugs are separated, and when they are combined. Note that the estimates of relationships with mental health conditions will control for the same demographic criteria. This will assess to what extent measuring relationships with alcohol or drug use separately differs to measuring within a polydrug use model. Given the prominence of the latent class method throughout this thesis, the next chapter will consider the shared methodologies used.

2. Methodology

2.1. Introduction

This chapter describes the shared methodologies used throughout the thesis. Firstly, the NPMS data will be described including detail on sampling procedures. Following this, details of the specific variables used in this thesis will be presented. Methods to describe polydrug use will be illustrated, with the prevailing statistical methodology, latent class analysis, described in detail. Particular attention will be paid to the assumptions, model fit considerations and software. Finally, multinomial logistic regression will be described; a technique which can both validate and describe latent classes. Note that chapters which have alternative statistical methodologies have these outlined in the relevant chapter's methodology section.

2.2. Data

All of the analyses conducted in this thesis were performed on data from the NPMS or "Psychiatric Morbidity among Adults living in Private Households, 2000" survey (Singleton et al., 2001a; 2001b). This was part of a series of Office of National Statistics (ONS) psychiatric morbidity surveys which also covered homeless adults, residents of institutions catering for those with mental health problems, adults with psychosis, prisoners and adolescents. A similar methodology was used across each of these surveys. The household survey used is the second wave following trends in psychiatric health of the population of Great Britain. The first wave was conducted in 1993 (Meltzer, Gill, Petticrew & Hinds, 1995). The dataset and associated documents were downloaded from the UK Economic and Social Research Council Data Archive on the 20th October 2004 at the following web address http://tinyurl.com/624ban.

The aim of this survey (and others in the series) was to collect information on the occurrence of mental health problems. It also contained questions on additional related areas including service use, intellectual functioning, stressful life events, social support, daily living and care needs, socio-demographic variables and drug and alcohol use. The data was collected by ONS interviewers between March and September 2000. Interviews were conducted using Computer Assisted Personal Interviewing (CAPI) and Blaise programming technology. Alcohol and drug use were predominantly self-completed by the respondent. However, a very small proportion had assistance with the interviewer either reading the questions with the interviewee making their choice, or the interviewer reading and responding to the question as per the interviewee's answers. Each interview lasted on average 90 minutes. All interviewers were trained in both the use of the instrument and adverse situations as might be expected by a study of this size, breadth and content.

2.3. Sampling

The sampling strategy reflects a stratified two stage probability sample. Firstly, the small user postcode address file (PAF) was obtained from Royal Mail. This is a list of all delivery points (or addresses) which receive less than 50 items per day, organised into postcode sectors containing on average 2500 households. Postcode sectors from the PAF were stratified based on socio-economic status in a region. Note that a region was defined as a function of the current NHS Regional Office area, and the previous Regional Health Authorities upon which the 1993 survey was based. This facilitates comparability between waves of data collection. The second stage involved further stratification, based on head of household socio-economic status and proportion of households without a car as indicated from the 1991 Census data.

From the full set of stratified postcode sectors 438 were selected with a probability proportional to the number of delivery points contained in it as an indicator of size. The majority of these were from England (n=370) with 46 from Scotland and 22 from Wales. Each sector had 36 delivery points (addresses) selected for approach. Note that an embargo had been placed on all addresses which have been sampled randomly in the past three years to reduce the burden on the public and to encourage participation in both the NPMS, and further studies. Interviewers then approached 15,768 addresses. A number of these houses were deleted from the list of potential addresses according to the inclusion criteria for the study. These included vacant or demolished properties, residences with no-one aged between 16-74 years old in the household, secondary or holiday homes or small businesses. Consequently, a total of 12,792 addresses were eligible for inclusion. When the ONS interviewers approached the houses to conduct the survey, they would select a person at random living in the household who were aged 16-74 using the Kish selection method (Kish, 1965). The survey had an overall 69.5% response rate and a total of 8580 respondents (Singleton, Lee & Meltzer, 2002).

2.4. Variables used

2.4.1. Illicit drug use variables

Questions were asked about 14 illicit drugs used in the past year, split over the two questions presented in Figure 2. The respondents were first asked about their use of cannabis, amphetamines, cocaine, crack, ecstasy, heroin or LSD, with the opportunity to enter in any of the numbers corresponding to these drugs as their response. A respondent was also able to enter in multiple numbers corresponding to the full range of drugs they have consumed from the subset presented. They were then asked about their yearly use of a further seven drugs, magic mushrooms, methadone, semeron (a fictional drug), tranquillisers, amyl nitrate, anabolic steroids, and glue, and again have the opportunity of selection of the full range of drugs used. These were recoded into 14 variables reflecting use in the last year. All were binary variables with ‘0’ indicating no use and ‘1’ indicating use in the past year.

YDrug
In the LAST 12 MONTHS have you taken any of these drugs?
Please type the numbers of ALL those drugs you have used in the LAST 12 MONTHS
If you have used NONE of them, type ‘8’
SET [8] OF
(1) Cannabis (marijuana, grass, hash, ganja, blow, draw, skunk, weed, spliff)
(2) Amphetamines (speed, whizz, uppers, billy)
(3) Cocaine or coke
(4) Crack (rock, stones)
(5) Ecstasy (E)
(6) Heroin (smack, skag, H, brown)
(7) Acid or LSD
(8) None of these

YDrug2
And, in the LAST 12 MONTHS have you taken any of these drugs?
Please type the numbers of ALL those drugs you have used in the LAST 12 MONTHS
If you have used NONE of them, type ‘8’
SET [8] OF
(1) Magic mushrooms
(2) Methadone or physeptone
(3) Semeron
(4) Tranquilisers (temazepam, valium)
(5) Amyl nitrate (poppers)
(6) Anabolic steroids (steroids)
(7) Glues, solvents, gas or aerosols (to sniff)
(8) None of these

Figure 2: Excerpt from the NPMS Questionnaire (p.73; Singleton et al., 2002)

Methadone, volatile drugs (glue) and anabolic steroids were excluded from the analysis as they had an extremely low frequency of use in the sample (.07%, .08% and .06% respectively). The deletion of these drug use variables with low probabilities reflect drugs which had effectively been used by less than seven individuals in the past year. The decision was taken to delete these as without their removal there may have been a substantial impact on model identification in the subsequent latent class analysis. Conversely, the inclusion of these variables into an analysis of a dataset with 8580 individuals would be to the detriment of the latent variable estimation without any relative theoretical gain from their inclusion. This follows similar methodologies to other purposively or randomly sampled surveys into drug use (e.g. Topp et al., 2004).

Two other variables used by very small numbers of respondents were heroin and crack. Their percentage of use was 0.16% and 0.14% respectively; however, in order to retain these drugs, a composite variable was created collapsing the use of either heroin or crack into one category. A different rationale was employed in the decision to keep these drugs. Both of these are key in terms of health outcomes. In addition, they are associated due to behavioural similarities among users of these drugs, in particular, the traditional association with abuse and dependence. Thus, there were nine illicit drugs used in these analyses, cannabis, amphetamines, cocaine, ecstasy, LSD, magic mushrooms, tranquillisers, amyl nitrate and the composite heroin/crack variable.

‘Semeron’ is a fictional drug and has been placed in this questionnaire to highlight a false self-report. It was originally included in the British Crime Survey in 1994 (Ramsey & Percy, 1996) and in the National Drug Campaign Survey in 1995 (McNeill, Raw & Heuston, 1996), and has been one of the most frequently used since then (Ramsey & Percy, 1997). It has been endorsed by one person in the yearly time frame and three in lifetime. This may indicate a false self-report. Following the methodology of these and other previous studies using this method, e.g. (Riley et al., 2001) who used the variant ‘simeron’, these individuals have been removed from the dataset.

2.4.2. Alcohol use variables

The alcohol use section commences with two qualifying questions asking the respondent whether they were current drinkers. These are presented below in Figure 3. Those who answer no to “drink now” were asked to clarify this answer, checking that those who drink even very occasionally were included into the analysis. Note that this serves two purposes. First to shorten the overall time burden if an individual has not consumed alcohol in the past year. Those who were identified as never drinking alcohol were screened out of the section. Secondly, those who perhaps have a small number of drinking occasions, and may refer to themselves as non-drinkers, as their most common pattern of use, were screened into the alcohol use section. Those who do not drink currently or have not consumed alcohol in the past year score zero on the total questionnaire. For the purposes of these analyses, any of the respondents who did not proceed to complete the AUDIT questionnaire were excluded from the analysis. This is consistent with other research such as population surveys in Ontario, Canada who excluded an older (than 64 years old) cohort who had missing items across the alcohol questions of interest (Ogbourne & DeWit, 2001) or a similar study in South East England (Cryer et al., 1999).

DrinkNow I'm now going to ask you a few questions about what you drink - that is if you do drink. Do you ever drink alcohol nowadays, including drinks you brew or make at home? (1) Yes (2) No	***ASK IF: DRINKNOW = NO*** **DrinkAny** Could I just check, does that mean you never have an alcoholic drink nowadays, or do you have an alcoholic drink very occasionally, perhaps for medicinal purposes or on special occasions like Christmas or New Year? (1) Very occasionally (2) Never

Figure 3: Introductory variables to the alcohol section of the questionnaire: distinguishing non-use from very occasional use (p.69; Singleton et al., 2002).

After these introductory questions, the alcohol section comprised of two main established questionnaires, both which were self-administered by the respondent. These were the AUDIT (Alcohol Use Disorder Identification Test: Saunders and Aasland, 1987; Babor, de la Fuente, Saunders & Grant, 1992b) and the Severity of Dependence Questionnaire (SADQ: Stockwell, Murphy & Hodgson, 1983). The SAD-Q is a lay administered measure of alcohol dependence. Individuals scoring eight or more on the AUDIT proceeded to answer the questions in the SAD-Q. This thesis will only assess patterns of ‘use’ in the population rather than alcohol dependence in the past year, and thus considers only the AUDIT.

The AUDIT questionnaire was originally designed by the WHO to screen for hazardous drinking in primary care. It is a ten-item questionnaire relating to alcohol use in the past year, and was originally designed to screen for excessive drinking and to assist the process of brief assessment of drinking behaviours. It was primarily designed for health care professionals to highlight individuals who might benefit from reducing or ceasing alcohol use. However, the questionnaire is simple and easy to use for lay persons to either deliver or self-administer. One of the advantages to the AUDIT is that it highlights individuals at risk of harm from their alcohol use behaviour rather than applying a diagnosis of either abuse or dependence. Consequently, the scale does have two main of cut points representing hazardous or risky drinking (eight or more) and harmful drinking (20 or more), the latter being more likely to suggest a possible alcohol abuse/dependence. This is an advantageous approach when examining behaviours in the general population.

Hazardous drinking increases the risk of medical consequences such as mental health problems or social problems. This pattern is more prevalent in the general population than those diagnosed with alcohol abuse and dependence. As a result, the bulk of alcohol related problems in a given general population may be attributed to hazardous drinking (Babor, Higgins-Biddle, Saunders & Monteiro, 2001). Therefore, the AUDIT questionnaire is an excellent means by which to determine a population estimation of harm caused by alcohol and is a more informative estimation of wider public health implications. In addition, when the focus is more on the diagnosed alcohol abuse and dependence, the instrument has been considered to have good sensitivity and specificity in the prediction of alcohol abuse and dependence (Bohn, Babor & Kranzler, 1995; Conigrave, Hall & Saunders, 1995). Therefore, it appears to be suitable for general populations where some abuse and dependence may be found.

For those who have used alcohol and thus proceed to complete the AUDIT questionnaire, there were ten items referring to alcohol consumption and related problems in the past 12 months. For the chapters in this thesis wishing to assess the presence or absence of hazardous drinking, the ten items of the questionnaire were summed to give a scale total. Scores of eight or more were deemed to represent this threshold of hazardous alcohol use behaviour (Saunders & Aasland, 1987). The original AUDIT items were measured on an ordered categorical scale from zero to four. Consequently, it was considered that it might be useful to treat the indicators as continuous then use latent profile analysis, which is a continuous analogue to LCA. However, upon inspection of the data, the ordered categorical approach was not a close enough approximation to continuous level data. In other words, the data was heavily skewed representing extreme levels of endorsement, illustrating an essentially binary pattern of response for most items. As the original scale was in the range of zero to four for all questions except question nine and ten which had the possible options ‘0’, ‘2’ and ‘4’, there would have been numerous empty cells in the cross classification tables which would have created model identification issues. In order to balance this problem, the variables were collapsed into an appropriate binary format for the purposes of latent class analysis.

Chapters six and seven examine patterns of alcohol use behaviour on all the ten indicators recoded from the original items. Note the questionnaire and original response categories are presented in Appendix 1. For the purposes of these analyses, these were collapsed into two categories, with ‘0’ referring to the option ‘never’ for questions one and three to eight, the option ‘1 or 2’ for question two and the option ‘no’ for questions nine and ten with ‘1’ representing all other responses for each question.

2.4.3. Demographic variables

Demographic variables which have been included in the analyses include gender (‘0’=female and ‘1’=male). Respondent age in years was measured as a continuous variable, in the range of 16-74 years old in accordance with the inclusion criteria of the study. Educational attainment was operationalised as a binary variable where ‘0’ indicated education beyond GCSE level and ‘1’, education to GCSE or below. In Great Britain, the first age at which adolescents are legally allowed to leave full time education is 16 years of age, primarily equating to GCSE level qualifications (although it must be noted that this does not mean that GCSE qualifications have been obtained). There is no legal obligation to remain in school or education past that age. The information used to define this variable is derived from the question “How old were you when you finished your continuous fulltime education at school or college?” (p. 98; Singleton et al., 2002). If a respondent in the study was deemed to have been educated to GCSE level or below, this represents those who were continuously educated to age 16, regardless of their GCSE performance. If they were aged 16 at the time of interview, they were deemed not to have passed the threshold into further education and were coded as being GCSE level or below. Conversely, education beyond GCSE level can include A levels/GCE, university, or vocational qualifications e.g. GNVQ or HND. This suggests an engagement with educational pursuits over and above the statutory requirements.

Economic activity was measured as economically active, i.e. being currently employed scoring ‘0’ and economically inactive as ‘1’. This was recoded from a three-group variable representing employed individuals, unemployed and economically inactive. The latter two of these were combined into one economically inactive group, representing those who do not earn a taxable income at present. Examples of individuals who may be in the economically inactive group would be homemakers, unemployed individuals or full-time students.

Other variables included were area type in which the respondent lived (0=rural/semi-rural; 1=urban). This was a variable which was not asked of the respondents. Instead this was coded by the interviewer at the beginning of the interview based on their observations of the area in which the respondent lived. This was another three-group variable, which was recoded to represent rural and semi-rural as one category distinct from that of the urban group.

The predictor ‘current smoker’ was generated through the questions “Have you ever smoked” and “Do you smoke now” from the original questionnaire. If the respondent never smoked or had smoked but did not at the time of the interview, then the participant was given a score of zero. Those who had a previous smoking history, but currently did not smoke were also coded zero. If they answered ‘yes’ to the question “Do you smoke now” they were coded as being a current smoker and scored one. It was not possible to create a variable which represented smoking behaviour in the past year, as was possible for illicit drugs and alcohol use behaviours; the questions being asked were less defined by time ranges; however, this is a typical way to assess smoking use behaviour (Wadsworth, Moss, Simpson & Smith, 2004).

2.4.4. Psychological variables.

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). This is a standardised interview used to assess common psychological conditions designed to be used by lay persons. It has 14 sections covering the neurotic symptoms of worry about physical health, depression, anxiety, depressive ideas, worry, irritability, concentration and forgetfulness, sleep problems, panic, phobias, compulsions, obsessions, fatigue and somatic symptoms. Each section is preceded by an opening question to assess whether the symptom has been experienced. If yes, they will be asked a further four questions primarily relating to the frequency, duration, and severity of that symptom over the past seven days. The only exception to this is the symptom of depressive ideas which has five items. Scores for each question within a section range from zero to four (or zero to five for depressive ideas). This can be totalled to give a score in the range of 0-57. Scoring 12 or above is indicative of symptomatology of clinical relevance, the range of 6-11 indicates some symptomatology and five or below illustrates a lack of evidence of psychological problems (Singleton & Lewis, 2003).

However, in chapters five, six, and seven, psychological status will be indicated by the presence or absence of a probable clinical diagnosis. Diagnoses of disorders were obtained through the application of algorithms to the 14 neurotic symptoms reflecting the ICD-10 diagnostic criteria for research. These create variables which express the absence (0) or presence (1) of depressive episode, Generalised Anxiety Disorder (GAD) and Mixed Anxiety and Depressive Disorder (MAD) amongst other diagnoses (Lewis, Pelosi, Araya & Dunn, 1992). It has been considered as a reliable scale in which to measure common mental disorders such as depressive episode, GAD and MAD across a severity continuum (Jenkins et al., 1997).

To assess suicidal behaviour in this sample, participants were asked directly about their involvement in such activities. The predictor used in the following chapters relates to attempting suicide at least once in an individuals' lifetime. These were coded as '0'= no attempts; '1'= one or more attempts in lifetime.

If an increased risk of poorer psychological health is found amongst polydrug users, it will be interesting to note their help seeking behaviours in response to these. This will be measured as visits to a General Practitioner (GP) in the past year for a psychological or physical complaint. These were coded '1' if an individual had visited their GP for an unspecified physical or psychological complaint in the past year and '0' if they had not. As the GP is the source to which all non-emergency referrals are made, and the gateway to further treatment, if there is an elevated risk of psychological or physical harm, it will be important to assess whether they were similarly likely to seek medical attention. This will provide valuable information to policy makers relating to unmet treatment needs, which is in turn a valuable indicator of health of the nation (Demyttenaere et al., 2004).

2.5. Analyses

This section will commence with an exploration of other methods to attempt to describe polydrug use and highlight the extent to which these may not be able to fully exploit the different patterns. This will be followed by a description and worked example of latent class analysis; the primary methodology used throughout this thesis. Patterns of polydrug use will be subsequently explored using multinomial logistic regression, and an exploration of this technique will conclude this section

2.5.1. Frequencies, correlations and cluster analysis

One of the primary methodologies used in the literature to explain drug or alcohol use is frequencies. Whilst this has utility in clearly illustrating the levels of usage of drug use in a particular sample, it is too simplistic to draw conclusions about polydrug use. This could be presented as 90% of the sample were using alcohol, 20% were using cannabis, 10% ecstasy, and 10% cocaine. This is good for summarising information but offers little detail on polydrug consumption. However, this method could be extended to cover patterns of polydrug use. For example, the frequency of ‘alcohol and cannabis’ use, ‘alcohol, cannabis and ecstasy’ or ‘alcohol and ecstasy’ could be estimated. In practice, to represent all patterns of polydrug use in a dataset, dependent on the number of variables measuring drug use, the possible combinations could be extremely large. Thus, the ability to draw detailed conclusions is difficult. Correlations offer a bivariate model to assess polydrug use patterns. This can illustrate the level to which one variable relates to another variable. However, this is unable to illustrate relationships beyond a pair of drugs used in a polydrug pattern. In addition, this is a variable centred approach, which has less utility in illuminating the relationship between individuals (DiStefano & Kamphaus, 2006).

However, there are ‘person centred’ analytical approaches available such as latent class analysis and cluster analysis. Cluster analysis assesses the similarity and differences in both the magnitude and pattern of data. However, the researcher makes considerably more decisions about the method during the analysis which can bias the solution (Aldenderfer & Blashfield, 1984). Vermunt and Magidson (2002) state that the main advantage latent class analysis has over cluster analysis as the structure is iteratively derived through maximising the loglikelihood function. This is through the utilisation of the expectation maximisation algorithm, which is described below.

2.5.2. Latent class analysis

The discipline of social science relies on the conceptualisations of traits which cannot be directly observed. For example, theoretical constructs such as intelligence, motivation, depression, anxiety or sporting ability are used to describe differences between individuals but there is no gold standard of measurement. Instead, we measure convenient representations of these concepts, which allude to these 'latent' or unobservable constructs and attempt an approximation of measurement. When these directly observable variables approximating to the latent constructs are categorical, latent class analysis can provide a mathematical model to represent the potentially underlying concept. This technique has been applied in many research areas including subtypes of depression (e.g. Eaton, McCutcheon, Dryman & Sorensom, 1989), alcohol dependence (e.g. Bucholz *et al.*, 1996) or drug abuse or dependence (e.g. Agrawal, Lynskey, Madden, Bucholz & Heath, 2007), and a worked example of this technique will follow.

Latent class analysis (LCA) can be used to identify subgroups or classes of cases similar to each other on a set of discrete observed variables. This modelling strategy estimates the number of classes of an underlying latent variable that can explain the covariation amongst observed categorical variables (Haagenars & McCutcheon, 2002). In this way, a latent variable be measured, and be expressed in a way that captures the heterogeneity, or range of different response patterns of endorsement of the observed variables. The model parameters include class membership probabilities per person (or class percentage estimates) and class-specific observed variable endorsement probabilities (or the probability of a class endorsing a particular drug such as cannabis).

The model to be tested in this hypothetical example is given in Figure 4. Conceptual model diagrams like these will be provided for each of the empirically based chapters in this thesis using latent class analysis. Circles in a model diagram represent latent variables. In this case the latent variable represents the concept of yearly drug use, of which there are a given k number of classes. The latent variable will be estimated from the observed variables which relate to it. Observed, (variables that can be measured) are illustrated by boxes. In this case the variables from which the latent variable is estimated are yearly use of cannabis, LSD, ecstasy and cocaine. Note the components are divided into parts relating to latent and observed variables.

A table of hypothetical data and relevant results are presented in Table 10 below. Consider that these four respondents come from a larger representative sample from the general population of Great Britain who have used any (or none) of four observed drugs in the past year (n=1,000). As indicated in the annotation to the table, the grey shaded area corresponds to the raw data entered into the analysis, and relates to the observed variables or boxes presented in Figure 4, where ‘0’ indicates no use in the past year and ‘1’ indicates use in the past year. The information in the table which is both bold and italicised represents information generated from a latent class analysis, i.e. relating to the circle in Figure 4.

Consider the observed component which reflects the shaded area in Table 10. This is the observed use of a named drug in the past year. A row represents a single participants' observed pattern of yearly drug use. Participant one has used all four drugs in the past year. Participant four has used cannabis only. Participant two has used all drugs except LSD and participant three has used cannabis and ecstasy. These form a selected proportion of respondents in a hypothetical study aiming to create a latent variable of polydrug use based on the four observed categorical indicators of drug use. This is the information that we are interested in modelling in the latent class analysis. A latent variable was considered to be able to explain the variability in response patterns to create classes or typologies. From the four indicators, there are 16 potential patterns of response in the dataset, from which we wish to create as few homogenous groups that represent the variability as possible.

Given that there are fewer classes than observed patterns, a conditional probability of membership of a certain class is provided by the procedure. This allows assessment of how well (or poorly) the classes represent patterns in the dataset. Examining first participant one, they have a .9 conditional probability of being in class 1. They express a pattern of response which is representative of others in that class, and their pattern of response is associated with membership of class two to a low level (.1). Contrasting with participant four, who has less representative membership of class 4 (their most likely class), with an endorsement probability of (.6). Note that the proportions of membership all sum to one as every individual is included in the classes, and that the individuals shown are only illustrative of four members of a larger subset of respondents.

The bottom row of Table 10 represents the size of each of the classes. This is a sum of each of the conditional probabilities (i.e. a column) for each class, and output to this effect can be provided by latent class software. Another parameter generated by the model is the number of people in each class based on their most likely latent class membership. In this example, there is one person in each class represented in the table. Comparing the conditional probabilities to the most likely latent class membership, it can be seen that these two methodologies represent largely similar results, however, there are slightly more members of class 1 and 3 when examining at the totals based on conditional probabilities.

Latent class analysis software can create an output file containing both the original data (the grey area of the table), the probability of each individual belonging to class 1, 2, 3 or 4 and their most likely class. The latter two, as outcomes from the latent class analysis are represented in bold in Table 10. When the best fitting model has been identified (see the fit criteria section 2.5.2.3), either the conditional probabilities of membership or most likely latent class can be used for multinomial logistic regression purposes, detailed later in this chapter, section 0. For the purposes of all analyses in this thesis, the conditional probabilities have been fixed and regressed on demographic or mental health variables. In this way, the assignment of individuals to classes is based on a probabilistic method not the most likely latent class (Clogg, 1995).

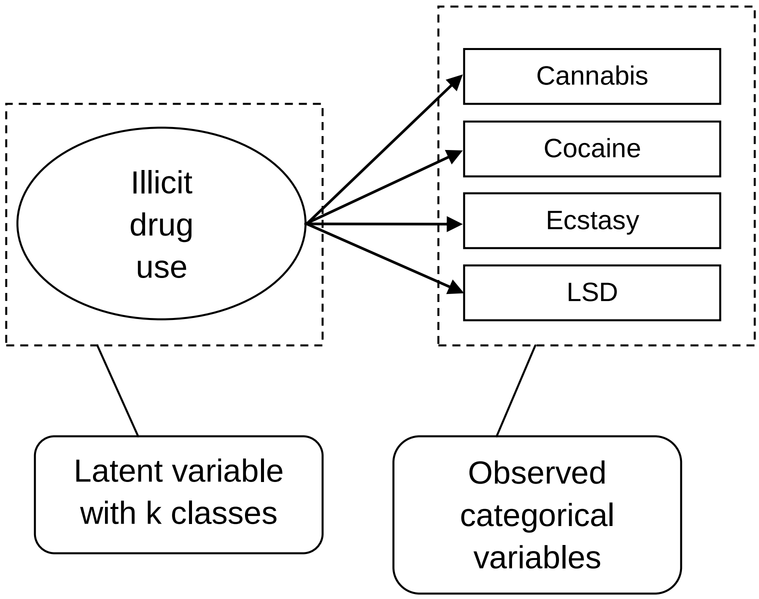

Figure 4: Conceptual model of four observed indicators of yearly drug use.

(Note: Highlighted components illustrate a component of the model, whether latent or observed.)

Table 10: Hypothetical data to illustrate patterns of response and outcomes of latent class analysis

Case	OBSERVED VARIABLES (BOXES)				**LATENT VARIABLES (CIRCLES)**				
	Drug used in the past year (1= yes; 0=no)				**Probability of being in each class**				**Most likely class**
	Cannabis	LSD	Ecstasy	Cocaine	**1**	**2**	**3**	**4**	
1	1	1	1	1	**.9**	**.1**	**0**	**0**	**1**
2	1	0	1	1	**.2**	**.7**	**.1**	**0**	**2**
3	1	0	1	0	**0**	**.1**	**.8**	**.1**	**3**
4	1	0	0	0	**0**	**.1**	**.3**	**.6**	**4**
Total conditional probability of being in each class, i.e. column totals represent the proportion of people in that category					**1.1**	**1.0**	**1.2**	**.7**	

(Note: that this represents only four respondents in a larger sample of the population of Great Britain).

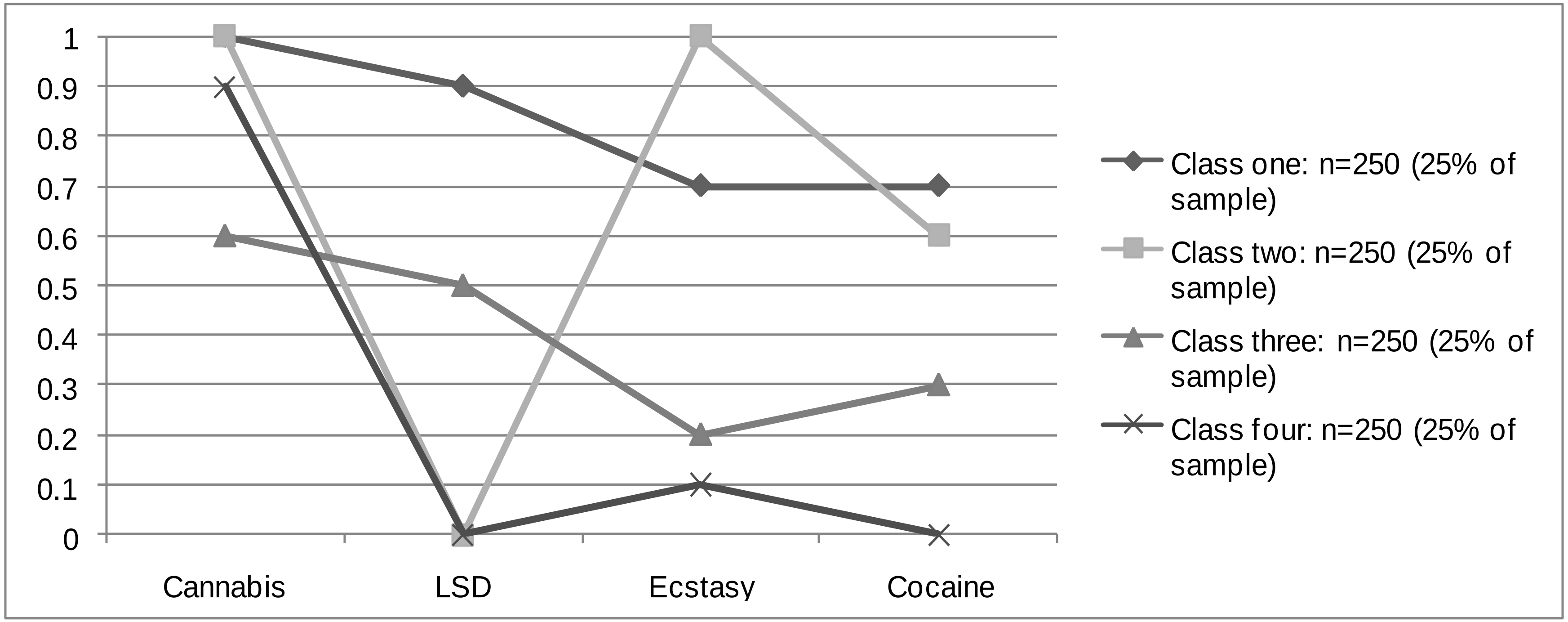

Figure 5: Profile plot of the four latent classes illustrating the probability of endorsement of each observed item in each latent class.

The other parameters generated by the model are that of the probabilities of endorsement of each of the observed items (i.e. cannabis, LSD, amphetamines, or ecstasy) for each of the four classes. Figure 5 is an illustration of how this can be expressed in practice. The X axis has the observed indicators along its axis. The Y axis represents the probability of members of each class saying yes to the given observed item. Each class is expressed as a separate line on the graph.

Patterns illustrated on the graph are useful to help name classes appropriate to the typical patterns expressed. For example, class 4 have a .9 (or 90%) chance of using cannabis in the past year and a very low probability of using LSD (0.0), ecstasy (.1) and cocaine (0.0). This would indicate most class members are cannabis only users, and thus a researcher might wish to name the class 'cannabis only'. Class 2 in contrast have 100% of their members using both cannabis and ecstasy. Around .6 proportionally are also using cocaine, however, there is no use of LSD in this class. Theoretically, this could be representative of a "cannabis, ecstasy and cocaine" class. Classes 1 and 3 are relatively similar to one another, however, class 1 have a higher probability of endorsing all of the observed yearly drug use variables. These could be potentially part of a continuum where class 1 has a heavier involvement in drug use pattern than class 3. In Figure 5 the continuum is illustrated by almost parallel lines in this graph. This raises additional questions. Firstly, it must be considered whether two classes add any additional information, or whether the model would be more appropriately expressed in a more parsimonious way, with classes 1 and 3 merged. Another way to demonstrate the utility of this pattern of use is by examining at whether the classes are different on extraneous variables, such as demographic information, to illustrate whether they are characteristically the same group. Finally, the probabilities of endorsement of each of the items should be inspected. Whilst over half of both groups are using both cannabis and LSD, class 3 has less than .3 of endorsing either cocaine or ecstasy. The members of class 1 have a 70% chance of being either an ecstasy or cocaine user. It might be considered to name class 1 appropriate to use of all the drugs, whilst class 3 might be considered appropriately named as “cannabis and LSD users” only.

2.5.2.1. Assumptions of conditional independence

The latent class analysis modelling technique assumes that the observed categorical variables are locally independent; the response to one observed indicator tells nothing about the response to another once the latent variable has been controlled for. This is similar to factor analysis in that the observed manifest variables are assumed to be independent of each other once loaded to the underlying factors. If a dataset fails to uphold this assumption, there are problems with model identification and theoretically irrelevant, meaningless latent classes may be generated (Vermunt & Magidson, 2002).

In practice, this means if an individual uses amphetamines, they are likely to use other drugs such as cannabis or ecstasy. However, they are not guaranteed to be using these other drugs, and thus the assumption holds. Equivalently, if an individual answers never (coded ‘0’) to the initial question of the AUDIT, they will all score ‘0’ on the remaining questions. However, if an individual answers ‘1’ to this question, they could answer ‘1’ or ‘0’ to any of the remaining nine questions and thus the assumption holds.

2.5.2.2. Determining number of latent classes of the latent variable

In order to perform a latent class analysis, and determine the optimal number of classes, a specific number of latent classes are enforced on the data.

In this thesis, estimations of two through nine latent class solutions were estimated. These models use a maximum-likelihood estimation approach determining the parameters of the model with the Expectation Maximisation (EM) algorithm. This is the default algorithm in Mplus for latent variable mixture modelling (of which latent class analysis is a specific type), and the process takes place in two steps. The first step involves calculation of the expected value of log likelihood function for a given number of classes. Therefore, Mplus estimates the conditional response probabilities and the endorsement probabilities for the given number of latent classes, calculating how well these estimates fit the data. A larger loglikelihood value represents a better fit. Step two involves increasing the accuracy of the function by adjusting the parameter estimates; if the estimates are improved the estimates are kept and improved upon, if estimates illustrate a fit deterioration, they are discarded. A cyclical repetition of steps one and two continues in this iterative way until the final criteria converges or when the iterative process stops improving and the change tends to zero.

In this process local maximum values may be generated through the model process (Haagenars & McCutcheon, 2002). This is when there is a change in the loglikelihood value which decreases the loglikelihood function and log thus reaching convergence point before the true global maxima. (Muthén & Muthén, 1998-2007) recommends using multiple sets of starting values and making a comparison of the loglikelihood values. In all latent class models performed in this thesis, 100 starting values were used with the best 20 optimised and the loglikelihood was checked to verify the presence of the global maxima. Should the occasion arise where the best loglikelihood is not replicated, the number of random starts and optimisations were increased until this status has been reached, and confidence can be placed in the solution. Where the number of starts has been increased in any of the chapters, this will be indicated in the relevant methods section.

2.5.2.3. Model fit

Traditionally the likelihood ratio chi-square (LRχ^2) and the Pearson chi-square have been used for latent class models. However, this is not suitable for larger sample sizes such as those found in this thesis (Markovitz, 2003). In addition, the likelihood ratio chi-square statistic is not suitable for testing models which are not nested i.e. have differing latent classes (McLachlan & Basford, 1988) due to low frequencies in the cross tabulations. Alternative fit indices include information criteria. The most often used are the AIC (Akaike Information Criterion; Akaike, 1987) and the BIC (Bayesian Information Criterion; Schwartz, 1978). Geiger, Heckerman, King & Meek (2001) found that the BIC is no longer robust with large sample sizes such as those found in the NPMS (Singleton et al., 2001a; 2001b) and the sample size adjusted BIC (SSABIC; Sclove, 1987), is preferable. Lowest values of this entire information criterion indicate superior model fit.

Additionally, the Lo-Mendell-Rubin likelihood ratio test which compares each model to its predecessor, i.e. *k* class model to *k-1* model- where *k* is a given number of latent classes (Lo, Mendell & Rubin, 2001). If you take a hypothetical latent class structure where the latent variable is comprised of four classes, the *k* (4 class) model would be compared to the *k-1* (3 class) model. This method tests the hypothesis that the null model *k-1* is acceptable. If the *p* value is greater than 0.05 the null model cannot be rejected, and the *k-1* model is acceptable. If the *p* value is less than 0.05 the estimated *k* model is superior, and the process must be continued by running the model with successive numbers of classes until the *k-1* model is superior. This is then the best number of classes to explain the heterogeneity of the data. It is also worth noting that the last class needs to be the largest class as the first class in the estimated model is deleted in the comparison of the two models (*k and k-1*). This is assessed by requesting TECH 11 in the output of Mplus.

Finally, another method of assessing how well a model fits the data is by examining at the bivariate residuals. By asking Mplus to generate TECH 10 output, the patterns of response are displayed. A significant bivariate residual, which is where there is a significant difference between the observed and expected frequencies for a particular pattern illustrates the degree to which the model does not fit the data. The observed data frequency represents the number of times the pattern appears in the raw data. The expected frequency is the frequency predicted by the model structure. In using this as a means of addressing model suitability, the bivariate residuals of the ten most frequent response patterns will be assessed for significance, with a higher number of significant residuals indicating a model's poor fit to the data. In practice, if the model cannot replicate the most common patterns of use in the database, then the patterns generated by the model will not fit the original data well.

There is still considerable debate surrounding the relative performance of fit indices in latent class modelling, and consequently the agreement of a combination of the sample size adjusted information criteria (SSABIC), number of significant bivariate residuals and the Lo-Mendell-Rubin likelihood ratio test will be used in this research to determine the best model fit. Entropy is an indicator of how the latent classes are distinct and separate from each other where a value close to 1 indicates clear classification (Ramaswamy, Desarbo, Reibstein & Robinson, 1993). It is a summary measure of the accuracy of placing respondents into classes based on posterior probabilities generated by the latent class model

2.5.3. Multinomial logistic regression

Once a suitable latent class structure has been selected from the information criteria and the Lo-Mendell-Rubin loglikelihood ratio test, the next step is to further investigate the characteristics of the latent classes in terms of predictor or background variables. This is useful to further develop the profile of the classes of latent variable.

The addition of predictors to the model through multinomial logistic regression can affect the formation of the latent classes. Therefore, two options exist when adding predictors to the model. Firstly, the addition of predictors can be allowed to affect the formation of the latent classes. There are advantages to this method in that the interaction between background variables actually influence the observed, manifest variables and, therefore, would influence the latent variable.

Conversely, the posterior probabilities can be fixed using the 'training' function in Mplus and thus the predictors do not affect the latent class formation. By fixing the probabilities, as is the case the analyses contained in this thesis, the latent classes are purely determined by the licit and illicit drug use behaviours in the survey and the background variables act as predictors. In this way, it is considered possible to perform 'weighted' multinomial logistic regression on the data (Muthén & Muthén, 2007) using exact probabilities rather than most likely class. Using fixed latent class probabilities has several advantages. Firstly, given that the alcohol use model has ten observed indicators, the illicit drug has nine and a combined model would have 19 observed indicators, the models are already computationally demanding.

However, to include the number of predictors in this thesis may make these computational demands unreasonable and likely result in an unstable or misleading solution. Secondly, the issue of classes being identified as with or without predictors is one essentially based on belief rather than evidence. No systematic simulation work to date supports either method; considering the wish to create latent class typologies of drug use, it could be considered advantageous to assess the latent variable separately, using the predictors to validate and lend theoretical weight to the results.

In terms of the output of the multinomial logistic regression analysis, M*plus* calculates the natural log of the odds (beta or β) of an event occurring in other classes relative to the reference class (this is usually the last class). In addition to the beta estimate, standard error (S.E.) and significance are also computed. The significance is a calculation of β/ S.E. which if exceeded 1.96, displayed a significant result for that factor. Only the odds ratio with 95% confidence intervals will be displayed. The significance of a predictor is also indicated if the 95% confidence limits span either side of one. A conceptual diagram illustrating the relationships between the variables is presented in Figure 6. This illustrates how the demographic variables of gender, age and employment status predict class membership of the illicit polydrug use variable

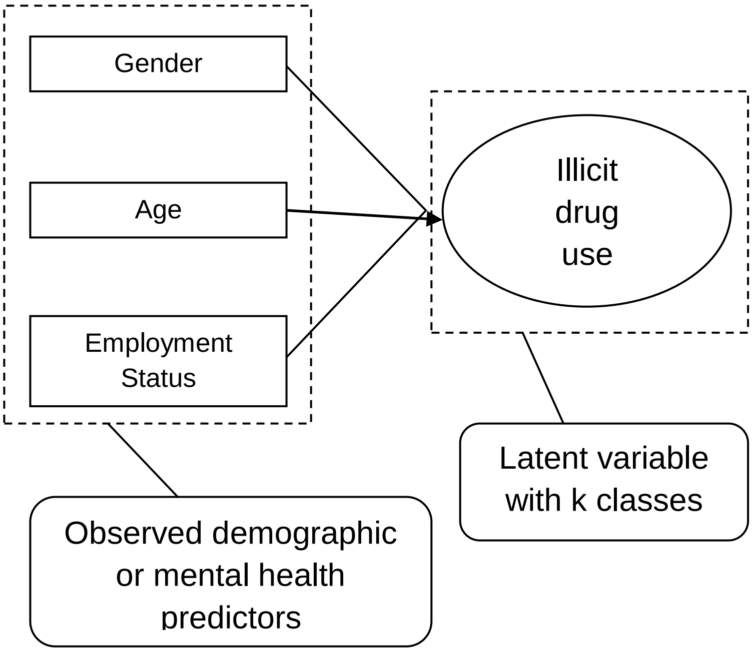

Figure 6: Conceptual model of multinomial logistic regression.

2.5.3.1. Optimal model selection

This is a variant on the multinomial logistic regression. It primarily runs two models. The first estimates the log odds for predictor variables to be freely estimated relative to the baseline class. As can be seen in Figure 7, assuming illicit polydrug use is a four class latent variable, three log odds will be estimated which represent how gender predicts class membership. These are called a_1, a_2 and a_3. For the other predictors, age and employment status, these log odds represent b_1, b_2 and b_3 and c_1, c_2 and c_3. They are all measured in relation to the baseline last class (class 4). A second model is then run which constrains or fixes the log odds for each predicted relationship (the effect of gender on class) to be the same across classes compared to the baseline. Using the example of gender, the analysis will be forced to generate log odds for the relationship between gender and class which are equal for all three classes compared to the baseline class. Therefore, $a_1 = a_2 = a_3$. For the other predictors in the model this is $b_1 = b_2 = b_3$ and $c_1 = c_2 = c_3$ for the predictors of age and employment status. As there are more free parameters (or less relationships to estimate) in this model, this is said to be a simpler (parsimonious) solution.

In order to determine whether the most parsimonious solution fits the data better, the 2Δ loglikelihood (2Δll) difference was compared. The loglikelihood is a measure of fit provided in the output of each of the models tested. The difference between the two loglikelihoods is multiplied by two to provide an approximation to the chi square distribution. Assessment of chi-square distribution tables illustrate whether significant differences are found between the two models. If the critical value for chi-square is less than the 2Δll for a given difference in degrees of freedom between the two competing models, then the differences are significant. If there are no significant differences between the models the more parsimonious restricted solution is favoured.

If there is a significant difference between these two models, to select the optimum multinomial logit model, constraints will be sequentially relaxed from model two until the 2∆ll test shows a model which is both parsimonious in terms of constraints but was also a good fit of the data. Modification indices in the Mplus output will be used to find the most likely variable to be relaxed testing the null (H_o) hypothesis that a model with x-1 parameters is a better fit of the data than a model with x parameters. This sequence of constraint relaxations continued until the p value was greater than 0.05, therefore, the H_o model cannot be rejected and the model with x-1 parameters was then taken as the best fit. Significance levels are determined by examining at critical values for a given degree of freedom difference in chi-squared tables. The global aims of this process are twofold first it creates a parsimonious solution and second it is able to estimate non-baseline classes which differ from each other and the baseline class.

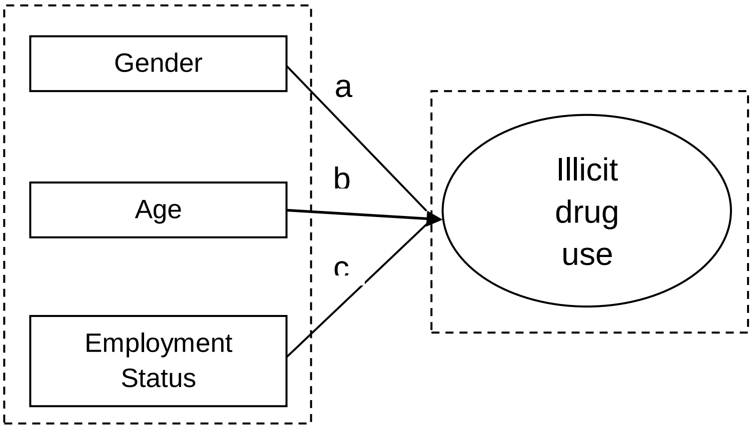

Figure 7: Conceptual model of multinomial logistic regression with log odds a, b and c.

2.5.4. Software

The primary software used in this thesis to perform latent class analyses and subsequent multinomial logistic regressions was Mplus version 5.01 (Muthén & Muthén, 2007). Notably there are a number of other software packages which can perform this kind of function such as Latent Gold (Vermunt & Magidson, 2005) or free software such as R http://cran.r-project.org/. Mplus was chosen for functionality, flexibility and ability to model complex solutions well. Graphical representations are all conducted in Microsoft Excel 2007, and all preliminary data analysis, recoding and descriptive statistics were conducted using SPSS (SPSS Inc., 2006).

3. The latent class structure of illicit polydrug use in the UK: findings from a national household population.

3.1. Abstract

Illicit polydrug use is common in the general population but little is known about how it is expressed. This chapter aimed to identify typologies of illicit polydrug use in Great Britain. A latent class analysis was performed on nine indicators of past year drug use (cannabis, cocaine, amphetamines, ecstasy, LSD, mushrooms, amyl nitrate, tranquillisers and a composite group of heroin and crack use) collected from a large multi-stage probability sample of the population of Great Britain (NPMS; n=8538). Multinomial logistic regression was used to validate and explore the relationship between class membership and demographic variables. Three classes best described patterns of response in the data. These were labelled class 1 'wide range', class 2 'moderate range' and class 3 'no drug use'. The multinomial logistic regression results confirmed significant associations between latent classes and gender, education, economic activity, smoking status, hazardous drinking and age. Members of classes 1 and 2 were significantly more likely to be male, have lower educational attainment, be economically inactive, and currently smoking than the baseline group. Those in class 1 and 2 were also 11.12 and 2.35 times more likely to be drinking hazardously respectively compared to those in the no drug use class. Class 1 was characterised as significantly younger than both classes 2 and 3. In conclusion, illicit polydrug use in Great Britain can be grouped into three distinct classes, which differ on key demographic variables. Hazardous alcohol and tobacco use were strong predictors of membership of

the illicit drug use classes, highlighting the frequency by which alcohol, tobacco and illicit drug use are combined.

3.2. Introduction

As chapter two described, illicit polydrug use is frequently found in studies of specific subpopulations or in the general population. However, there has been little research describing the nature of patterns of illicit polydrug use, and the characteristics of users. The overall aim of this chapter is to establish a description and typology of illicit polydrug use and identify if patterns are associated with demographic criteria. This introduction will review previous attempts to describe or model illicit polydrug use. These will be discussed in the context of any demographic differences between patterns, focussing on the key criteria of age, gender, employment status, education, rural and urban differences, hazardous alcohol consumption and smoking status to explore and validate classes.

Some previous research examining illicit polydrug use has focussed on the use of a particular substance to determine illicit polydrug users with a named primary drug of use. For example Topp et al. (2004) contrasted the characteristics of recent and regular ecstasy users in Australia in both purposive (dance drug) and random (general population) samples. The authors note that past year ecstasy users were predominantly illicit polydrug users. Rates of ecstasy illicit polydrug use, dependent on both the sample and the regularity of use of ecstasy were in the range of 88-96%. In addition, they found some demographic differences between users of ecstasy (who were also predominantly illicit polydrug users). Ecstasy users were mostly male (58%-62%) with a mean age in the range of 24 to 25 years. Furthermore, between

53% and 57% had completed post school qualifications, illustrating that these differently sampled populations of drug users were relatively well educated.

Von Sydow, Lieb, Pfister, Hofler and Wittchen (2002) also focussed on the primary drug ecstasy and found similar illicit polydrug use patterns to Topp et al. (2004). Adolescent former users of ecstasy from a baseline data collection in Munich, Germany were compared with those who had never used ecstasy in their lifetime. The authors found former ecstasy users were 3.9 times more likely to be smokers, 6.3 times more likely to drink alcohol, 12.2 times more likely to be using cannabis, and 17.3 times more likely to have used a hallucinogenic substance. The study also illustrated that those who had used ecstasy continuously in the past four years compared with those who had never used ecstasy in their lifetime were 6.9 times more likely to smoke. Continuous ecstasy users were also 2.6 times more likely to drink, 18.8 times more likely to be cannabis users and 11.6, 219.7, 222.6 times more likely to be using opiates, cocaine and hallucinogens respectively. Finally, those who were continuous ecstasy users over four years compared with those who were former users of ecstasy were 3.2 times more likely to be cannabis users, 14.7 times more likely to be cocaine users, 6.5 times more likely to have used hallucinogens, and 13.4 times more likely to have used inhalants. All of which demonstrate polydrug use as a normative behaviour for ecstasy users.

A study using the same dataset (Lieb, Schuetz, Pfister, von Sydow & Wittchen, 2002) compared lifetime ecstasy, stimulants and hallucinogen polydrug users with individuals who had not used these drugs in their lifetime. Thus, those who had prolonged use of ecstasy were more likely to use than those who used for less continuous time. They found that the ecstasy, stimulant and hallucinogen illicit polydrug use grouping were significantly less likely to be university educated (OR=.22) and were more likely to be unemployed (OR=4.13). Similarly, there were significant differences between those who were lifetime ecstasy, stimulants and hallucinogen illicit polydrug users compared with those who used other drugs in their lifetime (but not ecstasy). The former were less likely to be university educated (OR=.37) and times more likely to be unemployed (OR=3.60).

Alternative studies focussing on illicit polydrug use of a named drug include Kelly and Parsons (2008) study of 400 cocaine using night club attendees in Manhattan. The authors compared illicit polydrug cocaine users with illicit non-polydrug cocaine users and found that illicit polydrug users were more likely to be male (OR=1.66). Cocaine illicit polydrug users and illicit non-polydrug cocaine users were not significantly different in terms of their AUDIT score. The mean AUDIT score for illicit polydrug cocaine users and illicit non-polydrug cocaine users were 12.49 and 13.64. This illustrates that both groups of illicit users were drinking at a hazardous level as defined by Saunders and Aasland (1987). The link between illicit drug use and hazardous levels of alcohol use is also supported by other research. Parker and Williams (2003) in their cohort of young adults from North West England, found that 34.9% of current drug users drank every day, compared with 8.7% of alcohol abstainers. In addition, Wadsworth, Simpson et al., (2004) found the most frequent patterns of illicit polydrug use for those who had used an illicit drug during the year prior included current smoking and alcohol use above the recommended weekly limits. This represented 3.5% of their total sampled population of Merthyr Tydfil and Cardiff. The second most frequent pattern was similar; however, this group did not currently smoke and represented 3.2% of the population. Illicit drug users who drank under the recommended weekly limits for males and females represented a slightly lower percentage, with 2.5% of the population engaging in these behaviours and currently smoking and 2.0% engaging in these behaviours but who were not current smokers. This suggests that illicit drug use is related to other drugs, such as tobacco and alcohol.

Fendrich et al. (2003) in a multi-stage randomly sampled population of Chicago (n=627) found of those who had ever used illicit drugs in their lifetime, 73% were illicit polydrug users. In addition, they found no significant differences between those who had ever used ecstasy, ketamine, rohypnol, GHB, LSD and methamphetamine and age. This was through the comparison of polydrug rates for those aged 30 years or older with two age groups of 26 to 30 and 18 to 25 years. Where 'lifetime' drug consumption was considered, use of illicit drugs appears to be common across different age ranges, however, the majority of current use was be found in young users, generally of 25 years or younger.

Riley et al. (2001) in an opportunity sample of 'dance drug' users (n=122) found in the group of those using illicit drugs, the most frequent pattern of simultaneous illicit polydrug use mixing was that of ecstasy and amphetamines (63%). The second most common pattern of use with 27% was that of ecstasy, amphetamines and other drug use (predominantly LSD, mushrooms and cocaine). It is of note, however, that whilst this reflected past year drug use patterns, participants were asked to only note the number of drugs that they had taken whilst in a nightclub setting. Given that open use of drugs is actively discouraged by licensed venues, and the difficulty in concealing cannabis smoking, it was infrequent for a participant to have stated they used cannabis in this setting. Also predictably, given their sedative effects, tranquillisers had not been widely used in the nightclub environment. The study therefore only relates to simultaneous illicit polydrug use, as concurrent (yearly patterns) have not been specified by the authors.

Despite this, the most frequent patterns found in the study are supported by research by Verheyden, Henry, et al. (2003). In their opportunity sample of 466 ecstasy users from Manchester or London, the most frequent pattern of illicit polydrug use found was that of tobacco, amphetamines, cannabis and ecstasy. However, the authors note that females were more likely to engage in concurrent illicit polydrug use using a wider range of drugs; the mean numbers of drugs used were 4.77 for females and 3.72 for males. In addition, females were more likely than males to be simultaneous illicit polydrug users. Of the females in this sample 76.9% of females used in this way compared to 58% of males. However, despite this increased percentage of females engaging in simultaneous mixing behaviours, there were no significant differences between the numbers of drugs being used. The mean number of drugs being used on occasion for both females and males were 2.30 and 2.48 respectively. The sample was predominantly (93.4%) in the age range of 18 to 29 years, and 57% male.

A study by Pedersen and Skrondal (1999) assessed demographic differences between groups of drug users from an Oslo youth population (n=10812). They summarised the patterns of endorsement of drugs in their population as ‘no illicit drug users’, ‘cannabis only users’, ‘amphetamine only users’, ‘ecstasy only users’ and ‘amphetamine and ecstasy users’. The last group, amphetamine and ecstasy users who are illicit polydrug users were most likely to be male amongst the groups, suggesting that males are more likely to engage in illicit polydrug use. This group was seven times more likely to be a current smoker. They were also 1.3 times more likely to have experienced alcohol related problems[3] compared to members of the baseline no illicit drug use grouping.

Halkitis, Palamar and Mukherjee (2007) in a purposively sampled group of 450 gay and bisexual men concluded that illicit polydrug use (over the past four months) was common. Using bivariate correlations, the authors found amphetamines and ecstasy were the most likely to be combined (53%; r=.21), followed by amphetamines and cocaine (49.1%; r=.19). Other common comparisons were amphetamines and ketamine (42.2%; r=.32) and amphetamines and GHB with 25.6% (r=.36) of the sample engaging in this pattern of use. Another study which used bivariate comparisons of lifetime drug use was an opportunistic survey of 210 rave attendees in Quebec, Canada. This study found significant correlations between lifetime use of certain drugs (Gross, Barrett, Shetowsky, & Pihl, 2002). Significant associations were found between amphetamines and ecstasy, cannabis and magic mushrooms (psilocybin) and LSD and magic mushrooms. However, this does not illustrate fully the degree of illicit polydrug use, as it fails to highlight patterns which may encompass a wider range of drugs than the two given. For example, psilocybin lifetime use correlates with both LSD and cannabis, however, cannabis and LSD do not correlate significantly.

However, there have been some other attempts to group drug use together; less a person-centred approach but by location. Forsyth (1996) has classified patterns of illicit polydrug use by location of use in a dance drug sample of 135 night club attendees. The evidence for this classification comes

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[3] Alcohol problems were measured on a scale from zero to five. They were a subset of questions from Rutger’ s Alcohol Problem Index (RAPI; White & Labouvie, 1989)

from the percentage of use in the night club setting. The author hypothesised that there were three main classifications primary, secondary and non-dance drugs. Primary dance drugs refer to amphetamines, nitrites (including amyl nitrate) and ecstasy, representing those which are most frequently used in the night club or dance environment. Secondary dance drugs refer to those drugs which can form part of the dance drug repertoire, dependent on availability and desired effect. These include alcohol, cocaine, ketamine, LSD and magic mushrooms. The non-dance drugs contain the drugs tobacco, cannabis and tranquillisers. This was a novel approach. It is self-evident that drug use is somewhat situation specific; however, this may be more useful to model drug use patterns of those who attend dance events, rather than those who do not (such as those in a general population sample). These patterns were formed as part of the discussion of this paper, rather than as an integral part of the results. As a result, they have not been empirically tested for validity and wider applicability. Forsyth (1996) only provided frequencies of single drugs of use, and it is unclear to what extent these groupings might express illicit polydrug use over the past year, given that an individual may be using illicit drugs in more than one location.

Smit et al. (2002) sampled 6236 adolescent students from the most Dutch National School Survey on Drug use at that time using cluster analysis. They found three typologies of polydrug users best represented concurrent use of drugs in the past four weeks. The first of these, ‘A’ type, represented ‘ordinary’ illicit polydrug users and was comprised of individuals were likely to have used only the licit drugs alcohol and tobacco. This group comprised 59.9% of the sample. ‘B’ type was denoted ‘soft’ illicit polydrug user, endorsing cannabis, alcohol and tobacco and comprised 27.4% of the students. The ‘C’ group, comprising of ‘hard’ illicit polydrug users were using ecstasy, cocaine, amphetamine or heroin in addition to alcohol, cannabis or tobacco (8.6%). The probability of use of a given illicit drug in each group was not clear. The three groups were compared on several background variables using abstainers from all licit and illicit drugs as a reference category. Type B and C drug users were 1.80 and 2.51 times more likely to be male. Type A was more likely to be living in a non urban area (OR=.62). There was also a significant relationship with age in the defined range of 12 to 16 years; as drug use involvement increased so did age. The odds ratios were 2.17, 3.09 and 2.58 for type A, type B and type C in comparison to the baseline group. They also found that older adolescents are more likely to illicit polydrug use than younger adolescents. This is supported by studies which examine drug use in young adults such as Pedersen and Skrondal (1999), Degenhardt et al. (2004) and McCambridge, Mitcheson, Winstock and Hunt (2005) who illustrate that those who are younger but over the age of 18 are most likely to be either using in a polydrug use pattern. Whilst the Dutch education system is different to that in Great Britain, there was evidence that an increased involvement with education reduced the likelihood of being an illicit polydrug user (whether type A, B or C) compared with the baseline group, of illicit drug and alcohol abstention. In addition, the study was strengthened by a high response rate (95.5%).

Recent methodological advances in statistical modelling offer an alternative approach which can account for different patterns of response. For example, a study by Mitchell and Plunkett (2000) used latent class analysis on a sample of 2012 American Indian Adolescents determining four groups of users. In this analysis, all users were accounted for in the model. Class 1 membership was characterised by a fixed, no use response across all drugs, class 2 membership by alcohol and cannabis use, class 3 membership by alcohol, cannabis and small probabilities of other drugs and the fourth class ‘pleural’ drug user- cannabis, alcohol, cocaine, inhalants and other drugs. The profile plot illustrating probability of drugs used is given in Figure 8. The largest of these was class 2 with 50.2%, with 29.1% in class 3, 16.5% in class 1 and 4.1% in class 4. However, this study fails to examine demographic information to attempt validation of the classes instead using attitudes to alcohol, community and peer values, and thus it is difficult to estimate the demographic characteristics of the members of each of these classes.

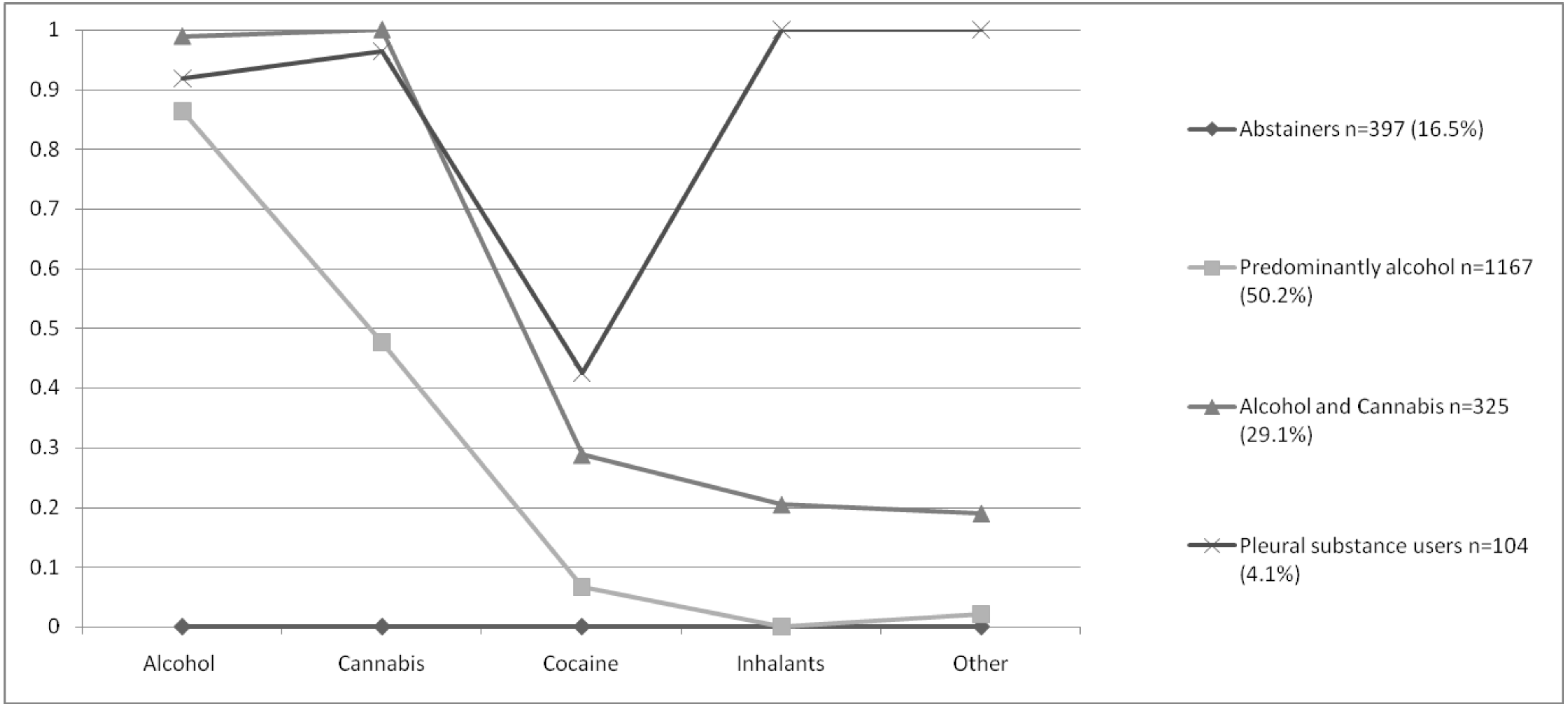

Figure 8: Profile plot of the four latent classes in the Mitchell and Plunkett (2000) survey.

Carlson, Wang, Falck and Siegal (2005) also used latent class analysis on a group of 402 adult ecstasy users in Columbus, Ohio sampled using a respondent driven strategy. The authors found three types of ecstasy user best characterised the patters of response in the sample. These were named limited, moderate and wide range drug users. Class 1, ‘limited’ range, was characterised by individuals who did not use or used few other drugs with Ecstasy in the past six months. As can be seen from Figure 9, any use of drugs predominantly reflected non-daily cannabis use and drunkenness beyond the mean days of the sample. The individuals in the moderate range group, class 2, had a higher rate of other drug use. This class was characteristic of a probability of use of non-daily cannabis, opioid and hallucinogen use of greater than 50%. An individual in class 3, the ‘wide’ range ecstasy use class, had the highest probability of using crack/cocaine, opioids, amphetamines, tranquillisers and hallucinogens. Of their ecstasy users, 20% were members of class 1, 52% were members of class 2 and 28% were members of class 3. Most of the sample were male (64%), of white ethnic origin (81.6%) and in the age range of 18 to 30 years. There were no significant differences between gender and educational attainment between the members of classes 1 and 2 compared to class 3. Those in the wide range class were 9.14 times more likely to be of white ethnic origin compared to members of the limited range latent class. In addition, significant differences were found between the classes on age. The members of the wide range ecstasy use class were also most likely to be the youngest (OR= .77) compared with those in the moderate range ecstasy use class (OR= .86) relative to the members of the baseline limited range ecstasy use class. The mean ages for the members of all three classes from the limited class to the wide range class were 22, 21 and 20 years old, and these were found to be significantly different from each other using ANOVA.

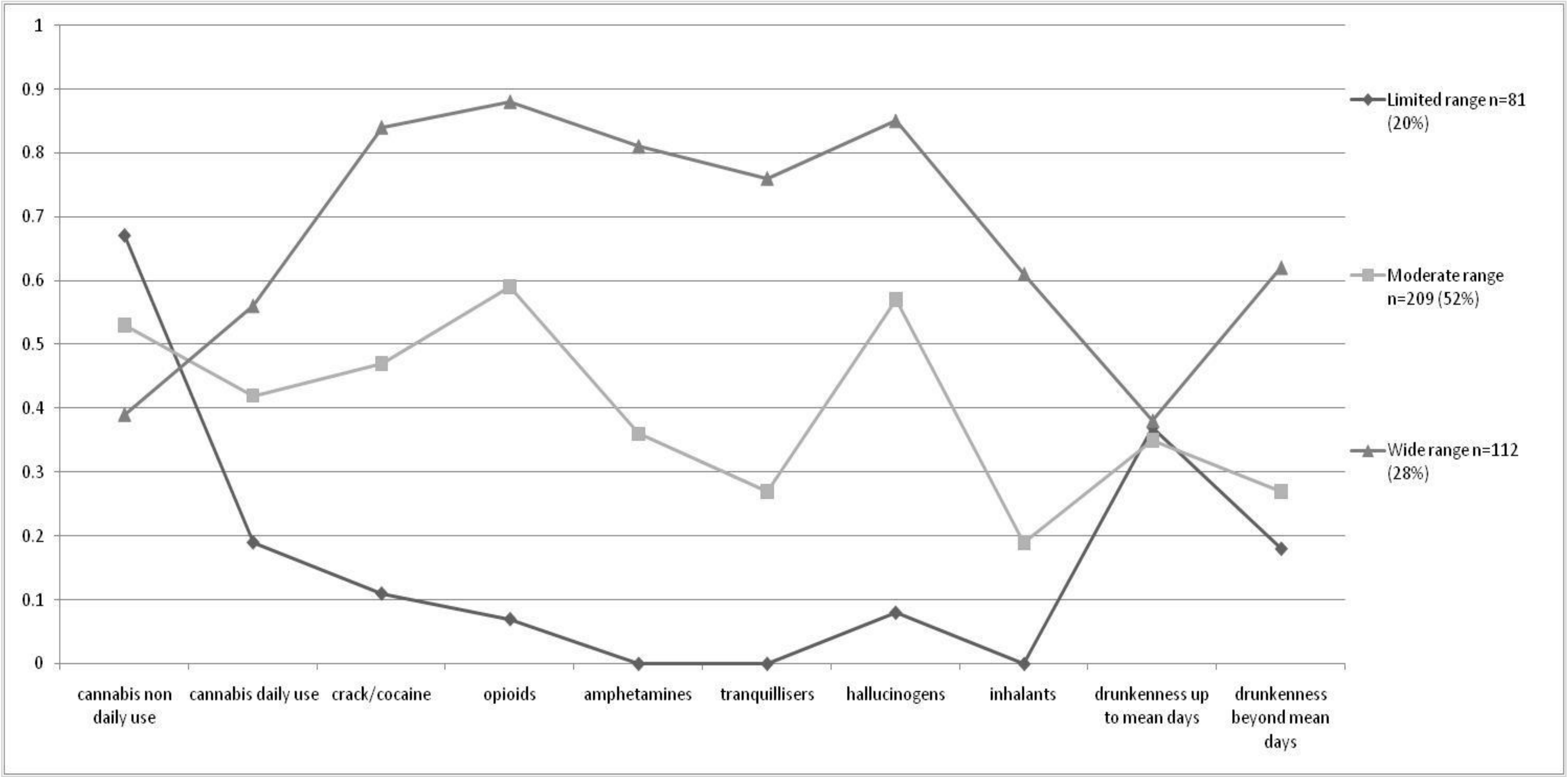

Figure 9: Profile plot of the three latent classes in the Carlson et al. (2005) survey.

Lynskey et al. (2006) found five groups of lifetime illicit drug users in their Australian twin sample (n=6265). These were low use (class 1; 69%), moderate use (class 2; 18%), party drugs (class 3; 7%), opiates/sedatives (class 4; 3%) and illicit polydrug users (class 5; 4%). The profile plot is replicated from the paper in Figure 10. Class 1, low use was characteristic of some cannabis use; its endorsement probability just over .4. The moderate use class (2) was characterised by a higher probability of cannabis use and some stimulant use. The party drug class (3) typically reflected cannabis, stimulant and hallucinogen use with a lower probability of using inhalants and cocaine. The opioid and sedative class (4) had a moderate probability of cannabis, sedative and opioid illicit polydrug use. Finally, the ‘polydrug’ use class (5) had the highest probability of using all of the eight drug use variables in their lifetime.

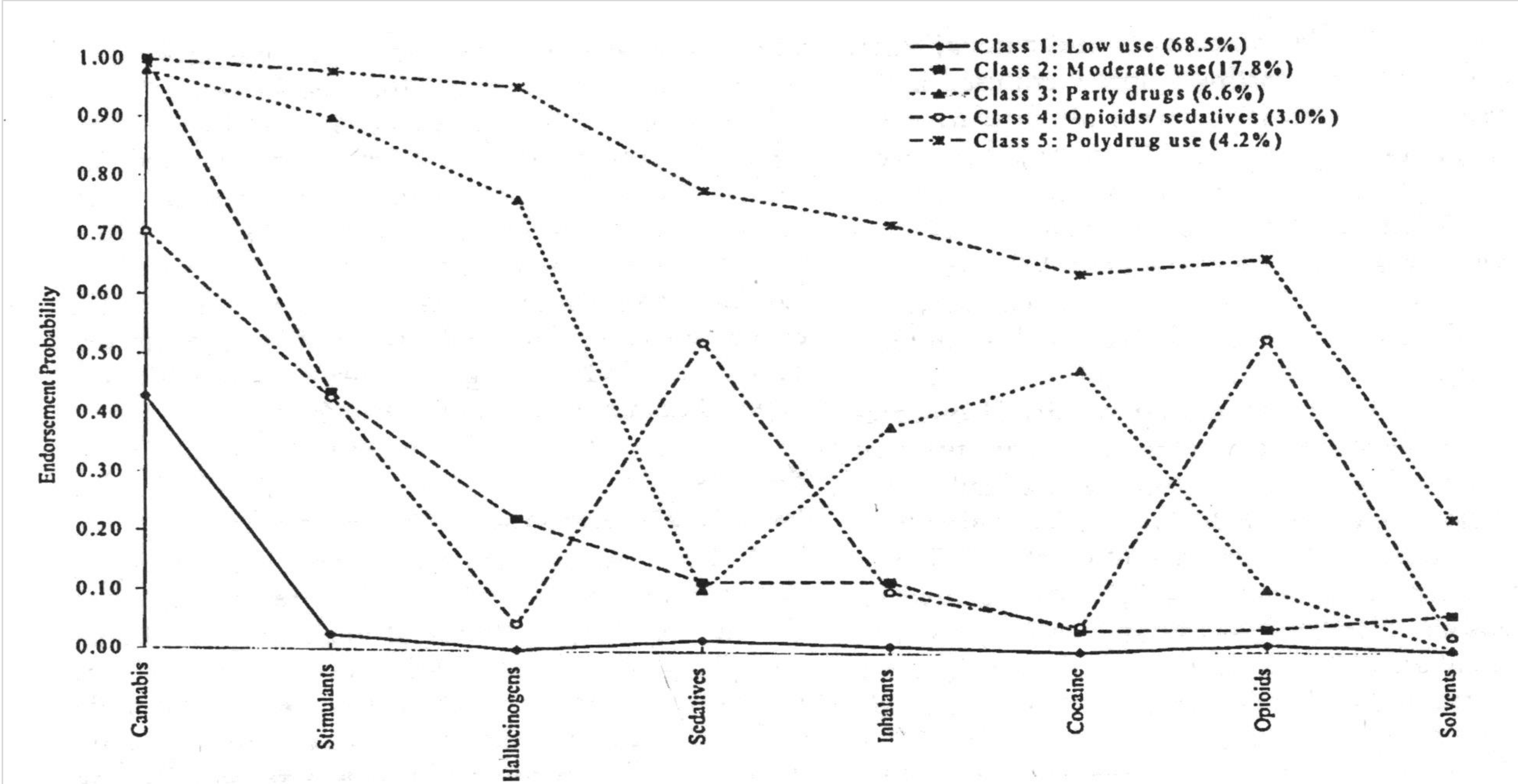

Figure 10: Profile plot of the five latent classes in the Lynskey et al. (2006) survey.

They also assessed gender differences between the five classes. The members of moderate use class 2 were 1.6 times more likely to be male than those in the baseline class 1. Similarly, those in the party drug (class 3) and illicit polydrug using class 4 were significantly more likely to be male with odds ratios of 2.0 and 2.7 respectively compared to members of the low use class 1. There was no significant relationship between the individuals in the opioid/sedative class with respect to gender. Significant differences were also found in relation to the use of other drugs. For example the moderate, party, opioid and illicit polydrug class members were 3.3, 3.8, 2.8 and 6.9 times more likely respectively to be nicotine dependent, or 3.4, 4.2, 2.7, and 7.6 times more likely respectively to be alcohol dependent compared to members of the baseline class of low use. If these are used as proxy measures for extent of use of either of these drugs, this illustrates a strong relationship between illicit drug use and extent of either alcohol or nicotine use.

Whitesell et al. (2006) also estimated patterns of drug consumption using the 1999 National Household Survey of Drug Abuse. They found four classes of lifetime illicit polydrug use and three classes of past year illicit polydrug use. The patterns of these are presented in Figure 11 and Figure 12.

The fourth lifetime use classes represented a class with no drug use. There was one class which was characteristic of alcohol use and a relatively low probability of cannabis use (around .35). The third class were predominantly alcohol and cannabis users although 30% used hallucinogens and 35% used inhalants. Finally, the polydrug class had the highest endorsement probability of alcohol and cannabis use. However, they also used cocaine, hallucinogens, inhalants, stimulants, tranquillisers and analgesics, with probabilities of between .7 and .9.

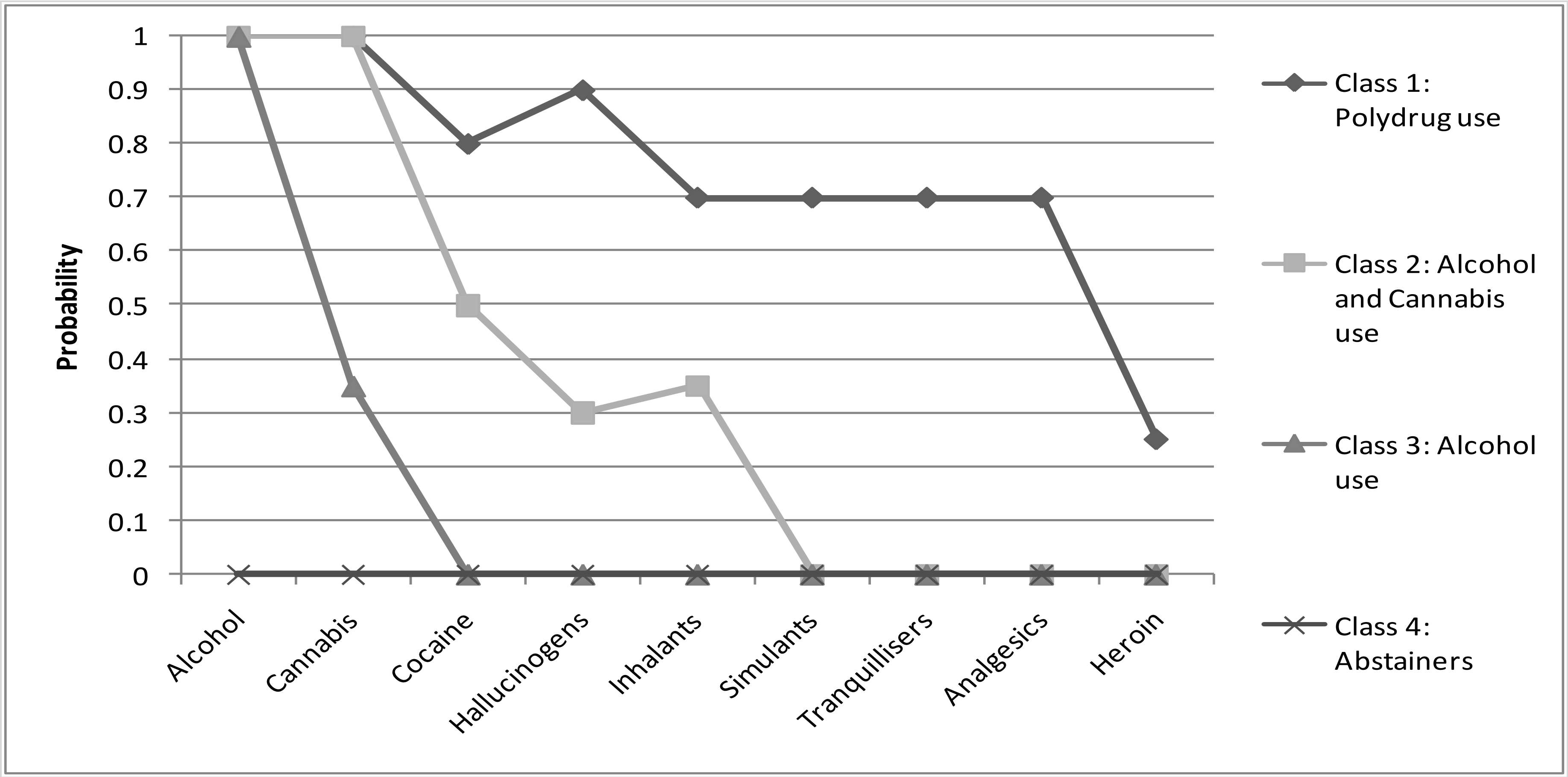

Figure 11: Approximate profile plot of four lifetime drug use classes in the Whitesell et al. (2006) study

Of the three classes of use in the past year, two resemble the patterns of endorsement of lifetime use. The first of these was the no use class. The second was the alcohol use only class. This was like the alcohol lifetime class; there were low probabilities of also using cannabis with a decrease in probability of around .1. Finally, the alcohol and drug use class reflected alcohol and cannabis use to a high probability and lower probabilities of cocaine, hallucinogens and analgesics. Note that these graphs should be interpreted cautiously, as the information was gained from a radar plot, which makes precise probabilities difficult to estimate.

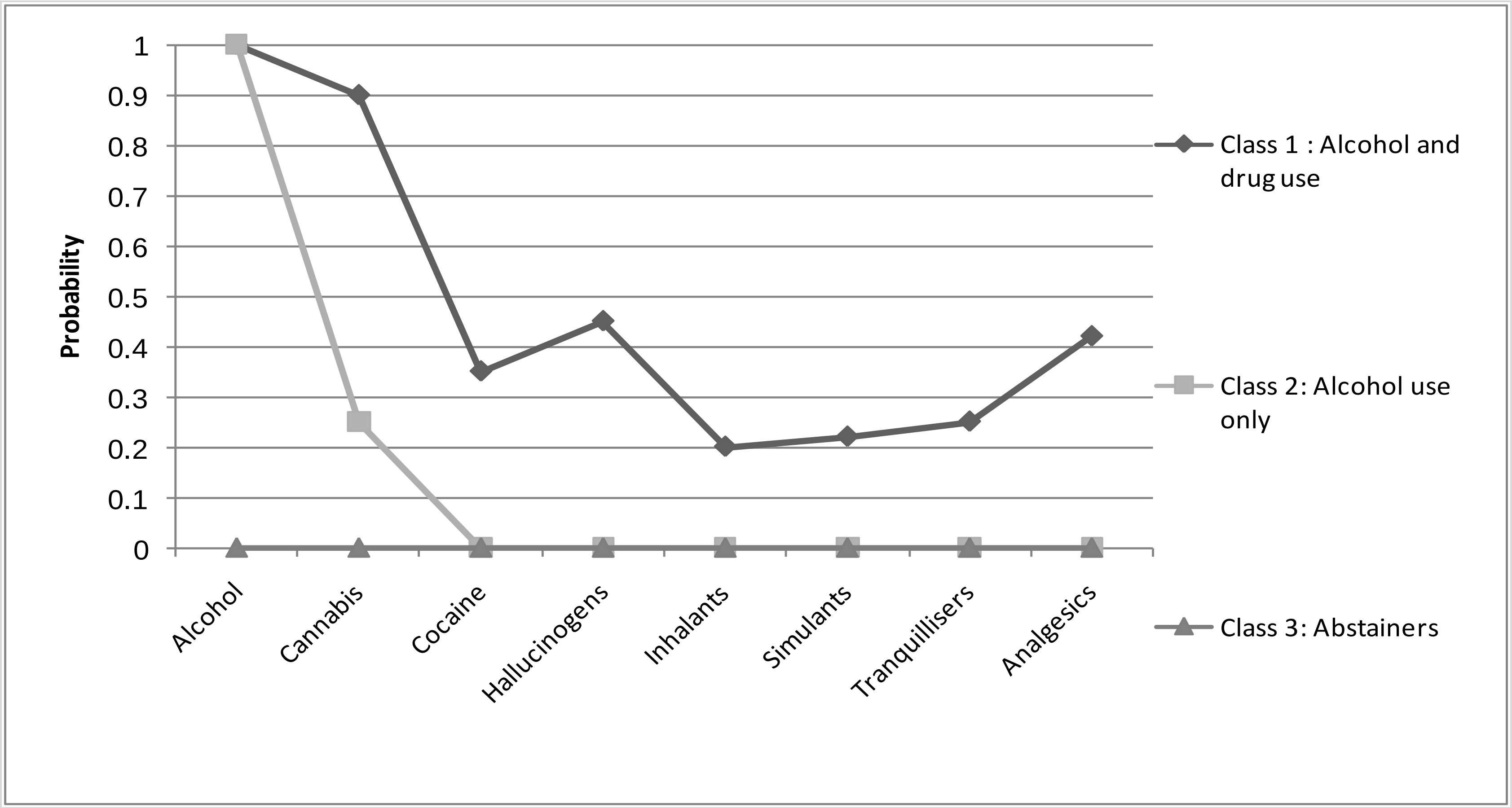

Figure 12: Approximate profile plot of three yearly drug use classes in the Whitesell et al. (2006) study.

Research with a single drug focus can also reveal further demographic differences, which might help to validate proposed models of illicit polydrug use. For example, there have also been notable differences between urban and rural areas in terms of their drug consumption. In a Scottish study of urban (Dundee) and rural (Perth and Kinross) secondary school students, Forsyth and Barnard (1999) found 43.9% of their entire sample had tried illicit drugs at least once, with the percentage slightly higher for the Dundee adolescents (although the differences were not significant). There were also some urban/rural differences in terms of specific drug use, with urban adolescents significantly more likely to have used ecstasy, LSD, or buprenorphine, and rural adolescents more likely to have used magic mushrooms or heroin. However, whilst illuminating, it is unclear how these urban and rural differences may be found in illicit polydrug users from the research presented. Furthermore, regarding gender differences for single drugs, Kelly, Parsons and Wells (2006) in a random time-space sampled survey of Manhattan club going adults (n=1914) aged 19-29, found that females were significantly less likely to be using ketamine (OR=.64), GHB (OR=.61) and crystal methamphetamine (OR=.73), but were more likely to be using cocaine than males (OR=1.28). There were no significant gender differences for LSD use in this sample. Chivite-Matthews et al. (2005) in a recent British Crime Survey of Drug Misuse Declared concluded men were twice as likely as women to have used drugs in the past year. This is supported by an Australian population survey from a similar time period as the NPMS (Degenhardt, Hall & Lynskey, 2001), in samples of university students (Webb et al., 1996), and in adolescents (Collins et al., 1998; Smit et al., 2002). However, it is notable that other evidence has suggested that gender differences in terms of drug consumption are decreasing, particularly in younger, ‘dance drug’ cohorts. A survey of 194 medical students in the UK found similar proportions of males and females taking illicit drugs, however, they had a higher proportion of females in their sample and no significance tests were performed on the proportions (Newbury-Birch, White & Kamali, 2000).

In a population survey of residents in Cardiff and Merthyr Tydfil by Wadsworth, Simpson, et al., (2004) females were found to be significantly less likely to be using illicit drugs than males (OR=.58). It is also of note that they used a mail out approach, so whilst they have sampled in a representative way from the population of these two locations, they had a low response rate at 27%. However, this population had a very similar gender and age breakdown to the NPMS with 58% females and a mean age of 45.61 (SD=18.00).

They also found several other demographic differences between users of illicit drugs in the past year and those who did not. Briefly, those who used illicit drugs were significantly more likely to have been in higher education (OR=1.96) or unemployed (OR=2.05). Illicit drug users were also less likely to be living in a rural setting (OR=.49), retired (OR=.18). Compared with individuals aged in the range of 18 to 25 years, those aged between 25 and 40 years old or older than 40 years were significantly less likely to be illicit drug users (OR=.57 and OR=.40 respectively). Illicit drug users were 2.40 times more likely to be drinking alcohol over the recommended weekly limits and 5.61 times more likely to be current smokers.

These demographic trends were similar to a recent US population survey comparing those who had used at least one illicit drug in the past year (.6% of the population and excludes alcohol). Those most likely to have been drug users in the past year were young males aged 18-24, representing 20.3% of all males in that age range in the US population (Falk et al., 2008). Contrasting this with the female proportion in the same age range, there is a notable decrease in the frequency of use of at least one illicit drug for women, with 13.0% representing the most frequent age range for females. This study of the US general population was collected in 2001-2002, around a similar time to the NPMS.

There have been various attempts to model illicit polydrug use. However, there are key limitations to some of these studies, which make it difficult to extrapolate the findings to illicit polydrug use typologies in general population samples. In many of the featured studies, the sample has been accessed opportunistically or through snowball referral (for example, Riley et al., 2001; Verheyden, Henry, et al., 2003). Thus, the probability that a person will be sampled is impossible to generate. This is important in applying results of a sample to the general population. In the absence of random sampling, biases between those who actively volunteer and those who do not can affect the results (Rosenthal & Rosnow, 1975). Random participant sampling limits the effects of biases and enable inferences to be made to the wider population from which it was sampled (assuming an acceptable response rate). This chapter will analyse a dataset which has been sampled randomly and stratified by socio-economic status to improve representation to the population of Great Britain (Singleton et al., 2001a; 2001b).

Age can also influence the ability to infer previous patterns of illicit polydrug use to the general population. For example, Mitchell and Plunkett (2000) studied a sample of adolescents. It is difficult to determine how representative this may be to the general population of Great Britain, as adolescent users form a very small subset (aged between 16 and 18 years) of this chapter’s dataset. Contextual specificity of some of the studies reported in this introduction might also influence the ability to generalise the findings. Samples of dance drug or nightclub populations, such as Kelly et al. (2006) and Gross et al. (2002) typically have higher rates of illicit drug use (Lim, Hellard, Hocking & Aitken, 2008) and illicit polydrug use (see chapter one) than general population samples. This higher use is theoretically applicable to a subset of the general population but could not be considered representative to the whole population.

Both the variables analysed, and the method of analysis is also important in determining the applicability of patterns of illicit polydrug use. As has been shown in this introduction, methodological techniques are not consistently applied across either general populations or other alternative samples. This chapter proposes the use of latent class analysis, which upon review of the evidence appears highly applicable to creating typologies of illicit drug use. There is also little consistency with the number and type of drugs included in analyses. For example, Mitchell and Plunkett (2000) included alcohol, cannabis, cocaine, inhalants and ‘other’ drugs, but a similar study using a different methodology assessed the use of cannabis, alcohol, tobacco, amphetamines and heroin (Smit et al., 2002). The dataset which will be analysed in this chapter will use as many of the illicit drug use variables as possible in this analysis, however, will not include those with very low numbers as to increase likelihood of model identification. In addition, these represent the majority of the most frequent drugs used in the past year in general population samples of Europe (EMCDDA, 2008).

In summary, this paper has two main aims. The first is to assess whether the variability in illicit polydrug use in the general population of Great Britain can be expressed in coherent typologies, overcoming some of the limitations of previous research. Given the inconsistencies reported above, it is not possible to make a priori predictions of the nature of the classes. The secondary aim of this paper will address the association of typologies with demographic criteria and compare them to existing literature on illicit polydrug use. The demographic variables to be used in this way are sex, age, educational attainment, employment status, area type where the individual resides, whether an individual is a current smoker and whether an individual drinks hazardously.

3.3. Method

3.3.1. Participants, data and sampling

The data analysed in this chapter was from the NPMS survey (Singleton et al., 2001a; 2001b). This was downloaded from the ESRC UK data archive hosted at the University of Essex. The total number of participants in this study was 8580; however, there were 42 individuals who were excluded. Exclusion criteria were not answering any of the drug use questions, or in answering the drug use questions they endorsed the fictional drug semeron. These individuals were deleted listwise to give a total effective sample size of 8538. All participants were resident in England, Scotland or Wales and were sampled using a stratified multi-stage random sampling strategy. Most of the sample were female (55.08%), and of white ethnic origin (93%). The mean age of the sample was 45.34 years old (SD=15.59). Further details of the data included in the analysis for this chapter are covered in chapter two, methodology.

3.3.2. Measures

3.3.2.1. Illicit drug use

Measurement of illicit drug use was based on use of one of nine drugs in the past year. The drug use variables included in this analysis were cannabis, amphetamines, cocaine, ecstasy, LSD, magic mushrooms, tranquilisers, amyl nitrate, and a heroin or crack composite variable. These were coded as no use (0) or use (1) in the past year.

3.3.2.2. Demographic and other drug use variables

Demographic variables used in the regression model were gender (female=0; male=1), employment status (economically active =0; unemployed/economically inactive=1), age measured as a continuous variable between 16 and 74 years old, educational attainment (beyond GCSE/statutory education=0; up to GCSE level or below=1) and area type of the participant's residence (rural/semi-rural=0; 1=urban). In terms of other drug use, the probability of an individual in a particular class being a current smoker was coded as '0' for those who were not currently smoking and '1' for those who were current smokers. In addition, hazardous drinking was a further predictor in the model. This is defined as an AUDIT (Saunders & Aasland, 1987) score of greater than eight. If a participant scored less than eight on this scale, they were not classed as hazardous drinkers and coded '0', those scoring eight or more were coded '1'.

3.3.3. Latent class analyses

Full details of the procedure and outcomes of latent class analyses are presented in chapter two and a summary will be given here. The observed indicators of illicit drug use from which the latent variable has been estimated are nine binary yearly illicit drug use variables reflecting the use of cannabis, amphetamines, cocaine, ecstasy, amyl nitrate, LSD, magic mushrooms, tranquillisers and the composite heroin or crack. This is indicated in the conceptual model diagram in Figure 13. In this statistical modelling technique, classes of drug use behaviour have been estimated to account for relationships between categorical observed variables (Hagenaars & McCutcheon, 2002). The model parameters generated are class membership probabilities (or class percentage estimates) and probabilities of class specific endorsement of illicit drug use variables. Fit criteria for models with two through nine classes have been presented. Decisions on best fitting models have reflected lowest information criterion (AIC, BIC and SSABIC), a Lo Mendell Rubin Likelihood Ratio Test (LRT) where the *k-1* model is superior when compared with *k* model, an entropy close to one and a minimal number of bivariate residuals. Competing models will also be judged on theoretical relevance. Full details of the sources of these criteria, the reference works from which they were derived, and the latent class method are found in chapter two.

3.3.4. Multinomial logistic regression

In the multinomial logistic regression the conditional probabilities of membership of each of the classes in the best fitting model have been saved and used as a dependent variable in a multinomial logistic regression. As a result, the latent classes were formed from drug use variables, and have not been influenced by the predictors in the model. Parameters presented from this model were odds ratios and confidence intervals. This allows illustration of statistical significance of each of the independent variables (whilst controlling for the other independent variables) on the conditional probability of class membership (dependent variable) where the last class (or class with least drug use involvement) was the comparison group. This has provided comparative odds ratios of the other classes with the baseline class. The conceptual diagram, Figure 13 illustrates that the predictors used were gender, employment status, age, educational attainment, area type, current smoking status and hazardous drinking.

To create a model which both fitted the data and provided a parsimonious solution, 2∆ll difference testing was used. This has also illustrated whether classes differ from each other in terms of the different predictors. In practice, a model was run which estimated the parameters freely for each class compared with the baseline class. After this, a fully restricted model was run, which essentially constrains the log odds and as such the odds ratios to be the same for a predictor for all the classes compared to the baseline class. In order to determine which model was best fitting, the 2∆ll difference was compared. To compare the significant differences, the 2∆ll approximates the chi square distribution. Assessment of chi-square distribution tables will illustrate whether there are significant differences between the two groups. If the critical value for chi-square is less than the 2∆ll for a given difference in degrees of freedom between the two competing models, then the differences are significant. If there are no significant differences between the models the more parsimonious restricted solution is favoured. Should the two models be significantly different from each other, the constraints (i.e. the stipulation that one odds ratio will fit all classes for a given predictor compared to the baseline class) has been sequentially relaxed using the largest modification index provided by the Mplus program for each given model. The 2∆ll difference between these models has been assessed for significant differences, with the view that when the two competing models are not significantly different from each other, the more parsimonious solution was preferred. Full details with a worked example of a 2Δll difference test are given in section 2.5.3.

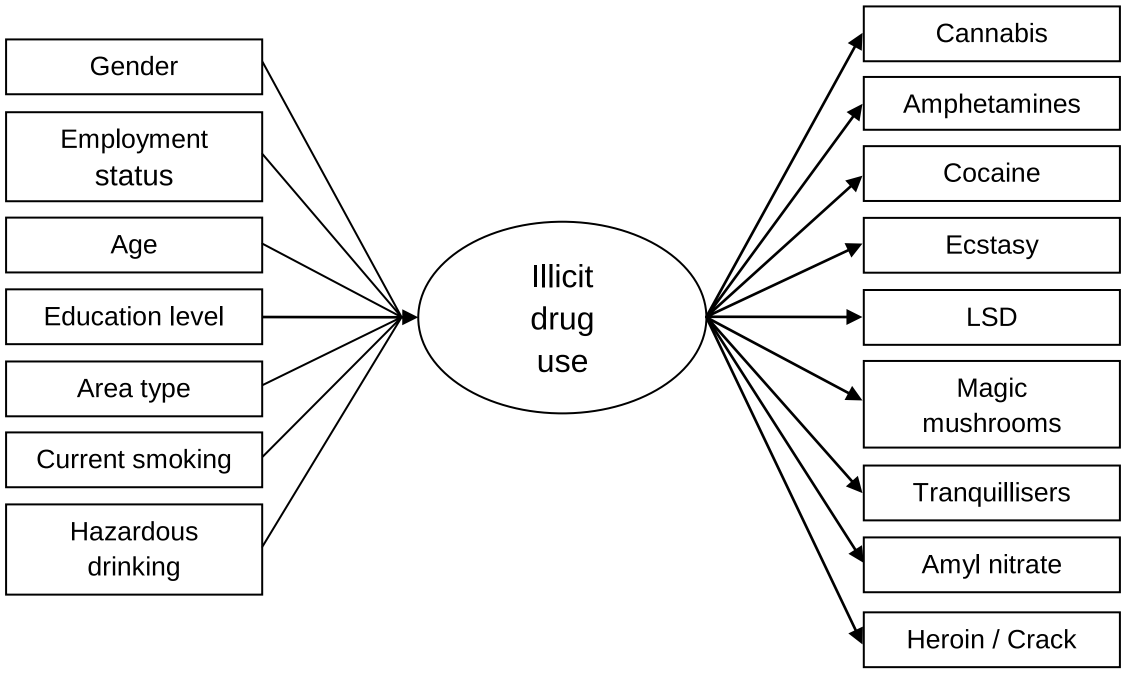

Figure 13: Conceptual diagram of model tested in chapter three.

3.3.5. Software

Data was prepared using SPSS version 15 (SPSS Inc, 2006). Latent class analyses and multinomial logistic regressions were all performed using Mplus version 5.01 (Muthén & Muthén, 2007).

3.4. Results

3.4.1. Frequencies of drugs used

Table 11 illustrates that 91.10% of the population had not used any illicit drug (cannabis, amphetamines, cocaine, ecstasy, amyl nitrate, LSD, magic mushrooms, tranquillisers, or the composite heroin/crack) during the past year. A small percentage, 6.14% of the population had used only one of the above drugs in the past year, which is approximately 69% of those who have used a drug. In terms of a frequency of illicit polydrug use, 31% of the drug users were illicit polydrug users in the past year, equating to 2.76% of the general population of Great Britain at the time of the survey. As the number of drugs being used in the past year increased, the number of individuals using that number decreased.

Table 11: Number of illicit drugs used per year (*over 100% through rounding).

Number of Drugs (n)	Frequency	Percent	Cumulative Percent	Percent of those who used n>0 drugs	Cumulative Percent of those who used n>0 drugs
0	7778	91.10	91.10	-	-
1	524	6.14	97.24	68.95	68.95
2	93	1.09	98.33	12.24	81.19
3	73	.86	99.18	9.61	90.80
4	26	.30	99.48	3.42	94.22
5	29	.34	99.82	3.82	98.04
6	11	.13	99.95	1.45	99.49
7	3	.04	99.99	0.39	99.88
8	1	.01	100.00	0.13	100.01*
Total	8538	100.00		100.01*	

Note shaded area represents those who were not illicit polydrug users in the past year

Predictably, the most common pattern of drug use in the past year was abstention in the general population, followed by the use of cannabis only (as can be seen in Table 12). The use of tranquillisers only was the next most frequent, followed by more typically club drug patterns of use involving cannabis, ecstasy, amphetamines, and cocaine. Notably 11 patterns are reported here given that the last two patterns were equally frequent. There were 78 different patterns of drug use expressed by the population of Great Britain illustrating considerable heterogeneity in patterns of use.

Table 12: Most frequent patterns of response of illicit drug use in the past year.

Most frequent patterns of response **Drug Use**	Frequency (%)	Frequency of pattern amongst all drug users in the sample n=760
No drug use	7778 (91.10%)	N/A
Cannabis only	458 (5.36%)	60.26%
Tranquillisers only	28 (.33%)	3.68%
Cannabis and ecstasy	23 (.27%)	3.03%
Cannabis and amphetamines	23 (.27%)	3.03%
Cannabis, amphetamines and ecstasy	22 (.26%)	2.89%
Cannabis and cocaine	22 (.26%)	2.89%
Amphetamines only	18 (.21%)	2.37%
Cannabis, amphetamines and cocaine	11 (.13%)	1.45%
Cannabis, amphetamines and ecstasy	10 (.12%)	1.32%
Cocaine only	10 (.12%)	1.32%
Total number of individuals in the 11 most frequent response patterns	8403 (98.42%)	N/A
Total number of individuals *not* in the 11 most frequent response patterns	135 (1.58%)	N/A
TOTAL	8538	N/A

3.4.2. Latent class analysis

The fit statistics of two through nine classes are presented below in Table 13. The information criteria AIC and BIC conflict, with the former suggesting an eight-class solution and the latter a two-class solution. However, SSABIC, which is less influenced by sample size, suggested a three-class solution was optimal. According to the LRT, the three-class solution is preferable, and only one of the residuals in this model (of the top 11 most prevalent) was significant. This corresponded to the pattern of cannabis and cocaine illicit polydrug use. However, given that most of the patterns are replicated, this suggests this model fits the data well.

Table 13: Fit statistics of latent class analysis on nine drug variables.

Number of Classes	LL (df)	AIC	BIC	SSABIC	Entropy	Number of Significant Residuals	LRT	p
2	-4293.29 (19)	8624.58	8758.58	8698.20	.98	0	2671.01	.00
3	**-4261.22 (29)**	**8580.45**	**8784.96**	**8692.81**	**.97**	**1**	**63.14**	**.00**
4	-4244.94 (39)	8567.87	8842.91	8718.98	.98	1	32.22	.05
5	-4240.11 (49)	8578.23	8923.79	8768.07	.97	1	9.54	.30
6	-4234.52 (59)	8587.03	9003.12	8815.63	.99	0	11.90	.38
7	-4228.66 (69)	8595.32	9081.92	8862.65	.98	1	11.66	.35
8	-4223.16 (79)	8604.32	9161.46	8910.41	.98	0	12.15	.74
9	-4220.36 (89)	8618.72	9246.37	8963.55	.98	0	5.21	.31

Note: LL(df) loglikelihood value and associated degrees of freedom; LRT Lo-Mendell-Rubin Adjusted likelihood ratio test value; AIC Akaike Information Criterion; BIC Bayesian Information Criterion; SSABIC Sample Size Adjusted Bayesian Information Criterion.

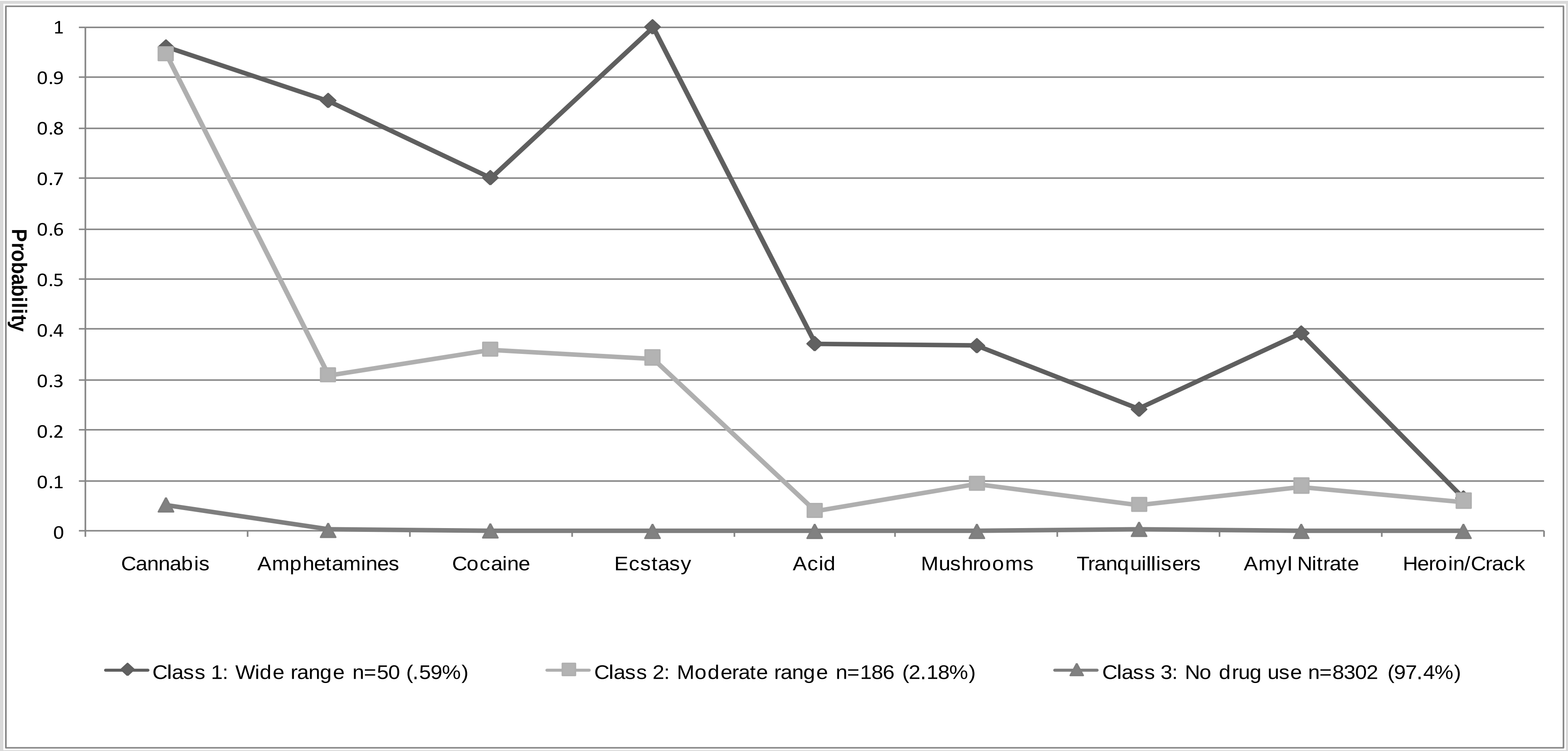

Figure 14: Profile plot of the three illicit polydrug use classes.

As can be seen from Figure 14, responses to the items in latent class 1 indicate a use of cannabis, amphetamines, cocaine, ecstasy and to a lesser extent, LSD, mushrooms, tranquillisers, amyl nitrate and the heroin/crack composite variable. Because of the wide range of drugs used, this group has been labelled as 'wide range' illicit polydrug users. Class 2 has a high probability of using cannabis and a smaller probability of using amphetamines, cocaine and ecstasy, and therefore has been named moderate range illicit polydrug users. A very small proportion of the individuals in class two are using some of the other drugs. Class 3, the largest class with 8302 members have predominantly used no drugs. Consequently, this represents a class with no drug use.

3.4.3. Multinomial logistic regression

The results of the multinomial logistic regression are presented in Table 14. The constrained model which fixed the log odds for the predictor variables to be equal across classes 1 and 2 compared with class 3 did not fit the data well. Two modifications were made to generate the optimal model. This refers to relaxation of the constraints on the variables hazardous drinking (as measured by AUDIT score greater than eight) and age. As can be seen in the model comparisons in Table 14, the p value is less than 0.05 until models 5 and 4 are being compared. Thus, according to this criterion, the null model *k-1* (Model 4) is acceptable.

Table 14: The results of the 2Δll test for the model.

	LL	*Df*	*Model v Model Comparison*	*2 Δ ll*	*Δ df*	*p* value
1.No constraints	-4054.20	43	2 v 1	21.02	7	p <0.05
2. Log odds constraints across all predictors	-4064.71	36	3 v 2	14.34	1	p <0.05
3. Constraints on the log odds to be equal except hazardous drinking	-4057.54	37	4 v 3	5.52	1	p <0.05
4. Constraints on the slope to be equal across all except hazardous drinking and age	**-4054.78**	**38**				
5. Constraints on the log odds to be equal across all except hazardous drinking, age and employment	-4054.56	39	5 v 4	0.44	1	**p >0.05**

The results of the regression model four are given in the below table (Table 15). Individuals in class 2, were over two times more likely to be drinking in a hazardous manner, however, members of class 1 were 11 times more likely to have a hazardous pattern of drinking. Similarly, as age increased by one year, an individual was less likely to be in classes 1 and 2 compared to class 3. This suggests members of these classes were more likely to be younger than the baseline class. Note that those in the class 1 were the most likely to be the youngest with odds ratio .87 compared to .91 for class 2 compared to members of class 3.

Membership of either class 1 or 2 was associated with twice the likelihood of being male compared to those in the reference class 3. Similarly, the members of classes 1 and 2 were 6.81 times more likely to be a current smoker, and almost 1.5 times more likely to be educated past the age of 16 compared to the members of class 3. There were no significant differences in area type or employment status found between the classes.

Table 15: Odds Ratios (95% Confidence Intervals) of the optimum multinomial logistic regression model.

<table>
<tr><td></td><td colspan="2">Odds Ratio (95% CI)</td></tr>
<tr><td></td><td>Class 1
Wide range</td><td>Class 2
Moderate range</td></tr>
<tr><td>Gender (male)</td><td colspan="2">1.94 (1.52-2.47)</td></tr>
<tr><td>Currently smoking (yes)</td><td colspan="2">6.81 (5.25-8.84)</td></tr>
<tr><td>Educational attainment (GCSE level or below)</td><td colspan="2">1.60 (1.26-2.03)</td></tr>
<tr><td>Area type(urban)</td><td colspan="2">1.30 (.99-1.69)</td></tr>
<tr><td>Employment status (economically inactive)</td><td colspan="2">.87 (.67-1.13)</td></tr>
<tr><td>Hazardous drinking (AUDIT score 8+)</td><td>11.00 (5.39-22.42)</td><td>2.31 (1.80-2.98)</td></tr>
<tr><td>Age</td><td>.87 (.85-.90)</td><td>.91 (.90-.92)</td></tr>
</table>

OR (95%CI) in bold are significant

3.5. Discussion

This chapter used latent class analysis to create three typologies of illicit polydrug use patterns in the general population; two classes displayed illicit polydrug use patterns, wide and moderate range users, and one was characteristic of no illicit drug use in the past year. This section will first discuss how these illicit polydrug patterns found in the general population relate to previous research before a consideration of the latent class patterns and their relationship with demographic criteria.

This chapter has illustrated that 8.9% of the population of Great Britain were using illicit drugs in the past year, and of this percentage 31% were illicit polydrug users. This rate of illicit drug use has previously been compared with the Drug Misuse Declared (DMD) surveys (see chapter one), finding greater similarities with the most recent DMD in 2008 (Hoare & Flatley, 2008). A recent survey of the general population of the United States (from the National Epidemiologic Survey of Alcohol and Related Conditions; NESARC), found a lower rate of 6.2% of yearly illicit drug use. Notably though, this rate is considerably less than populations which are ‘rave’ or ‘dance drug populations’ which tend to focus chiefly on drug users in a given environment (Lim et al., 2008). Consequently, these populations are more likely to illicit polydrug use, and their rates of illicit polydrug use tend to be considerably higher than the percentages found in this study. Even using a more selective time frame of illicit drug use in the past 90 days, Sterk et al. (2007) found an illicit polydrug use rate of 98.1% in their opportunistic sample of ecstasy users, which is not reflective of trends in a general population.

From Table 12, it can be seen that the most frequent observed pattern of use was that of cannabis only at 60%. This is consistent with all existing estimates of cannabis use compared to the other illicit drugs, which has already been described in the introduction. This was the most common pattern of illicit drug use in Pederson and Skrondal (1999), with 9.9% of their Oslo youth endorsing this pattern of use. If cannabis is the first illicit drug used in the gateway theory, it would make sense that there might be a number of individuals who stop at this point in the sequence.

Other frequent patterns of observed use include the use of tranquillisers only at 3.68% (or .33% of the total population of Great Britain). A recent study by Simoni-Wastila and Strickler (2004) who assessed the percentage of non-medical use of tranquillisers considered their estimate of 1.45% of the US population to be a conservative estimate. They state that given non-medical use is any non-prescribed, or non-compliant with GP/Doctor instruction and thus statistics relating to tranquillisers may be an underestimate unless this is explicitly stated. The remaining patterns in the 11 most frequent centred on the traditional club drugs of cannabis, ecstasy, amphetamines and cocaine. These drug combinations are the most commonly reported in dance drug samples. Despite the focus of research into ecstasy illicit polydrug use, sole use of ecstasy was uncommon and did not feature in the 11 most common patterns of use. This is supported by previous research including Topp et al. (2004) who found an 88-96% rate of illicit polydrug use in their ecstasy populations.

This chapter has also illustrated that these 78 observed patterns of use are best summarised into three distinct classes. Predictably, the smallest class represented those who used the widest range of drugs. This is backed up by the percentages of individuals using a given number of drugs from Table 11.

Class 2, the moderate range class was over three times greater in magnitude than class 1. However, the largest class was the non-drug use class.

Class 1 was characterised by high probability (above 70%) of using the drugs cannabis, amphetamines, ecstasy and cocaine, with a lower probability of additional use of LSD, magic mushrooms and amyl nitrate. This would appear to be a pattern closely associated with dance drug environments and is similar to the patterns found by Von Sydow et al. (2002) in Munich, Germany. Their study found lifetime ecstasy users were 12 and 17 times more likely to have used cannabis and hallucinogens, with the odds ratios increasing considerably for more recent (and heavier) ecstasy users. Furthermore, this pattern of use was similar to the simultaneous illicit polydrug users in Riley et al. (2001). This study found the use of 'ecstasy and amphetamines' and 'ecstasy, amphetamines and other drugs' (mostly LSD, mushrooms and cocaine) to be common. However, as has been previously noted, this does not include cannabis, as it is difficult to discretely consume cannabis in a nightclub environment. . However, Parker, Aldridge and Measham (1998) illustrated the relaxing effects of cannabis compliment stimulant use, being commonly used to reduce the high, and facilitate sleep. Thus, it is unsurprising class 1 was highly characterised by cannabis use

Class 2 was characterised by moderate range drug use. Like class 1, it had a high probability of cannabis use. However, it differs from class one through a lower probability of amphetamines, cocaine and ecstasy use; members of this class have a typical probability in the range of 30% to 40%. Furthermore, it has extremely low probabilities of use of other illicit drugs which were somewhat characteristic of class 1. Class 3 was characteristic of extremely low (or zero) probabilities for yearly use of all illicit drugs entered into the analysis.

The three-class model of illicit polydrug use proposed in this chapter is inconsistent with alternative classifications as proposed by Forsyth (1996). In this study, the primary dance drugs were amphetamines, nitrites (including amyl nitrate) and ecstasy, the secondary dance drugs were alcohol, cocaine, ketamine, LSD and magic mushrooms and finally the non-dance drugs were tobacco, cannabis and tranquillisers. The divisions Forsyth proposes are not reflected in either class 1 or class 2 probabilities of drug use. Potentially, this is because the majority of members of the general population are not attending events where illicit drug use is common (like a ‘rave’ or ‘night club’). In addition, whilst this classification might still hold in dance drug users, the classification was based on a relatively small sample.

The structure of illicit polydrug use presented in this chapter bears some similarities to previous latent class analyses reported in the introduction. The wide range ecstasy use class identified by Carlson et al. (2005) was somewhat similar to class 1 reported in this study in terms of their amphetamine and cocaine use. Although it is noted that cocaine use in the Carlson study refers to both crack and powder cocaine use; in this study, crack and heroin are assessed as one variable due to their low probability of use in the sample and behavioural similarities. However, their wide range ecstasy users have considerably higher proportions of inhalant, hallucinogen use and opioid (heroin) use to this chapter’s class 1. Their moderate range ecstasy users were similar in their amphetamine use only to the class 2 patterns reported in this chapter.

It is difficult to compare with cannabis use between this analysis and that of Carlson et al. (2005) due to the different way the use was measured; however, this will be addressed in the next chapter addressing the extent of use. Generally speaking, it is difficult to meaningfully compare Carlson and colleagues classes' due to the populations used. Whilst there were some similarities, only two classes were found in this chapter which were likely to have contained ecstasy users.

The latent class structure proposed by Lynskey et al. (2006) of lifetime use in a twin sample was also somewhat similar to the typologies found in this chapter. Characteristics of class 1 in this study shared some similarities with the party drug and illicit polydrug use classes in Lynskey and colleagues' solution. The members of class 1 had similar probability of using cannabis, stimulants (including amphetamines and ecstasy) and cocaine. However, the illicit polydrug use class had much higher probabilities of other drug use compared to class 1. The party drug class was more similar in sedative (including tranquillisers) opiate and inhalant (including amyl nitrate) usage but had much higher probabilities associated with hallucinogens (including LSD & magic mushrooms). There appeared to be no equivalent to the moderate range illicit polydrug use class in this sample. Once again, it is difficult to directly compare the samples, as Lynskey and colleagues profiled use in a twin sample, and the yearly prevalence of twins in the UK is approximately 15 births in every 1000 (Office of National Statistics, 2007). In addition, they measured lifetime use instead of yearly use.

The profiles of the three classes were dissimilar to those reported in the Mitchell and Plunkett (2000) study. They found two classes which were predominated by high probabilities of alcohol with one characterised by a higher probability of using cannabis than the other) and one using a multitude of drugs. Notably this ‘pleural’ drug user class had a considerably lower probability of cocaine use to class 1. Another difference between these two classes was the endorsing the ‘other’ drug use variable in the Mitchell and Plunkett (2000) study, which is not directly comparable to variables used in these chapter’s analyses. It is also difficult to compare these latent class structures given that the Mitchell and Plunkett (2000) study also included alcohol use in its classifications.

The three classes found in this chapter appear to have some face validity. The associations between classes and demographic variables are consistent with theory and previous research. From the results class 1 and 2 can be characterised as more likely to be male, currently smoking and educated to GCSE level or below, when compared with our no illicit polydrug use drug users. The data also suggests that the only differences between members of class 1 and class 2 compared to class 3 represent the likelihood to drink hazardously as measured by the AUDIT and the age of the respondent. Both the illicit drug use groups were around twice as likely to be male. This is supported by Smit et al. (2002). Their clusters of cannabis (with alcohol and tobacco) and cannabis and other illicit drugs (with alcohol and tobacco) found similar odds ratios (1.8 and 2.5 respectively) to those in this chapter. Lynskey et al. (2006) found similar differences in lifetime drug use of an Australian twin sample. Their moderate and party drug users were closest to this figure with odds ratios of 1.6 and 2.0 respectively compared with those who did not use illicit drugs in their lifetime. However, Kelly et al. (2006) found significantly higher use in females of cocaine use, and Carlson et al. (2005) found no significant differences in gender in their latent classes of ecstasy users living in Ohio. Verheyden, Henry, et al. (2003) found that females were using a wider repertoire of drugs than males. However, given that the differences found in this chapter were not drug specific, it could be suggested that dissimilarities with above mentioned research is to be expected due to the variable way in which illicit polydrug use has been measured between studies. It would appear that this solution is strongly supported by research into general population samples such as Chivite- Matthews et al. (2005) who found a ratio of two males for every one female represented in those who used illicit drugs. Similarly, Wadsworth, Simpson, et al., (2004) in their population of Cardiff and Merthyr Tydfil found their illicit drug users to be .58 times less likely to be female. Finally, data from the NESARC study also supports a greater proportion of males than females amongst illicit drug users (Falk et al., 2008).

The membership of illicit polydrug use classes 1 and 2 reflect an increased likelihood of being educated to GCSE level or below (OR=1.60). This is consistent with previous research such as Lieb et al. (2002) who found that their illicit drug users were less likely to have been university educated compared with those who did not use illicit drugs. Support also comes from an adolescent study which found increased involvement in education was a protective factor against the use of illicit drugs (Smit et al., 2002). However, two studies have found that education was related to increased education. The first of these, Wadsworth, Simpson, et al., (2004) in their study of those living in Cardiff and Merthyr Tydfil found those who had used any illicit drug were likely to be of a higher education than those who did not use illicit drugs. Furthermore, there was a rate of 45% and 46% of cannabis lifetime use in medical students (Newbury-Birch et al., 2000) and students from a wide range of faculties (Webb et al., 1996), suggesting that the illicit drug use is not confined to those who have achieved lower educational attainments.

Two of the predictors were not significantly different between class memberships; these were employment status and area type. Previous literature examining the relationship between drug use and economic activity would appear to suggest a relationship. For example, Lieb et al. (2002) found economic inactivity to be related to ecstasy and other stimulant use compared with both illicit drug users (who did not use these drugs) and lifetime abstainers from drug use (OR's= 4.13 and 3.60 respectively). Given the percentages of ecstasy and other stimulant drugs in particularly the members of class 1, this finding is somewhat surprising. The finding of no urban/rural differences is more expected as Forsyth and Barnard (1999) found drug specific differences in comparison of their urban and rural areas, and no significant differences overall. Of the drugs the authors found to be significantly different, ecstasy and LSD were found to be more associated with urban residents, but magic mushrooms and heroin were more related to rural dwellers. Given the relationship of these drugs with the latent class typologies in this chapter, further evidence is provided to illustrate the importance of measurement in elucidating demographic difference.

This chapter described the membership of either latent class 1 or 2 appeared to increase the likelihood of smoking by 6.81 times compared to the members of the class 3. This is of very similar magnitude to Von Sydow et al. (2002) who found their current and regular ecstasy users were 6.9 times more likely to smoke. Whilst we cannot estimate the amounts of drugs used by either of these two latent classes at this point, the differences in Von Sydow et al. (2002) findings could be attributed to either ecstasy or the range of other drugs used by this group. As the members of classes 1 and 2 were equally more likely to be currently smoking; this is further evidence that illicit drug use relates to tobacco consumption. This is supported by Pedersen and Skrondal (1999). They also found odds ratios of around seven between their researcher selected group of amphetamines and ecstasy compared to those who did not use illicit drugs. This suggests that any drug use increases the risk, as these categories had some other differences in terms of their drug use.

Conversely, there were characteristic differences between the wide and moderate latent classes regarding hazardous drinking status. Whilst they were both significantly related to this level of alcohol use and related problems, there were considerable differences in magnitude between the two classes compared to the characteristics of the baseline class. This suggests that the wider the range of drug use as was characteristic of class 1, the more likely an individual is to be hazardous drinking. Similar results were found by Lynskey et al. (2006) where their ‘polydrug’ using class, who had the widest range of lifetime drug use were 7.6 times more likely to be alcohol dependent compared to their class of lifetime abstainers from illicit polydrug use. Parker et al. (1998) also found that of their young adult cohort, almost 35% of their current drug users were also drinking every day.

The magnitude of the odds ratio characteristic of class 2 in relation to hazardous drinking was considerably lower (OR= 2.31). However, this is similar to those who had used any illicit drugs as found by Wadsworth, Simpson, et al. (2004a). The authors concluded that illicit drug users were 2.4 times more likely to be drinking alcohol over the recommended limits.

The finding that ‘moderate’ and ‘wide range’ drug users are 6 times more likely to be smokers and between 2 and 12 times more likely to be hazardous drinkers would suggest that the tradition of separating the three drugs in research (Williams & Parker, 2001) might be simplistic. Whilst in cross-sectional research causal inferences are difficult to establish; nevertheless, the results of hazardous drinking, as a mediating variable, between the two more numerous classes of drug user indicates an important link between drug use and alcohol. Further research may also wish to link alcohol and smoking into these patterns of illicit polydrug use.

The variables of age and hazardous drinking which differed according to whether an individual was in the wide or medium range drug use patterns lend tentative support to Williams and Parker's (2001) statement that 'delayed moderation of use could cause serious health problems'. The 'moderate range' illicit polydrug users were slightly younger compared with the 'wide range' illicit polydrug users. This effect of age is reflected in the work of others (Pedersen & Skrondal, 1999; Degenhardt et al., 2004; Topp et al., 2004; McCambridge et al., 2005).

Whilst self-report data can be falsified in any population or survey-based data, this should be less likely to impact this research given that the questions on drug abuse were self-completed by the respondent and may eliminate expectation bias (Topp *et al.*, 2004). Additionally, inclusion of a fictional drug 'semeron' to attempt to highlight individuals who may report spurious use of drugs also offers some safeguard. It is often a criticism of population surveys that they neglect student or institution data and thus important patterns of use (Ramsey & Percy, 1996; Feigelman et al. 1998). However, this chapter illustrates a way for these other populations to be analysed, and in the umbrella of surveys carried out by the OCPS, prison inmates and homeless individuals were also participating in separate divisions using the same instrument, facilitating comparisons. Investigations using similar techniques to this chapter could compare these illicit polydrug use patterns. This chapter has drawn from several self-selecting or purposive sampling data from previous published work illustrating some similarities and differences to the analyses contained within. The methodology used might help to move away from drug specific work, to find patterns of use which can explain the multiple varieties of simultaneous and concurrent illicit polydrug use.

In the present analysis yearly use was taken to be the most useful indicator of drug taking behaviour. Lifetime use, as Shiner and Newburn (1997) concede, often overestimates drug use rates, primarily because someone who has tried a drug once is grouped in the same category as a chronic drug user. Conversely, occasional drug users are unlikely to be adequately represented in monthly reports (Ramsey & Percy, 1996). Furthermore, longer reference periods like one year are good for assessing behaviour and problems (Dawson, 2003). This measure of drug use also falls in line with the British Crime Survey reports (Chivite-Matthews *et al.*, 2005). Using this indicator, concurrent illicit polydrug use is the most likely type; however, use in this sample may also involve some simultaneous use. In addition, it is regrettable that there is no inference of quantity, frequency or duration of use; however, it has been tentatively suggested by Carlson *et al.* (2005) that those who use a wider range of drugs tend to use more of each drug in the range.

Comparisons with similar research often presents conflicting results, as the number and type of drugs in the analysis is frequently different. In this chapter, as many drugs as possible were kept in the analysis that would not affect model identification (see chapter two). From this study and the possibility of others using respondent driven methods there is scope to assess the effect of current psychological status of these patterns of illicit polydrug use.

Finally, a number of analyses have a priori decided to create a forced class of no use (e.g. Mitchell and Plunkett, 2000). Whilst it may have been preferable to have forced this class to be no drug users, the deciding of characteristics of the ‘control’ group is often fraught with difficulty (Dafters et al., 2004). However, unlike Dafters and colleagues, whilst we could have enforced a no use group on the data, it was considered more appropriate in the context of the objectives to allow the heterogeneity of the patterns of illicit drug use to shape class characteristics. This represents a move towards a person-centred approach to illicit drug use behaviour.

In conclusion, this chapter has described the extent of heterogeneity in patterns of illicit drug use in the population of Great Britain. This can be expressed as three different latent classes of illicit drug use behaviour which have key demographic criteria, which can provide further information on patterns of use. Future research might wish to examine the extent of drug use in these classes to elicit the frequency of involvement and validate the classes as being distinctly different from each other in terms of their drug use. The next chapter explores each latent class in terms of its use of component drugs.

4. Validating the latent class structure of illicit polydrug use in Great Britain: Does lifetime consumption of drugs differ between classes?

4.1. Abstract

Chapter three has proposed illicit polydrug use could be explained in terms of three latent classes: ‘no drug’, ‘moderate range’ or ‘wide range’ illicit polydrug users. The validity of this model of illicit polydrug use requires assessment in terms of its ability to account for different quantities of drug consumption. This chapter aimed to determine if there were significant differences in the lifetime consumption of four of the most frequently used drugs in the sample. This chapter used data from the NPMS study conducted in Great Britain (n=8538). A multivariate analysis of covariance (MANCOVA) was used to compare self-reported estimates of frequency of lifetime drug use. The independent variable was illicit polydrug class, of which there were three levels (class 1 ‘wide range’, class 2 ‘moderate range’ and class 3 ‘no drug’ users). The dependent variables were self-reported lifetime frequency estimates of cannabis, ecstasy, amphetamines and cocaine use. Age was entered as a covariate. A significant main effect was found for the effect of all drugs used $F(8, 17064) = 1494.06$; $p < .000$; Pillai’s trace= 0.82; partial $\eta^2 = 0.41$. In addition, a linear contrast was found to fit the data with a significant decrease in lifetime frequency of use from class 1 to 3. Lifetime frequency of ecstasy use was found to vary most between classes, followed by use of amphetamines, cocaine and cannabis. The highest frequencies of drug use were found in the wide range drug users. This illustrates a continuum of wider drug use relating to greater lifetime frequency of use for each component drug in a given class.

4.2. Introduction

In chapter three, illicit polydrug use was defined in the context of use in the past year. Three classes emerged from a latent class analysis. The classes were labelled ‘wide range’, ‘moderate range’ and ‘no illicit drug’ users. However, these profiles describe the range of drugs being used but make no inferences to the extent of use of each drug in the three latent classes. The endorsement of a drug in one of the latent classes could represent either experimental use or prolonged consumption.

Pharmacological and addiction research suggest that negative consequences of drug use, including fatalities are implicated with dose and frequency of ingestion (Hammersley et al., 1999). In addition, the impact of drug use on mental health is affected by both the range of illicit polydrug use and the extent of use of each drug in an illicit polydrug use pattern (Guillot, 2007). Prior to further investigation as to the implications of the patterns of illicit polydrug use, it will be important to determine broad estimates of the extent to which drugs have been used in each of the three classes, i.e. the level of lifetime consumption of each drug.

Whilst there are numerous studies to suggest that wider range drug users are consuming more of each drug these have been over multiple time periods and use a variety of different techniques. For example, using a bivariate approach, Daumann et al. (2004) found higher lifetime dosage of ecstasy use was correlated with higher lifetime dosage of amphetamine use (r=.47). Those who had used both ecstasy and amphetamines in an illicit polydrug use pattern also had a higher mean duration of regular use and a higher mean frequency of use than those who did not. The duration of regular ecstasy use was also moderately correlated with the duration of regular use of cannabis (r=.42). This suggests an increase in the extent of other drugs such as cannabis and amphetamines.

Proxy measures of extent the of drug misuse have also been used. Lynskey et al. (2006) did not measure the frequency of drug use directly. However, they did assess the relationship between at least one symptom of abuse or dependence of cannabis, cocaine/stimulants, sedatives or opiates in a given latent class membership. It is suggested that certain levels of consumption must be present for either abuse or dependence to occur, and, this could be considered a proxy measure for extent of use. The classes of lifetime drug use found in their Australian twin sample (n=6525) have already been described in chapter three; briefly these reflected groups of low use, moderate use, party drugs, opioids/sedatives and 'polydrug' users. These broadly reflect a continuum of number of drugs used in a lifetime increasing as move from the low to polydrug use classes. As this continuum increased in polydrug use involvement, the percentage of individuals having at least one symptom of abuse or dependence also increased. Of the members in the illicit polydrug using class, 85% had one or more symptom of abuse or dependence on cannabis. Furthermore, 55% and 20% of the members of this class had one or more symptom of abuse or dependence on 'cocaine or stimulants' and sedatives respectively. The opioid class, class four were more likely to have any symptoms of opioid abuse or dependence.

Scholey et al. (2004) in an internet study of night club drug users focussing particularly on ecstasy use remarked that if individuals were older they would have the potential to use drugs for longer, and thus have consumed a larger quantity in their lifetime. This study used chi-square calculations to illustrate whether the frequency of ecstasy use was able to predict the frequency of use of other drugs. In these either 2*4 or 3*4 contingency tables, the extent of involvement with ecstasy use was significantly related with the extent of involvement with other illicit drugs. However, this method is limited in approach, as it takes a global view for all items in the contingency table; significances were found when some of the percentage differences between two groups were 1% or less in the table. There was also neither an estimation of the size of the significant effect nor any testing pairwise of differences. This may have been able to illuminate where the differences lay, facilitating direct comparisons with classes of illicit drug use found in chapter three.

Milani, Parrott, Turner and Fox (2004) compared two groups of ecstasy users, heavy (use greater than 20 times) and light (use between one and 20 times) in terms of differences of other drug use. This study found heavy ecstasy users were more likely to use cocaine, amphetamine, LSD, magic mushrooms, poppers and ketamine compared to the light ecstasy use group. There were also significant gender differences expressed particularly in the heavy consumption group with males more likely to be using amphetamines, opiates, poppers and ketamine. Whilst the differences between the two groups were clear by the percentages presented, the authors only conducted significance tests between gender in a given pattern of ecstasy use. They did not test statistical differences between patterns of ecstasy illicit polydrug use consumption, which makes it difficult to lend weight to their conclusions. However, they suggest that heavier ecstasy use is related to a wider range of drugs being used.

In an opportunity sample of young adults (n= 280) Milani, Parrott, Schifano and Turner (2005) compared five researcher chosen groups of drug users. These groups were based on the extent of their cannabis use, and represented ‘cannabis abstinent controls’, ‘current monthly users’, ‘current weekly users’, ‘current daily users’ and ‘former heavy users’ (no use in the past year, but prior daily use). They found a linear trend between extent of cannabis use and that of other drugs being used. The highest level of additional drug consumption was found in the two groups who were either former or current heavy users (daily use). This suggests that frequent use of cannabis predicts frequent use of other drugs.

Dafters et al. (2004) assessed the differences in lifetime consumption across four groups, ‘no illicit drug use’ controls, ‘cannabis only’, ‘cannabis and ecstasy light’ users and ‘cannabis and ecstasy heavy’ users. Those who were in the ecstasy using groups (whether light or heavy) were more likely (by mean number of lifetime uses) to have used amphetamines, cocaine and heroin than the cannabis use only group. Those in the heavy ecstasy (and cannabis) use group had a higher lifetime consumption of LSD compared to the cannabis only group. However, not all these differences were tested for statistical significance. However, there were similarities in the mean number of lifetime uses of cannabis between the cannabis only and the two ecstasy and cannabis use groups. Whilst there was an increasing percentage trend as progressed from cannabis only to heavy ecstasy and cannabis use, it was not found to be significantly different using ANOVA.

A recent study in adolescents aged 14 to 15 (n=3919) assessed the differences in other drug consumption focussing on cannabis use (McCrystal, Percy & Higgins, 2007). The authors assessed the frequency of other drug use between three groups, no cannabis use, low frequency cannabis users and high frequency cannabis users. As the involvement in cannabis use increased, so too did percentage rates of the use of other illicit drugs. These trends were found to be significant using chi-squared tests. This suggests that increased involvement with cannabis is associated with increased likelihood of the use of other drugs.

Demographic trends associated with heavier drug use might also suggest that a wider range of illicit drugs used relates to heavier use patterns. For example, in a snowball sample of ecstasy users in Atlanta, Georgia, Sterk et al. (2007) found the heaviest patterns of ecstasy use in males. Latent class patterns of illicit polydrug use presented in chapter three found the members of the wide range illicit polydrug use class were most likely to be male. Therefore, this suggests that wider ranges of illicit polydrug use may reflect larger consumption patterns in the general population of Great Britain.

Carlson et al. (2005) also found some evidence for heavier use in wider range of drug use patterns. The patterns of drug use found in their sample of ecstasy users living in Ohio reflected three patterns of use: ‘wide’, ‘moderate’ and ‘limited’ range ecstasy users. Supporting evidence that extent of use relates to width of drug use pattern is primarily found in the cannabis and alcohol use frequencies. Their wide range ecstasy use class had the greatest probability of drunkenness beyond the mean days in the sample per month. Of the members in this class, 62% endorsed this item; a higher probability than the members of either the ‘moderate’ range (27%) or the members of the ‘limited; range class (19%). The members of the ‘wide’ range ecstasy users also had the highest probability of using cannabis daily (56%) compared with 42% and 19% for moderate and limited range ecstasy users respectively.

Furthermore, the authors used multinomial logistic regression to predict frequency of ecstasy use between class memberships. Individuals in the wide and moderate range groups were 14.66 and 4.13 times more likely respectively to have used ecstasy over 50 times in their lifetime compared with the limited range ecstasy use class. In addition, the wide range class was 6.38 times more likely to have used ecstasy 10-50 times in their lifetime compared with the baseline limited range group. No significant differences were found between the moderate range and limited range classes on this lifetime frequency of ecstasy use. This is a clear indication that the wider the range of drugs, the greater the quantity used of each of the component drugs in the range (as expressed by latent class pattern).

In conclusion, evidence from both researcher and empirically derived patterns of illicit polydrug users would suggest the wider the range in a pattern of use, the higher the quantity of each component drug. However, it could be that in the general population, wide range illicit polydrug users may either extensively use more drugs throughout the year or perhaps using a wider range of drugs, but only once in that year. Therefore, inferring that a particular drug has influence on any outcome variable may be spurious and the validity of the classes could be questioned. This chapter will attempt to quantify drug misuse in each of the three latent classes found in the Great British population from chapter three, wide range, moderate range and no drug use. It is hypothesised that the wider the range of the drugs used, the larger the extent of involvement in a particular drug. Given that the older an individual is, the greater the exposure opportunity would be to use illicit drugs; therefore, age will also be controlled for as a covariate.

4.3. Method

4.3.1. Participants, data and sampling

The data used in this chapter was taken from the NPMS (Singleton et al., 2001a; 2001b). This was conducted using a stratified multi-stage probability sample of households in England, Scotland and Wales. Analyses were performed on 8538 individuals who answered the drug use section, excluding the 42 participants in the study who either did not answer the drug use section or endorsed the use of ‘semeron’ in their lifetime. The mean age of the sample was 45.34 years (SD=15.59 years). Females represented 54.08% of the sample. Further details of the survey’s data, participants and sampling procedures can be found in chapter two.

4.3.2. Measures

A between subjects multivariate analysis of covariance (MANCOVA) was performed on four dependent variables. These represented the amount of four illicit drugs used by an individual in their lifetime. These were cannabis, amphetamines, cocaine and ecstasy. Note that these are the most frequently used illicit drugs in the European Union and Norway not just in the UK (EMCDDA, 2008). The question was “How many times have you ever used *named drug*” (p. 74; Singleton et al., 2002). All the dependent variables were measured on a scale with ‘0’ indicating no use, ‘1’ less than 10 times, ‘2’ 10-100 times and ‘3’ more than 100 times.

The independent variable was illicit polydrug use class, which had three levels: ‘wide range’, ‘moderate range’ and ‘no drug’ users. This represents the most likely latent class for each participant in the dataset derived from the latent class analysis of four illicit drugs provided in chapter four.

In addition, the age of participants was controlled for in the analysis as a covariate. The older an individual was the higher the potential lifetime total, for two reasons. Firstly, there is a greater time opportunity to consume more drugs and secondly, there is more time to progress in frequency of use in a given drug using career. Using age as covariate in this way reflects a similar methodological strategy to other work in the field, for example research by Scholey et al. (2004) into extent of illicit polydrug use patterns in ecstasy users.

Several of the assumptions underlying MANCOVA were violated in this study; however, the analysis was intended to be descriptive rather than inferential. Firstly, assumptions regarding homogeneity of variance-covariance matrices were violated[4]. Coupled with this, n values for the levels of the independent variable were of unequal numbers. Pillai's trace was used in favour of other statistics given its robust nature with data issues such as these (Tabachnick & Fidell, 2006). If an overall significant effect was found between the levels of latent classes and the level of consumption of drugs, pairwise comparisons were performed to illustrate where the significant differences lay. To reduce the chance of Type I errors, a Bonferroni adjustment was performed giving an adjusted alpha value of .013[5] which equates to an overall alpha of .05.

4.3.3. Software

All analyses were conducted in SPSS version 15 (SPSS Inc, 2006). Graphic illustrations of the Estimated Marginal Means were achieved in Microsoft® Excel Vista.

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[4] Box's M test of equality of covariance matrices was significant (Box's M=52207.93; $F_{(20,67434.78)} = 2561.32$; $p < .005$).

[5] There were 36 comparisons across all four dependent variables and three levels of independent variables

4.4. Results

Table 16 shows the frequency of use across the lifespan. Most of the sample had never used any of the four illicit drugs, whether cannabis, cocaine, ecstasy or amphetamines. Of those who had used illicit drugs during their lifetime, the most frequent category illustrating extent of involvement for cannabis reflected use over 100 times. For amphetamines, ecstasy and cocaine, the pattern was slightly different. For these drugs, the most frequently endorsed use category was between 10 and 100 times. There was some evidence of experimental use, where use did not exceed 10 times for all four drugs.

Table 16: Frequency of drug use consumption in the general population of the UK.

	No use in past year (0)	Less than 10 times (1)	10-100 times (2)	More than 100 times (3)
Cannabis	7854 (91.99%)	134 (1.57%)	241 (2.82%)	309 (3.62%)
Amphetamines	8406 (98.45%)	39 (.46%)	65 (.76%)	28 (.33%)
Ecstasy	8405 (98.44%)	36 (.42%)	70 (.82%)	27 (.32%)
Cocaine	8411 (98.51%)	55 (.64%)	58 (.68%)	14 (.16%)

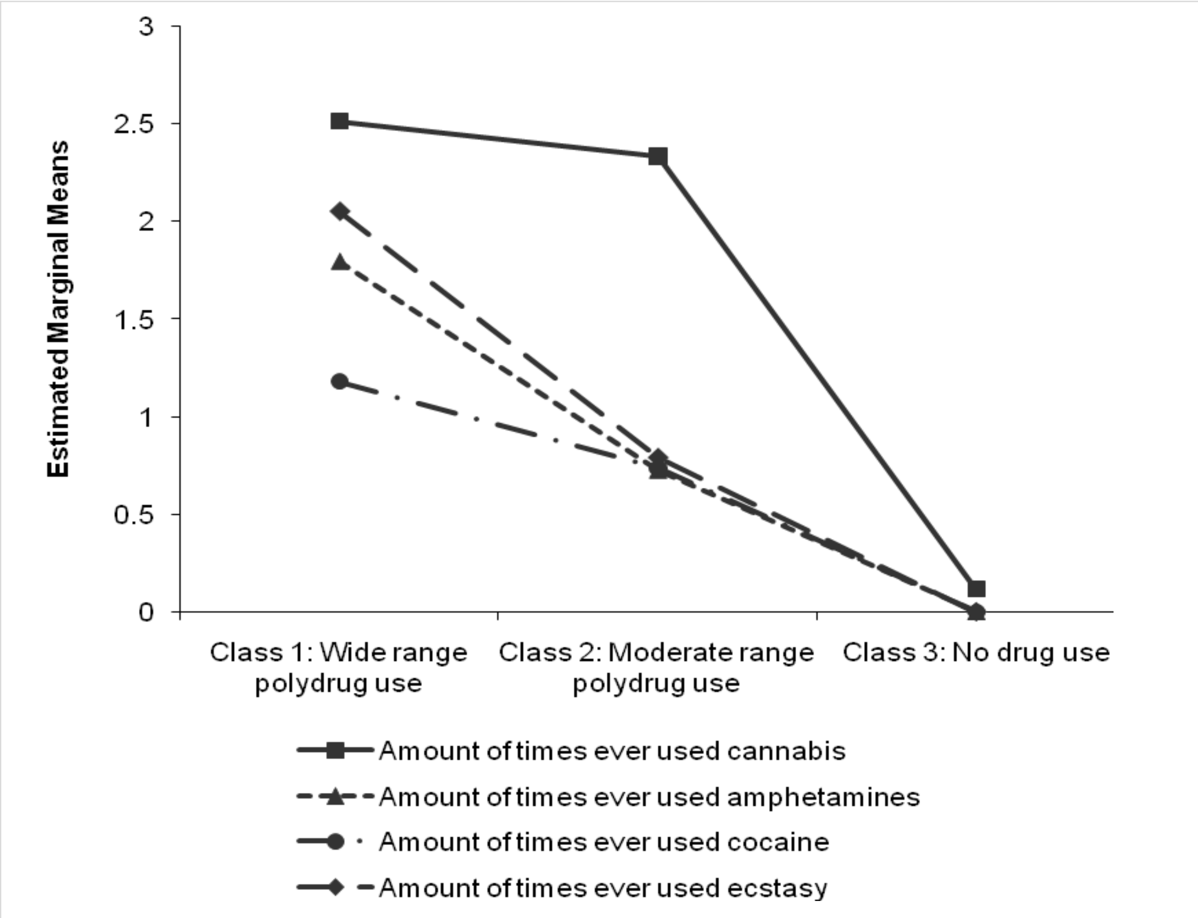
There was a statistically significant difference of class membership (the independent variable) on the four dependent variables representing the amount of lifetime use of cannabis, ecstasy, amphetamines and cocaine ($F(8,17064)= 1494.06$; $p<.000$; Pillai's Trace= .82; partial $\eta^2 = .41$). The effect of age (as a covariate) on the combined effect of the dependent variables also reached statistical significance $F(4,8531) = 98.86$; $p<.000$; Pillai's Trace = .04, although the effect size was notably low (partial $\eta^2 = .04$).

Table 17: Results of MANCOVA of class membership (IV) on amount of lifetime use of four drugs (DV's)

	Dependent Variable	Sum of squares	*df*	Mean squares	F ratio	p value	Partial η^2
Class	How many times used cannabis?	1121.62	2	560.81	2183.34	.00	.34
	How many times used amphetamines?	244.19	2	122.10	3600.22	.00	.46
	How many times used ecstasy?	309.55	2	154.77	5769.06	.00	.58
	How many times used cocaine?	159.56	2	79.779	2808.43	.00	.40
Age	How many times used cannabis?	100.94	1	100.94	392.99	.00	.04
	How many times used amphetamines?	.05	1	.05	1.53	.22	.00
	How many times used ecstasy?	.10	1	.10	0.39	.05	.00
	How many times used cocaine?	0.01	1	0.01	3.80	.53	.00

The independent variable of illicit polydrug use class had the strongest effect on amount of times ever used ecstasy $F(2, 8534) = 5769.06$; $p<.000$; partial $\eta^2 = .58$. Class had the weakest effect on the amount of times ever used cannabis, however, this was still significant $F(2, 8534) = 2183.34$; $p<.000$; partial $\eta^2 = 0.34$. Significant differences were also found across classes for the amount of times ever used both cocaine and amphetamines. A polynomial contrast was applied to the data. A linear trend was significant for all dependent variables showing a decline in amount of cannabis, amphetamines, cocaine and ecstasy used from class 1 to class 3. An illustration of this significant change in estimated marginal means across all variables is given in Figure 15. This also showed differences between classes 1 and 2 were slight for times ever used cannabis, but more pronounced for the amount of times ever used ecstasy.

Figure 15: Illustration of the estimated marginal means for each of four drugs in the three illicit polydrug use classes.



Note: 0= no use; 1=<10 times used; 2=10-100 times used; 3=>100 times used in lifetime.

From these estimated marginal means, class 1, the wide range illicit polydrug use class, was characterised as having two drugs with a mean lifetime use of over two (i.e.10-100 times used in lifetime). These were ecstasy (M= 2.06) and cannabis (M=2.51). In class 2, moderate range illicit polydrug use class, only the number of times ever used cannabis was above two (M= 2.33). Furthermore, only the members in class 1 had all four drugs with lifetime use of above one (indicating up to ten times used) but below two (indicating in the range of10-100 times used), with amphetamines (M=1.80) and cocaine (M=1.18). The amount of all remaining drugs in all remaining classes was less than ten times.

These estimated marginal means were subject to pairwise comparisons between classes or levels of the independent variable with a Bonferroni adjustment. The mean differences were summarised and are presented in Table 18. All comparisons were found to be significantly different amongst classes and lifetime use of these drugs, with the only exception being the amount of times cannabis was used in lifetime between the members of classes 1 and 2 (mean difference =.18; 95% CI = -.01-.37; p=.080). The largest differences between all three classes and over all four drugs were found between classes 1 and 3.

Table 18: Mean differences between the three classes in terms of the amount of times ever used one of four drugs.

	Comparison between classes		Mean difference	Standard error	P value
Amount of times ever used cannabis	Class 1	Class 2	.18	.08	.08
	Class 1	Class 3	2.39	.07	.00
	Class 2	Class 3	2.22	.04	.00
Amount of times ever used amphetamines	Class 1	Class 2	1.07	.03	.00
	Class 1	Class 3	1.79	.03	.00
	Class 2	Class 3	.73	.01	.00
Amount of times ever used cocaine	Class 1	Class 2	.44	.03	.00
	Class 1	Class 3	1.18	.02	.00
	Class 2	Class 3	.74	.01	.00
Amount of times ever used ecstasy	Class 1	Class 2	1.26	.03	.00
	Class 1	Class 3	2.05	.02	.00
	Class 2	Class 3	.79	.01	.00

Bonferroni adjustment for 36 comparisons; p value .013

4.5. Discussion

This chapter has illuminated quantifiable differences in the number of times the four most prevalent illicit drugs were ever used in Great Britain between the three illicit polydrug use classes. These further validate the members of the wide range (1), moderate range (2) and no drug use (3) classes as having distinct characteristics which are common to the membership of a class, but different between classes. The effect of class was significant, suggesting that the characteristic mean amount of drugs used declined when moving from class 1 to class 3 whilst controlling for the effects of age.

Class 3 was found to have the highest level of all four drugs used overall. This is strongly supported by previous research. Scholey et al. (2004) found significant global chi-square differences of extent of ecstasy use and of other illicit drugs. The authors suggested from this that wider range illicit polydrug use was associated with higher individual drug consumption. Milani et al. (2004), in comparing their light ecstasy users (use between one and 20 times) and comparisons of heavy ecstasy users (greater than 20 times used) also lend support. Their heavy ecstasy users had a wider range and quantity of other drugs used. However, on average those in class 1 were consuming ecstasy and cannabis over 100 times in their lifetime. This class also on average consumed cocaine and amphetamines between 10 and 100 times during their lifetime. As mentioned previously, cannabis is often considered to be more closely related to alcohol in terms of its perceived harm (EC, 2008; Nordentoft & Hjortoj, 2007), and it is unsurprising that the frequency of lifetime use reflects this. In addition, Milani et al. (2005) found their current daily cannabis users were most likely to have used additional drugs in greater quantities. Thus, it could be proposed that high levels of lifetime use of one drug are universally related to high levels of other drugs.

The average lifetime frequencies of use of class 2 provide some counter evidence to this statement. Members of class 2 were typically using cannabis over 100 times, but amphetamines, cocaine and ecstasy were ingested less than 10 times during the lifetime. This suggests that cannabis use was the primary drug of use in this class, with a more experimental approach to other drugs being used. Consequently, high levels of lifetime use of one drug seem to indicate that perhaps there are higher levels of other drugs in a given illicit polydrug use pattern.

Class 3 was distinct from the other two classes. It was characterised by no drug use in the past year in chapter three. In this chapter it has been illuminated this class is characteristic of extremely low levels of cannabis use, and no lifetime use of amphetamines, cocaine, and ecstasy.

The greatest effect of class was found on the frequency of lifetime ecstasy use with the least effect on the frequency of lifetime cannabis use. This would suggest that lifetime consumption of ecstasy differs most across classes followed by amphetamine, cocaine and cannabis. The frequency of ecstasy use found in the wide and moderate ecstasy use latent classes in Carlson et al.'s (2005) sample was similar. The authors found these classes were respectively 15 and four times more likely to use this drug more than 50 times in their lifetime than their limited range ecstasy user class. The frequency of ecstasy use found in class 1 is somewhat similar to Carlson and colleagues' wide and moderate ecstasy use classes; the mean lifetime frequency of ecstasy use in class 1 illustrated use above 10-100 times. The characteristics of those in class 2, however, would appear to reflect somewhat more experimental use of ecstasy with use, just under 10 times. This would suggest that models of illicit polydrug use, which use ecstasy as the basis of a latent class analysis, may have limited comparability to general population surveys. Furthermore, Carlson et al. (2005) found three patterns of ecstasy user, however, a similar number were not found in this current dataset.

There is some support for the division of ecstasy by quantity in Milani et al. (2004). They grouped their lifetime ecstasy users into groups of heavy (use greater than 20 times) and light (less than 20 times but at least once) use. The former of these is somewhat alike class 1 and latter more characteristic of class 2. However, whilst the cut off points might be validated by this research, there are some theoretical caveats. The nomenclature of these groups attributes any significant relationships that these groups to ecstasy, when both the study by Milani et al. (2004) and analyses conducted to date in this thesis have described considerable illicit polydrug use in ecstasy users with given lifetime quantities of use. Thus the name ecstasy polydrug user does not encompass behaviour within a class.

Note that the proportion of cannabis did not differ between the members of latent class 1 and 2. This is supported by Dafters et al. (2004) who found no significant differences between cannabis use in their researcher selected categories of 'cannabis only', 'cannabis and light ecstasy use', and 'cannabis and heavy ecstasy use'. In addition, this provides some support for the gateway theory (Kandel, 2002; Kandel & Faust, 1975). The sequence suggests cannabis is the first illicit drug of use, followed by ecstasy, amphetamines and finally cocaine use. This is similar to a pattern derived by Pedersen and Skrondal (1999) in a sample of 10812 adolescents living in Oslo, who hypothesised that the sequence of use after licit drugs was cannabis, amphetamines, ecstasy and heroin, where the positions of amphetamines and ecstasy are interchangeable in the sequence. Cocaine use, which has been assessed in this chapter, was not one of the drugs included by the authors in their analysis.

Scholey et al. (2004) also suggested that age would be related to lifetime consumption of illicit drugs. A significant relationship was found between quantity of lifetime cannabis use and age in this chapter, although the effect size was low. The relationship between lifetime quantity of ecstasy use and age was close to significance, however, age was not significantly related to the quantity of either lifetime cocaine or amphetamine use.

In terms of limitations of this approach, we are unable to assess the level of drug involvement in the other drugs given the varying size of the drug classes proposed, and the low probability of endorsement across all classes. However, as stated above the four most frequently used illicit drugs were included which enabled comparisons to be made across all three classes.

In conclusion, this chapter lends support to other work which suggests that those who use drugs in a wider pattern of illicit polydrug use are more likely to be consuming more of each component drug in their illicit polydrug use pattern. Given the hypothesised relationship between dosage of drugs used and psychological harm, this chapter has provided context on more common trends of extent of use in each of the polydrug use groups. This will contribute to the elucidation of relationships between illicit drugs and mental health to be considered in the following chapter.

5. The latent class structure of illicit polydrug use in Great Britain: Relationship with psychological health.

5.1. Abstract

Links have been made between poor psychological health and drug use, but the relationship is affected by the illicit polydrug nature of drug consumption. This chapter aims to use drug use typologies generated through latent class analysis from chapter three to determine the relationship between poorer psychological status and the three typologies of illicit polydrug use. A latent class analysis regression model was run which estimated the relationship between current psychological status and the wide range, moderate range and no drug use classes. Data used was from the 2000 NPMS (n=8538). Beyond predicted relationships with demographic variables found in chapter three, illicit polydrug users in classes 1 and 2 were significantly more likely to have mixed anxiety and depressive disorder, depressive episode and have attempted suicide in their lifetime compared to the no drug use class. Profiles of illicit polydrug use derived from data illuminated that both the 'wide' and 'moderate' range illicit polydrug user had the most likely demographic profile for mental health disorders, however, the magnitude of this risk did not differ between the two typologies in comparison to baseline class of no drug use. Thus, any illicit drug use might be considered to increase the risk.

5.2. Introduction

The primary work illustrating comorbidity between psychological status in the general population and illicit drug use comes from data examining drug abuse and dependence (Newcomb, Scheier & Bentler, 1993). A recent review of this area assessing the relationships between common mental disorders and abuse or dependence found anxiety and depression particularly common in the assessment of comorbidity (Jané-Llopis & Matytsina, 2006). However, some epidemiological population surveys such as the NCS and NCS-R have illuminated associations between poorer psychological health and any illicit drug use excluding abuse and dependence (Kessler et al.,1996; Robins & Regier, 1991; Merikangas *et al.*, 1998; Degenhardt et al., 2001) with some of the most frequently associated being anxiety, depression and suicidal behaviours. However, umbrella terms referring to any drug use fail to encompass the wide variety of illicit polydrug use patterns which might affect any relationship with mental health.

Some researchers have attempted to elucidate the relationship between illicit polydrug use and harm by assessing the relationship with single drugs. Kelly and Parsons (2008) in their time-space study comparing illicit polydrug and illicit non-polydrug cocaine users in Manhattan found no significant differences between their groups of illicit polydrug cocaine users and cocaine users who were not illicit-polydrug users. DeWin et al. (2006) found no significant differences between ecstasy users and ecstasy naive participants in a Netherlands cohort study at either their baseline measurement or at follow up using the Beck Depression Inventory (BDI). Furthermore, in an opportunistic sample of 22 ecstasy users, Hopper et al., (2006) found that that all participants had relatively low mean Beck Anxiety Inventory (BAI) and BDI-II scores, with means of 2.68 (SD=2.66) and 6.36 (SD=5.07) illustrating little difference with population norms.

Scheier et al. (2008) in their sample of ecstasy users from Miami and Sydney found the average Center for Epidemiologic Studies Depression Scale

(CES-D; Radloff, 1977) score was around six for the whole sample. This considerably lower than the cut off score of 16 for this scale, which indicates depression levels of clinical relevance (Radloff, 1977). Multinomial logistic regressions on four latent classes of ecstasy abuse or dependence symptoms revealed that the differences between asymptomatic ecstasy users (i.e. no symptoms of either abuse or dependence) differed very slightly from those who had symptoms. The odds ratios (representing one-unit change in the CES-D) were 1.09 and 1.13 for the members of the moderate and severe dependent classes. There were no significant differences for those with mild symptoms compared to the asymptomatic class.

Keyes et al. (2008) in their study of 8666 ecstasy users from the National Epidemiologic Survey of Alcohol and Related Conditions (NESARC) study compared four researcher chosen categories of use. These were ecstasy users who used in the past 12 months (current), lifetime ecstasy users who had not used in the past year (past), lifetime use of other illicit drugs excluding ecstasy (other) and lifetime abstention of illicit drugs (no drugs). Current ecstasy users were significantly more likely to have experienced a DSM-IV anxiety disorder compared with the no drugs group (OR=3.7). However, the likelihood of experiencing either any mood disorder, major depressive disorder (MDD) or generalised anxiety disorder (GAD) were not significant compared to the baseline no drug use group. The former ecstasy users were 3.5 and 2.5 times more likely to have any mood or anxiety disorder diagnosis respectively. Specifically, they were 3.6 times more likely to have GAD and 2.2 times more likely to have MDD. Other drug users (not ecstasy use) also had an elevated risk of mental health conditions. They were 2.4 times more likely to have any mood disorder and 2.2 times more likely to have any anxiety disorder. Their risk of MDD was similar to the former ecstasy users being 2.2 times more likely to have this condition, however, for GAD the odds ratio for having a GAD diagnosis was 2.8, slightly smaller than the former ecstasy users.

Relationships between psychological status and illicit drugs are complicated as some of the illicit drugs produce symptoms of these disorders as a temporary effect of the drug. For example, cannabis users can often experience anxiety and panic attacks, during and shortly after use. Thomas (1996) in a community sample from Hastings, New Zealand found that one in five of their 199 lifetime cannabis users had experienced acute panic or anxiety following cannabis administration. Moreover, females were significantly more likely to have experienced these symptoms compared to males. Chronic high doses of cannabis were particularly related (Hill & Gorzalka, 2006), suggesting that dose is also relevant to the experience of these negative effects. Patton et al. (2002) found daily cannabis use in the past year elevated the risk of anxiety or depression in a cohort study of adolescents in Victoria, Australia with an odds ratio of 5.6 compared with those who had used cannabis (in the range of zero to five times) in the past 12 months. However, it is worth noting that females were 2.5 times more likely to experience these common mental disorders compared with males in the same sample. Withdrawal symptoms of cannabis reflect the symptoms of depression, low mood, fatigue, and sleep problems, but potentially these effects are transient. Amphetamine users are also commonly associated (even if the event is rare) with affective symptomatology (Baker & Dawe, 2005).

A review on the effects of ecstasy shows links with depression (Green et al., 2003). Their review of the literature in this area hypothesises that this is due to serotonin depletion and serotonergic neurodegredation, which has the potential to create transient and more enduring depressive symptoms in some users. Naughton, Mulrooney and Leonard (2000), in a review of the evidence on the range of serotonin receptors further propose that the serotonin system, considered by Green et al. (2003) to be affected by the use of ecstasy, is also linked to other psychological disorders such as anxiety, OCD and schizophrenia. However, once again, given most drug users are not using ecstasy in isolation and ecstasy is not the only drug which acts on this system, illicit polydrug use affects the conclusions.

Other attempts to explain the relationship between drug use and mental health hypothesise that any suspected transient or enduring change in the serotonin system, could be protected against if cannabis is also used. This provides further evidence that polydrug use is an important factor in assessing relationship between psychological status and drug use. Morley, Li, Hunt, Mallett and McGregor (2004) using an animal model found the co-administration of ∆9-tetrahydrocannabinol (the primary active ingredient of cannabis) and a synthetic cannabinoid CP 55,940 with ecstasy seemed to reduce serotonin depletion compared to the rats who were administered ecstasy alone. Parrott, Gouzoulis-Mayfrank, Rodgers and Solowij (2004) in a meeting report summarising the findings from two previous studies found any psychopathological differences were attributable to cannabis use not ecstasy use. Research by Morgan, McFie, Fleetwood and Robinson, (2002) in comparing their groups of ecstasy users found both anxiety and depression as measured by the Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 1977) was predicted by the number of cannabis joints used in lifetime, but not ecstasy use. They further suggest as their groups were different on several illicit (and licit) drugs, it is difficult to isolate the drug responsible due to polydrug use. However, Degenhardt *et al.* (2001) in their review of the relationship between drug use in Australia concluded cannabis was not associated with anxiety and affective disorders. Schifano et al., (1998) in a study of 150 patients consecutively presenting to an Addiction clinic who had used ecstasy at least once compared the characteristics of ecstasy lifetime users who had at least one mental health condition compared with those who did not. They found those with mental health conditions were significantly younger than those who did not. In addition, the problematic users had a higher ecstasy lifetime intake, higher ecstasy frequency and higher single occasion intake compared with the non-problematic users. However, when examining the range of drugs used by individuals in those two groups, whilst the problematic users were more likely to have used opiates (78% versus 41%), those who were not problematic users had higher alcohol problems (47% versus 23%) and other drug use, like amyl nitrate and LSD was higher in the non-problematic group (57% versus 30%). This might suggest the non-problematic group were more likely to be using a wider range of drugs, contrary to expectations.

Unfortunately, the authors did not provide any statistics for actual drug use differences which might illuminate this issue further. Moreover, this was a population who had referred themselves to treatment at an addiction clinic. There were no details in this paper as to what the individuals were presenting for, which may have influenced the results considerably. Furthermore, 53% of the sample had at least one existing mental health condition, and any consequences found may be related to the treatment population with little applicability for a general population sample. The only significant predictors of poorer psychological status in a multinomial logistic regression model controlling for demographic factors were that of increased quantity of ecstasy used in lifetime, ‘alcohol and ecstasy’ polydrug use and no opiate use. As inclusion criteria for this study was at least one dose of ecstasy, attribution of harm for those who might just have used ecstasy once in their lifetime may be problematic (Verheyden, Henry, et al., 2003). Primarily the studies' approaches presented above have chosen groups based on either their cocaine, ecstasy or cannabis use, and the use of other illicit drugs may have influenced the findings to an unknown degree.

Further evidence of shortcomings of single drug research in assessing the relationship with psychological status was illustrated by Guillot (2007) in a review examining the relationship with ecstasy use and depression. This study concluded that 11 of 22 studies reported significantly elevated depression scores with ecstasy use. Notably, these were using a range of instruments, as some of the studies illustrated in this introduction have illuminated the range of instruments available, four of the significant differences were found using the Hamilton Depression Scale (HAM-D; Hamilton, 1960), two using the SCL-90-R, three using the Beck Depression Inventory I (BDI-I; Beck, 1987) and two using Beck Depression Inventory II (BDI-II; Beck, 1996). Other key methodological confounds are also noted which cast doubt on the findings. These were low sample sizes, referring to ecstasy users from clinical populations as relevant to the general population of ecstasy users, but most importantly, the lack of isolation of ecstasy as a cause. Frequency tables of patterns of use provided in the studies clearly illuminate a range of lifetime and more frequent illicit (and licit) drug use. As can be seen above, single drug research struggles to find methodologically strong evidence for relationships with mental health status. It could therefore be suggested if harm is caused by illicit drug use, poor methodologies, and the lack of account of illicit polydrug use, make it difficult to draw any conclusions about harm. Many researchers have attempted to account for differences (or lack of found differences) through attribution of dosage effects, suggesting psychological problems in ecstasy users are considered to be dose related (Bolla, McCann & Ricaurte ,1998; Morgan, 2000; Gouzoulis-Mayfrank et al., 2000; Reneman et al, 2001; DeWin et al., 2006; Soar, Turner and Parrott, 2006). However, as chapter five has revealed, dose is additionally related to range of illicit polydrug use, and a more sophisticated explanation is needed to understand the relationship.

There have been some further efforts to assess drug use which make attempts to account for illicit polydrug use. Lieb et al. (2002) in a longitudinal community study of young adults (aged from 14-24 years old) living in Munich, Germany found those who used ecstasy and related drugs (e.g. stimulants and hallucinogens) were significantly more likely to have a diagnosis of GAD (OR=2.10) or MDD (OR=1.53) compared with a group of those who used other illicit drugs. However, despite these differences in likelihood of mental health conditions, there were few significant differences between their researcher chosen categories in terms of their help seeking. The exception was found between ecstasy and related drug use group and no illicit drug group with the former, the ecstasy and related drug use group 2.3 times more likely to have attended a session with a psychologist than the no illicit drug group. The medical practitioners included in the questions were neurologists, psychiatrists, psychologists and general practitioners.

Daumann et al. (2004) found in their opportunity sample of ecstasy users and non-ecstasy using controls that as the lifetime dose of amphetamine increased, so too did depressive and anxiety symptoms as measured by the SCL-90-R. In addition, the average frequency of use of amphetamines and cannabis were significantly correlated with anxiety (r=.29 and r=.36

respectively). Furthermore, average frequency of cannabis use also correlated significantly with depression (r=.30). In comparing their ecstasy users with non-ecstasy using controls, they found significantly higher anxiety scores for the ecstasy users, however, no significant differences were found for depression. This study also had a longitudinal component which assessed those who used ecstasy at baseline and either used cannabis in the 18 months between time points or had not used cannabis between the two time points. They concluded that anxiety, measured as the change between SCL-90-R anxiety scores at the two time points, significantly decreased for those who had not used cannabis during the eighteen month follow up, but significantly increased for cannabis users. This relates to a mean decrease of SCL-90-R scores of just over two and an increase of anxiety scores just over one. They therefore suggest long-term psychological problems may be related to cannabis rather than ecstasy use. This was a finding supported by Parrott et al. (2004) and Morgan et al. (2002).

Furthermore, Verheyden, Henry, et al. (2003) in their opportunistically sampled ecstasy users surveyed in Manchester and London, found some differences between related consequences dependent on the drugs used with ecstasy. Using groups of two drugs, they found ecstasy and cocaine users had increased negative effects (usually in 24-48 hours of ingestion) and increased positive effects compared with those who did not use cocaine with ecstasy. Furthermore, they found those who used amphetamines with ecstasy had increased physical problems than those not using amphetamines. Whilst the study was not designed to accommodate more sophisticated analyses beyond grouping two drugs together, it is of note that the questionnaire was not designed by the authors, but rather another psychologist on behalf of the BBC. The authors note had they been involved with the dataset from the outset, they might have been able to elucidate more sophisticated patterns of use and illicit polydrug use.

Still, whilst there is some attempt to combine drugs in appropriate illicit polydrug use patterns, there are still individuals who will not be accounted for in the patterns. However, researchers such as Lynskey et al. (2006) in an Australian twin sample use alternative methodologies. They found five classes of lifetime drug use, low use, moderate use, party drugs, opioids/sedatives and illicit polydrug use. These have been fully described in the introduction to chapter three. Compared to those in the baseline low use class 1, members of moderate use class 2, opioids/sedatives class 4 and illicit polydrug using class 5 were all significantly more likely to have experienced social anxieties with odds ratios of 1.2, 1.6 and 1.6 respectively. Elevated risk of major depressive disorder was found across all classes compared to the members of the baseline low use class. The odds ratios ranged from 1.7 times more likely for those in the moderate use class to 3.5 times more likely for the members of the opioid/sedative class. Furthermore, the moderate use class membership was 3.7 times more likely to have attempted suicide than the baseline class membership. Those in the party drug class had a slightly lower odds ratio (2.1), but were still significantly more likely to have attempted suicide in lifetime as those individuals in the low use class. However, the opioid/sedative and the illicit polydrug class members had the highest risk. They were 7.1 and 9.3 times more likely to have attempted suicide in their lifetime compared to those in the baseline low use class.

Furthermore, in their review of drug use, abuse and dependence and it’s comorbidity with mental disorder, Crawford, Crome and Clancy (2003) also found drug use was also a risk factor for suicidal behaviour. This was supported by a recent study on convenience samples of adolescents living in Tennessee, (n=10273) which found a strong relationship between drug use and suicidal behaviours (Dunn, Goodrow, Givens & Austin, 2008). Female suicide attempts were predicted by ever trying cigarettes (OR=1.80), cannabis (OR=1.84), cocaine (OR=1.58) or inhalants (OR=2.45). Predictors of adolescent suicide in males were significantly predicted by ever trying or daily use of cigarettes with odds ratios of 1.51 and 1.55 respectively. Lifetime use of illicit drugs predictive of male suicide attempts were cocaine (OR=1.6), inhalants (OR=2.26) and intravenous drug use (OR=1.50). It is of note the mean ages of the studied sample were 12.8 years for females and 12.9 years for males. The rates of suicide attempts in this population were extremely high, considering their young age, with 12.6% of females and 7.4% of males having attempted suicide at least once in their lifetime. O'Boyle and Brandon (1998) suggest increases on the Addiction Severity Index (ASI; McLellan, Luborsky, Woody, & O'Brien, 1980) in suicide attempters were found to be related to comorbid psychological problems and wider illicit polydrug use patterns. However, it must be noted the 103 participants in this study were in drug abuse treatment.

Given the strong relationship found between smoking and hazardous drinking from chapter three, it is interesting to note smoking is also associated with alcohol and illicit drug use, depression and suicidal behaviours (Alverado & Breslau, 2005). This is supported by a recent review of the literature on alcohol use and suicide, Baigent (2005) concluded higher AUDIT scores correlate with suicidal ideation and behaviour. Consequently, it would appear evident both licit and illicit polydrug use may be a risk factor for suicide attempts given the strong link between hazardous drinking as measured by the AUDIT and illicit polydrug use.

In conclusion, it is evident relationships between mental health and single drug research may be affected by the full profile of drugs used by an individual. It can also be hypothesised the relationship between drug use and psychological comorbidity is more pronounced dependent on the number of drugs used. Finally, it is thought drug use increases the risk in individuals who might not already be in an at-risk group. To facilitate this assessment, adjusted estimates of relationships with mental health will be used. Consequently, the predictors used in chapter three will be controlled for whilst assessing the relationship between mental health and illicit drug use. This is more methodologically sound than those which do not control for confounding factors (Macleod et al., 2004). This study therefore has two aims, to understand the relationship between current psychological status, help seeking and differing types of illicit polydrug user and secondly, to determine how this relates to their potential for risk in considering their sociodemographic profile.

5.3. Method

5.3.1. Participants, data and sampling

There were 8538 participants analysed in this chapter representing those who answered all the drug use questions and did not use ‘semeron’ from the NPMS survey (Singleton et al., 2001a; 2001b). The data was from a multi-stage stratified sample representative of adults living in Scotland, England and Wales. Data was accessed via the ESRC UK data archive hosted by the University of Essex. Participants were mostly female (55.08%) with a mean age of 45.34 (SD=15.59). Full details of the participants, data and sampling strategy are given in chapter three.

5.3.2. Measures

5.3.2.1. Illicit drug use and the three-class latent variable solution

Similar to chapter three, the drug use questions asked in the report were based on the Diagnostic Interview Schedule (DIS- Robins, Heltzer, Croughan & Ratcliff, 1981) and include questions on the past year use of the drugs cannabis, ecstasy, cocaine, amphetamines, magic mushrooms, tranquillisers, amyl nitrate, LSD and the composite variable heroin or crack. These were all binary variables which reflected no use (0) or use of the drug at least once in the past year (1).

The latent structure, as unchanged from chapter three, was only determined by these drug use variables, and was not allowed to covary as a function of predictor variables. To summarise, chapter three illustrated the heterogeneity in drug use could be expressed in three distinct groups; ‘wide range’ polydrug users, ‘moderate range’ polydrug users and no drug users. Chapter four illuminated that greater involvement in illicit polydrug use also reflected an increase in the level of use of each of the drugs in a particular class.

5.3.2.2. Demographic, other drug use and mental health variables

The demographic variables used in this chapter were the same as those used in chapter three. Briefly, these reflect a participant’s gender (female=0; male=1), employment status (economically active=0; unemployed/economically inactive=1), age (continuous variable in the range of 16 and 74 years old), educational attainment (beyond GCSE level/statutory education=0; up to GCSE level or below=1) and area type where the participant lived (rural/semi-rural=0; 1=urban). The relationship with hazardous alcohol use was measured as an AUDIT score of greater than eight. Participants scoring less than eight on the scale were coded ‘0’ and those who scored eight or above were coded ‘1’. Current smoking status was measured as ‘0’ for those who were not currently smoking and ‘1’ for current smokers.

Mental health predictors used in this model were generated by application of algorithms on answers to the Clinical Interview Schedule Revised (CIS-R; Lewis & Pelosi, 1990). This created ICD-10 diagnoses (Lewis et al., 1992). Further information on the CIS-R is provided in chapter two. The three diagnoses of generalised anxiety disorder (GAD), mixed anxiety and depressive disorder (MAD) and depressive episode were included in this analysis as predictors with ‘0’ representative of no diagnosis and ‘1’ representative of a present diagnosis. In addition, whether an individual had attempted suicide in their lifetime has been measured (0=no attempts; 1=one or more attempts in lifetime). Furthermore, the predictors relating to General Practitioner (GP) service utilisation in the past year for either a physical or psychological problem have been assessed. These were coded ‘0’ for no visits in the past year and ‘1’ for one or more visit to their GP for treatment for either a physical or psychological problem in the past year. Further details of these predictors are given in section 2.4.

5.3.3. Multinomial logistic regression

Using the conditional probabilities of membership from chapter three of each of the three classes for each of the individuals in the dataset have been saved and used as the dependent variable the multinomial logistic regression. The demographic and other (licit) drug predictors presented in chapter three remain in this chapter, as can be seen in the conceptual model diagram provided in Figure 16. The mental health predictors have been added to the model. This technique produces odds ratios and confidence intervals, and statistically significant predictors have been highlighted. The comparison group was the class with the lowest drug use involvement (class 3, no drug use). To determine a parsimonious model which fits the data well, 2Δll testing was used.

Given the odds ratios of the demographic predictors may change in the model where the mental health variables has been added, the 2Δll testing begun with a freely estimated model across all predictors. This has been compared in terms of fit with a model which constrains the independent variables to have the same odds ratio for a particular predictor across all classes. Should there be no significant differences between these models the most restricted model has been reported. If significant differences between the two models were found, restrictions on the fully constrained model have been relaxed until there was no significant difference between two competing models. In this case, the more restricted of the two was reported as the best fitting model. Full details of the 2Δll testing, in addition to a worked example are presented in section 2.5.3.1.

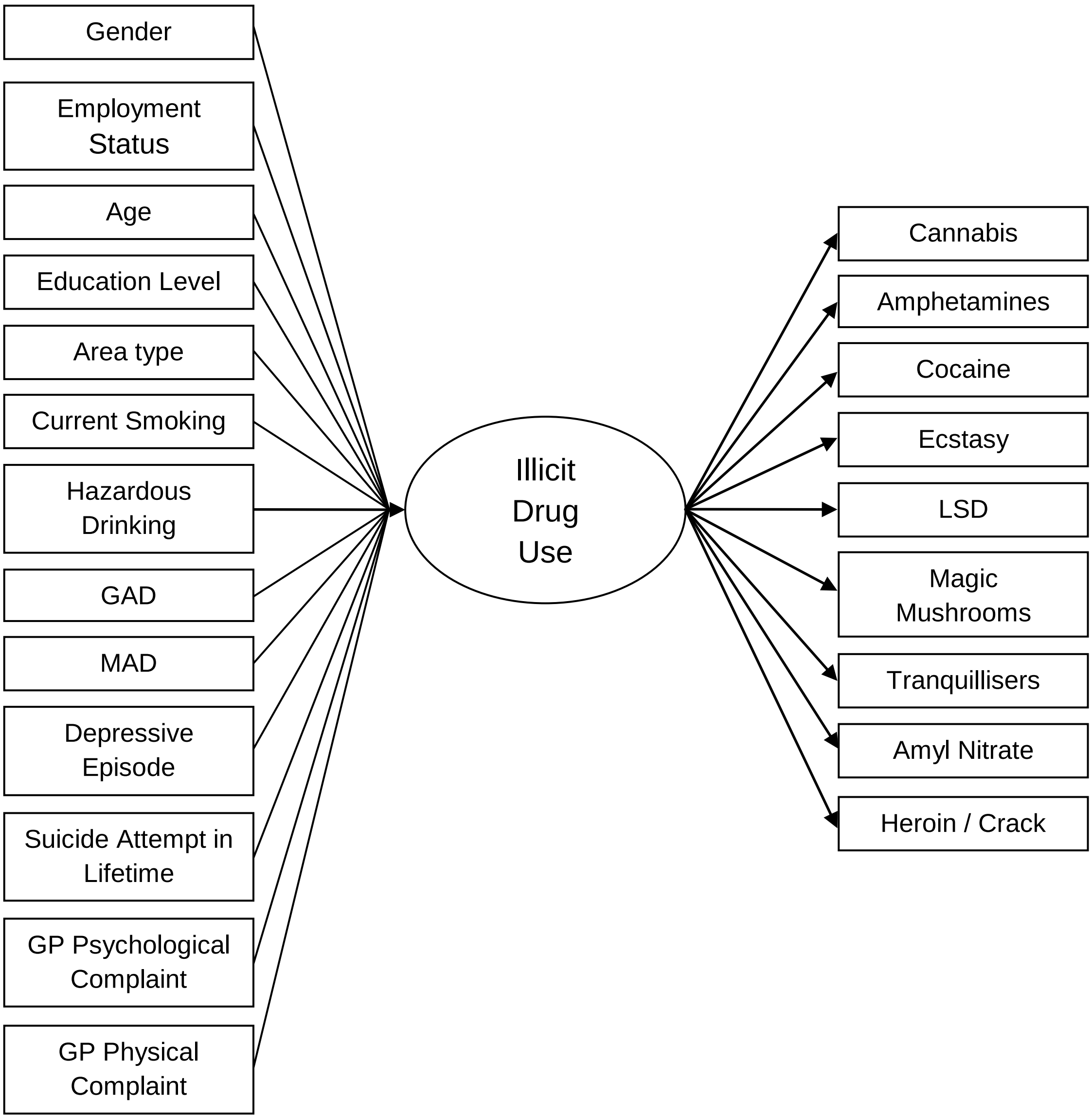


Figure 16: Conceptual diagram of model tested in chapter four.

5.3.4. Software

Data was prepared for analysis using SPSS version 15 (SPSS Inc, 2007). Multinomial logistic regressions were performed using Mplus version 5.01 (Muthén & Muthén, 2007). Graphs were drawn in Microsoft Excel Vista.

5.4. Results

5.4.1. Multinomial logistic regression

The model generated from chapter three was the baseline model to which the predictors of generalised anxiety disorder, mixed depressive and anxiety disorder, depressive episode, suicide attempt in the past year and GP service use for either a physical or psychological complaint were applied. Initially the free parameter model (model 1) was estimated, i.e. the log odds across both classes 1 and 2 for each of the variables could be freely estimated with reference to the baseline class 3. A model with the parameters constrained to be of equal log odds across both class 1 and class 2 in reference to baseline class 3 was then generated. Through 2Δll testing, the log odds for the mental health variables could be held constant between classes 1 and 2 compared to the baseline class (see Table 19). Like chapter three, this reflected a model which freely estimated the predictors of hazardous drinking and age.

Table 19: The results of the 2Δll test for the model.

Model	*Ll*	*Df*	*Model v Model Comparison*	*2Δll*	Δ *df*	*p* value
1. No constraints	-4040.50	55	2 v 1	23.00	13	p <0.05
2. Log odds constraints across all predictors	-4052.00	42	3 v 2	14.34	1	p <0.05
3. As model 2 but with constraints relaxed on hazardous drinking	-4044.83	43	4 v 3	5.82	1	p <0.05
4. As model 3 but with constraints relaxed on hazardous drinking and age	**-4041.92**	**44**	5 v 4	0.50	1	**p >0.05**
5. As model 4 but with constraints relaxed on hazardous drinking, age and employment status	-4041.67	45				

The results from this model are shown in Table 20. Members of both classes 1 and 2 were 2.11 more likely to be male, 6.27 times more likely to be currently smoking and 1.64 times more likely to be educated to GCSE level or below compared to the baseline class of no drug use. The predictors, area type and employment status remained non-significant. There were some differences in the magnitude of these predictors in the context of mental health variables. Odds ratios for hazardous drinking and current smoking decreased, however, there was a slight increase in the odds ratio for gender and educational attainment in magnitude of around .17 and .04 respectively.

Regarding mental health, an individual in either the moderate or wide range classes were more likely to have depressive episode, mixed anxiety and depressive disorder and or to have attempted suicide in their lifetime (1.85, 1.51 and 1.55 respectively). There was no elevated likelihood to seek GP help for either a physical or psychological problem than the baseline no drug use, or an increased likelihood of generalised anxiety disorder by either of the wide or moderate range drug use classes

Table 20: Odds Ratios (95% Confidence Intervals) of the optimum multinomial logistic regression model.

<table>
<tr><th></th><th colspan="2">Odds Ratio (95% CI)</th></tr>
<tr><th></th><th>Class 1: Wide range</th><th>Class 2: Moderate range</th></tr>
<tr><td>Gender (male)</td><td colspan="2">2.11 (1.66-2.11)</td></tr>
<tr><td>Current smoker (yes)</td><td colspan="2">6.27 (4.82-8.15)</td></tr>
<tr><td>Educational attainment (GCSE level or below)</td><td colspan="2">1.64 (1.28-2.08)</td></tr>
<tr><td>Area type (urban)</td><td colspan="2">1.27 (.97-1.65)</td></tr>
<tr><td>Employment status (inactive)</td><td colspan="2">1.01 (.77-1.32)</td></tr>
<tr><td>Depressive episode</td><td colspan="2">1.85 (1.04-3.29)</td></tr>
<tr><td>Generalised Anxiety Disorder*</td><td colspan="2">1.52 (.92-2.54)</td></tr>
<tr><td>Mixed Anxiety and Depression</td><td colspan="2">1.51 (1.07-2.15)</td></tr>
<tr><td>Suicide attempt in lifetime</td><td colspan="2">1.55 (1.04-2.32)</td></tr>
<tr><td>GP physical complaint*</td><td colspan="2">1.22 (.96-1.22)</td></tr>
<tr><td>GP psychological complaint*</td><td colspan="2">1.05 (.73-1.51)</td></tr>
<tr><td>Hazardous drinking (AUDIT score 8+)</td><td>10.49 (5.14-21.37)</td><td>2.20 (1.71-2.83)</td></tr>
<tr><td>Age</td><td>.86 (.85-.89)</td><td>.91 (.90-.92)</td></tr>
</table>

Note: significant predictors in bold

5.5. Discussion

This chapter investigated the relationship between latent classes of illicit drug use and the diagnosis of mental health conditions. From the evidence presented there was an increased risk of certain mental health conditions associated with any illicit drug use. Additionally, there were no differences in the likelihood of having a psychological condition between class 1 and class 2 in relation to class 3. This would illustrate those who limit drug intake on particular drugs may still experience a higher risk of detrimental health. This poses two questions: is the risk of mental health conditions related to dose response, or is it due to the drugs that are in common across classes? The findings will be discussed examining any differences between the classes by psychological condition and demographic criteria.

Class 1 and class 2 were almost two times more likely to have a depressive episode compared with the baseline class 3; however, this was not equivocally supported by previous literature. In support, Lieb et al. (2002) found users of ecstasy and other related drugs were 1.53 times more likely to have major depressive disorder (related to the ICD-10 depressive episode) than those who did not take these drugs. Lieb and colleagues, however, did not attempt to account for illicit polydrug use and any significant effects could be related to the use of other drugs. The majority of other studies either found no relationship (DeWin et al., 2006; Hopper et al. 2006; Kelly & Parsons, 2008) or no relationship of clinical relevance[6] (Scheier et al., 2008).

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[6] The CES-D (Radloff, 1977) is a tool which screens for current depressive symptoms. It is designed to be used as a lay instrument, and thus does not provide a diagnosis. However, the developer of the scale suggests that a cut off point of around 16 is of clinical relevance, as it may highlight those who have a symptomatology which requires treatment from a clinician.

Green et al. (2003) propose that any effects of ecstasy on depression are related to dose response. Findings in this chapter have illustrated that increased risk in the general population of Great Britain does not appear to be related to dose of illicit drugs. Even though there was a two-fold risk increase in depression, those in class 1 used ecstasy on average more than 100 times compared to an average 10-100 times in class 2. The lifetime frequency of amphetamine use in class 1 was also higher than class 2. This would imply the increased risk of depression and anxiety as suggested by Baker and Dawe (2005) in their review of the impact of amphetamine use on mental health, is either not dose related or a specific drug is not contributing to the elevated risk.

The results of this chapter have illustrated anxiety was not significantly related to illicit drug use which would appear somewhat supported by the literature. For example Keyes et al. (2008) found their current ecstasy users in the NESARC study were 3.7 times more likely to have any anxiety condition, but there were no significant differences for the specific condition assessed by these analyses (GAD). Furthermore, the authors concluded other drug use (not ecstasy) elevated the risk of any anxiety diagnosis (but not GAD specifically) by 2.2 times. This might suggest other anxiety conditions may be relevant to past year drug use patterns. However, this chapter did find a relationship between mixed anxiety and depression in both the membership of the class 1 and 2 compared with those in class 3, with an elevated risk of 1.51 times. This would suggest any anxiety expressed by this group might be a manifestation of a comorbid condition of mixed anxiety and depression rather than anxiety alone.

Suicide attempts during the lifetime were also found to be equivalently significantly related to the members of classes, with these classes 1 and 2 being 1.55 times more likely to have attempted suicide compared with those in class 3. Whilst this significantly elevated risk is not unsurprising, it was not related to wider range illicit polydrug use as found by O'Boyle and Brandon (1998). Alternatively, Baigent (2005) who found higher AUDIT scores correlated with suicide ideation and behaviour. This interpreted in the context of the relationship of class 1 and hazardous drinking levels is somewhat surprising. Given the difference in the odds ratios between the two illicit drug use classes in terms of AUDIT score, it is surprising there was no corresponding difference between these groups in terms of their suicide attempt risk.

The elevated risk for depressive ideas, mixed anxiety and depression and suicide attempts in the lifetime found in this chapter could warrant higher levels of treatment seeking. However, this was not found between the classes; there were no significant differences between treatment seeking compared to the baseline no drug use class. This may have happened for a number of reasons, perhaps these individuals are generally not typical attendees of primary care services, or it may relate to perceived problems with disclosure of substance use. The finding by Lieb et al. (2002) that their ecstasy and related drugs group were more likely to see a psychologist than those not consuming illicit drugs would not appear to be supported by this research. However, this work has highlighted there could be an unmet need for treatment in illicit drug users, and GP's should be particularly aware those using illicit drugs who may be of an elevated risk for psychological conditions are not readily seeking treatment. GP's may wish to consider brief screening of at-risk individuals in their surgeries such as young males.

Whilst there has been some evidence of increased dose of drug use and increased risk of mental health conditions from the literature base, evidence from this latent class regression analysis would appear to be unsupportive.

Given there were no significant differences in the odds ratios between the members of these two classes, this could be caused by two possible solutions. Firstly, there is no dose response relationship between mental health and drug use, and any use elevates the risk, secondly, the significant relationships found could be relevant to what the two classes have in common.

Evidence from Patton et al. (2002) finds regular cannabis users were 5.6 times more likely to have either anxiety of depression compared to those who had only used cannabis between zero and five times in the past 12 months. This suggests a strong dose response relationship with cannabis in particular; however, the use of other drugs could still be implicated. Parrott et al. (2004) also implicated cannabis as being more related to mental health conditions than ecstasy, however, this was not found to be responsive to dose. The drug used at a similar lifetime level across the membership of the wide and moderate latent classes is of cannabis, with both using over one hundred times. This similarity may suggest cannabis use might be related to anxiety and mood disorders. This contrasts with the findings of Degenhardt et al. (2001) but supports Morgan *et al.* (2002) and Daumann *et al.* (2004). Gouzoulis- Mayfrank and Daumann (2006a) even suggested in ecstasy users, polydrug use in ecstasy users of cannabis might protect against mental ill-health; however, this does not hold in this chapter. Alternatively, it could be argued the risk may have been higher without its use.

Whilst it is difficult to conclude which drug was at fault, and somewhat futile given widespread illicit polydrug use, it is apparent illicit drug users are aware of the elevated risk. Verheyden, Maidment and Curran (2003) found the most frequent reason for quitting ecstasy were mental health worries attributed to their drug use; 66.9% of the participants thought their concerns regarding the long-term effects of ecstasy use would cause them to cease their use. Williamson and Evans (2000) back this finding in cannabis users who originally use the drug to relax but paradoxically anxiety attributed to their use was the main reason cited for quitting the drug. The awareness of the potential mental health impact of their drug use does not translate into more visits to their GP. If this is due to individuals being unwilling to disclose substance use activities, individuals may wish to avail of more anonymous treatment services, and these should be promoted an alternative, second choice to a GP visit.

Despite the finding any illicit drug use increased the harm compared with members of class 3, this research would suggest drug specific harm reduction interventions might be unhelpful. Moreover, given class 1 and 2 illicit polydrug use patterns are also tobacco smoking and drinking hazardously, it is difficult to ascertain which drug or combination is causing the elevated risk of mental health problems, without further investigation. Harm reduction strategies should move to tailor interventions to particular patterns of polydrug use.

There may be several reasons for any relationship between illicit polydrug use and psychological status. The relationship could be present as the causes of both drug use and mental health conditions overlap. Secondly, those with psychological conditions might be using illicit drugs to self-medicate against their conditions (Khantzian, 1985; 1997). Finally, it could be suggested drug use causes mental health changes. Whilst this study is cross sectional and therefore, causal relations are problematic, there is some evidence to suggest depression exists before drug use (Falck, Carlson, Wang & Siegal, 2006; Guillot & Greenway, 2006). This lends some support to the self-medication theory, but this does not rule out development of conditions post drug use involvement. However, there is contrary evidence from the International Consortium of

Psychiatric Epidemiology (ICPE; Merikangas et al., 1998), a collective of countries using the CIDI instrument to assess mental health burden. The ICPE suggest the temporal relationship between mental health conditions and onset of drug use is less conclusive for depressive episodes, but there is evidence that more often, anxiety disorders precede illicit drug use. Lieb et al*.,* (2002) in a study examining at ecstasy use considered psychiatric conditions to be more likely to precede rather than follow the onset of ecstasy use. Additionally, there are problems with this approach. Schifano et al. (1998) suggest none of their individuals reported their self-reported mental health problems came prior to their ecstasy use. They also state one of the advantages of their study over other methodologies was by using clinical ratings, their study would be more valid. It could be considered by using their drug use as the rationale to attend an addiction clinic, they may have perceived biases about which came first. Their priority is clearly to secure treatment to reduce symptomatology, and responsibility for the condition could be transferred to the drugs of use when a more complex aetiology could be at work.

Despite this, it is widely considered drug misuse is a major cause of psychiatric disorders in other settings. For example, Milani et al. (2005) in their opportunistic sample of nightclub attendees, found one fifth complained of psychological problems which they attributed to their drug use. Of these depression and anxiety were the most frequently cited. However, if we are unable to isolate single illicit drugs from their other drugs in an illicit polydrug use pattern, and research continues to not take account of polydrug use, then individuals may well believe or expect their drug use will cause them psychological harm. They may also attribute the cause to their drug use. In addition, blaming drug use absolves responsibility for a condition which can be caused by multiple biological or psychosocial factors and the interactions between these two (Jorm, Christiansen & Griffiths, 2005).

If a dose response relationship is implicated in elevated risk of psychological disorders, age of onset may not be the same as age of heaviest use. If the effects of drug use are related to the dosage (even in a given range of drug use), then age of heaviest use may be a better indicator. Future research might wish to explore this indicator in relation to patterns of illicit polydrug use.

Green et al. (2003) hypothesise the relationship between drug use and mental health is of concern if the use of the drug increases the risk of individuals who would not otherwise be in high-risk groups for developing a psychological condition. Therefore, it is important to ascertain the most likely profile for the mental health conditions that have been addressed in this paper. Numerous studies have illustrated significantly more women are experiencing mood or affective disorders (Kessler, 2003; de Graff, Bijl, Smit, Vollebergh & Spijker, 2002; Andrews, Henderson & Hall, 2001; Lieb, Becker & Altamura, 2005). It has been suggested there is no real relationship between mental disorders and age (Wittchen & Jacobi, 2005). In terms of urban and rural differences, Kovess-Masfety, Lecoutour and Delavelle (2005) have stated although in some studies there have been higher differences for urban dwelling individuals, the differences were more likely to be attributed to social norms. This is supported by Andrews et al. (2001). Fryers, Melzer and Jenkins (2003) in a review of studies concluded four of five studies addressed illustrated a significant relationship between lower educational attainments and mental health conditions. In addition, in six of seven studies unemployment was significantly related to poorer psychological health. This has support from other studies which were not included in this review, including Andrews et al. (2001), Hunt, Issakidis and Andrews (2002), de Graff et al. (2002), WHO International Consortium in Psychiatric Epidemiology (2000) and Lorant et al., (2003).

In comparison, our profiled illicit polydrug users were most likely male, educated to GCSE level or below with no significant differences in employment or urban/rural living status compared to the no drug range drug users. They primarily differ from the risk factors above in gender, employment status and urbanicity. From this analysis, it is apparent the drug users were not the most at risk of mental health conditions and thus may have increased their risk through their drug use or associated behaviours.

The findings suggest the full profiles of drugs used in each of the classes were associated with elevated risk of mental health conditions. Illicit polydrug users should be made aware of this increased risk. Whether or not they are part of a similar aetiology or a causal position, it is difficult to ascertain. Cohort studies which account adequately for illicit polydrug use over time might be able to elucidate this issue. Whilst this cross-sectional study could not attribute causal relations, nor was it possible to conclusively attribute risk to any particular drug, it is could be suggested the risk of experiencing mental health disorders is elevated in the presence of illicit polydrug use. However, patterns of illicit polydrug use found to date were generated from illicit drugs. A strong relationship has also been found with licit alcohol use in terms of hazardous use. Regarding future directions for research, it will be useful to determine whether this alcohol use affects the risk of poorer psychological status, and which patterns of use are particularly relevant. With this in mind, the next chapter will explore alcohol use patterns.

6. Patterns of alcohol consumption and related behaviour in Great Britain: a latent class analysis of the Alcohol Use Disorder Identification Test[7]

6.1. Abstract

Efforts to create typologies of alcohol use and related behaviours have been mostly derived from populations of alcoholics. These illustrate patterns of more severe alcohol involvement which do not represent wider alcohol use trends in the general population. Therefore, this chapter aims to identify classes of alcohol use and related problems in a general population sample of Great Britain. These were identified from 7849 respondents in a multi-stage sample of the population of Great Britain (NPMS). A latent class analysis was performed on 10 indicators of alcohol use and related behaviour from the Alcohol Use Disorder Identification Test (AUDIT). Multinomial logistic regression was used to validate and explore the relationship between class membership using key demographic and mental health variables. Six distinct typologies best described alcohol use and related problems in the population of Great Britain. Three were heavy consumption groups. One of these experienced multiple negative consequences, one was associated with alcohol related injury and social pressures to cut down and an additional class experienced memory loss. A single moderate consumption class was found with low probabilities of alcohol related problems. The final two classes were mild consumption classes, one with no related consequences and one with alcohol related injury and social pressures to cut down. Four of these follow a continuum of increased

[7] Part of this chapter has been published in Alcohol and Alcoholism. Full reference is Smith, G.W. & Shevlin, M. (2008) Patterns of Alcohol Consumption and Related Behaviour in Great Britain: A latent Class Analysis of the Alcohol Use Disorder Identification Test (AUDIT). *Alcohol and Alcoholism*, 43, 590-594. This can be accessed directly from http://tinyurl.com/9zbgxz

consumption leading to increased alcohol related problems and two which do not. Differences between alcohol use classes are apparent with an increased risk of anxiety disorders, and suicide attempts in lifetime for the highest consumers of alcohol and a reduced risk of depressive episode for most classes.

6.2. Introduction

Most of the research into typologies of alcohol use behaviours has tended to focus on alcohol abuse or dependent populations. Empirically developed typological schemes used to classify alcoholics have included binge, episodic, sporadic and steady typologies (Epstein, Labouvie, McCrady, Jensen & Hayaki, 2002). However, there are also numerous others including; type 1 & 2 (Cloninger, 1987), type A & B (Babor et al., 1992a) and Jellinek's gamma, delta and epsilon subtypes (Jellinek, 1960). Although some of these typologies have been found to have predictive and clinical utility, they have been invariably derived from relatively small samples of those with alcohol abuse or dependence. It is also difficult to extrapolate these patterns to general population samples as the percentages of this clinically relevant symptomatology in the general population is very low; forming a small subset at the most severe end of a hypothesised alcohol use spectrum. The International Consortium of Psychiatric Epidemiology found a lifetime prevalence of drug use disorders (including both alcohol and illicit drugs) over 28 countries in the range of 1.5% in Italy and 15% in the Ukraine (Kessler et al., 2007). This is evidence that lifetime prevalence of these conditions represent a small subset of yearly alcohol use patterns.

Moving from the focus exclusively on problematic alcohol consumption, to a wider range of alcohol related behaviours, there have been some attempts to develop population-based typologies of alcohol use. Slater, Basil and Maibach (1997) performed a k-means cluster analysis of 2910 individuals' representative of the American general population discovering five profiles of drinking behaviours. These were non (26%), light (30%), moderate (20%), episodic (14%) and heavy (8%) drinkers with fewer than 3% found to be atypical of these five patterns. Non-drinkers were characterised by seldom, if ever drinking, had a mean age of 62 years old and were mostly female (60%). Light drinkers consume one or two drinks per sitting, were on average 32 years old and were predominantly female (62%). The next three categories see a shift in the gender proportion. The decrease in proportion of females in the moderate, episodic and heavy groups were 41%, 43% and 21% respectively. The group of moderate drinkers tended to have two drinks per occasion, slightly more than three times per week with an average age of 47 years. Episodic drinkers approximately had three or more drinks, two to three times per week and heavy drinkers drank over four times per week with over four drinks per occasion. The average ages of the episodic and heavy group were 29 and 44 years old. In addition, relating alcohol use to current smoking, the heavy drinkers were likely to be smoking the heaviest with the mean number cigarettes per day of 10.07. Those in the episodic, moderate, light and non-drinking clusters had means of approximately 6, 4, 4, and 3 cigarettes per day. This suggests the heavy drinking pattern is most likely to be associated with extent of current smoking behaviours. Whilst the postal survey methodology utilised in this study generally has a lower response rate than other methods which can cast doubt on the representativeness of the outcomes, this study counters this caveat with a response rate of 55%; relatively high for this kind of method. In addition, it could be considered except for the episodic group, that this represents a continuum of severity in alcohol use behaviour. Using the ‘Health as Personal Value’ index (Lau, Hartman & Ware, 1986), moderate and non-drinkers valued health more than the other groups (as a proxy for health seeking behaviours). Consequently, the authors argue their lifestyle choices may play a protective role in maintaining good health (including mental health).

Rouillier *et al.* (2004) in a hierarchical agglomerative clustering method cluster analysis identified seven clusters based on the amount and type of alcohol consumed using a sample of 2150 men aged between 45 and 60 years old. The first of these groups, abstainers were a priori determined by the use of 5g or less of alcohol per day. The following six clusters were determined in the analysis, the first being low alcohol use on average 15.7g alcohol per day. The next five groups were determined in relation to beverage of choice and are presented in increasing quantity format. The high-quality wine group consumed 31.6g per day on average, followed by the beer and cider group with a mean of 33.2. The mean alcohol use of the following digestives group was 33.5g per day with the final two groups representing local and table wines with means of 36.2g and 46.2g respectively[8]. They also had some key demographic differences. As the groups increase in consumption age also increases in a defined age range of 45-60 years old. In addition, the first six groups are more likely to live in an urban area with a percentage in the range of 63-68% in this category. However, the heaviest consumption group were more equally split in terms of the urban and rural breakdown. The table wine group was the most likely to be unemployed at 11%, with the abstaining class least likely to be unemployed

[8] For comparison, a typical bottle of wine is approximately 70g.

6.5%. In addition, the highest proportion of individuals who currently smoked tobacco were also found in the heaviest drinking group at 24%. The limited age range of the sample makes it difficult to extrapolate the findings to general population surveys; however, it gives an estimation of the variability that can be found in this age range. Additionally, the primary focus of this study formed a randomised control study of food and supplement intake and the effect on health (particularly cardiovascular). Whilst this is not a criticism per se, the method of collection, representing the 24hr intake of all food and drink on six random days per year (two weekends, and four weekday) may find an under-reporting of more episodic patterns that could be captured in other survey designs.

Alternative typological techniques to cluster analysis have also been employed. Reboussin, Song, Shrestha, Lohman and Wolfson (2006) in a latent class analysis on a sample of 4056 adolescent current drinkers (16-20 years old) concluded three types of drinker. These were termed ‘non-problem’, ‘risky problem’ and ‘regular problem’ drinkers. As Figure 17 shows, it would appear for this population the profiles seem to follow a broad continuum of increased consumption leading to increased problems. However, the heaviest two consumption groups did not differ greatly between in terms of their percentages of problems, suggesting drinking behaviours beyond the lowest group elevate the risk of negative consequences.

The first class was the largest single group representing 43% of the sample and comprised of non-problem drinkers who consumed little alcohol and had few problems. The second group (30%), risky problem drinkers would drink alcohol to the level of drunkenness two to three days per month (52%) and have moderate to low probability (35%) of binge drinking episodes (five or more drinks on at least one occasion in the past two weeks). Finally, the regular problem drinkers' group, representing the remaining 27% of the sample had a 98% probability of endorsing the binge drinking item. A similar percentage of this group were characterised by drunkenness during the past month. They were also the most likely to have mental or physical health problems and spent on average six days drunk in the past month. Comparing the two problem drinking groups (regular and risky), the regular group was 1.5 times more likely to be male, almost twice as likely to be 18-20 compared to 16-17 years old, and 2.6 times more likely to use cannabis. However, despite the progress in the area afforded by the methodology, like the Rouillier et al. (2004) study, the age range of this sample makes it difficult to extrapolate the findings to the general population.

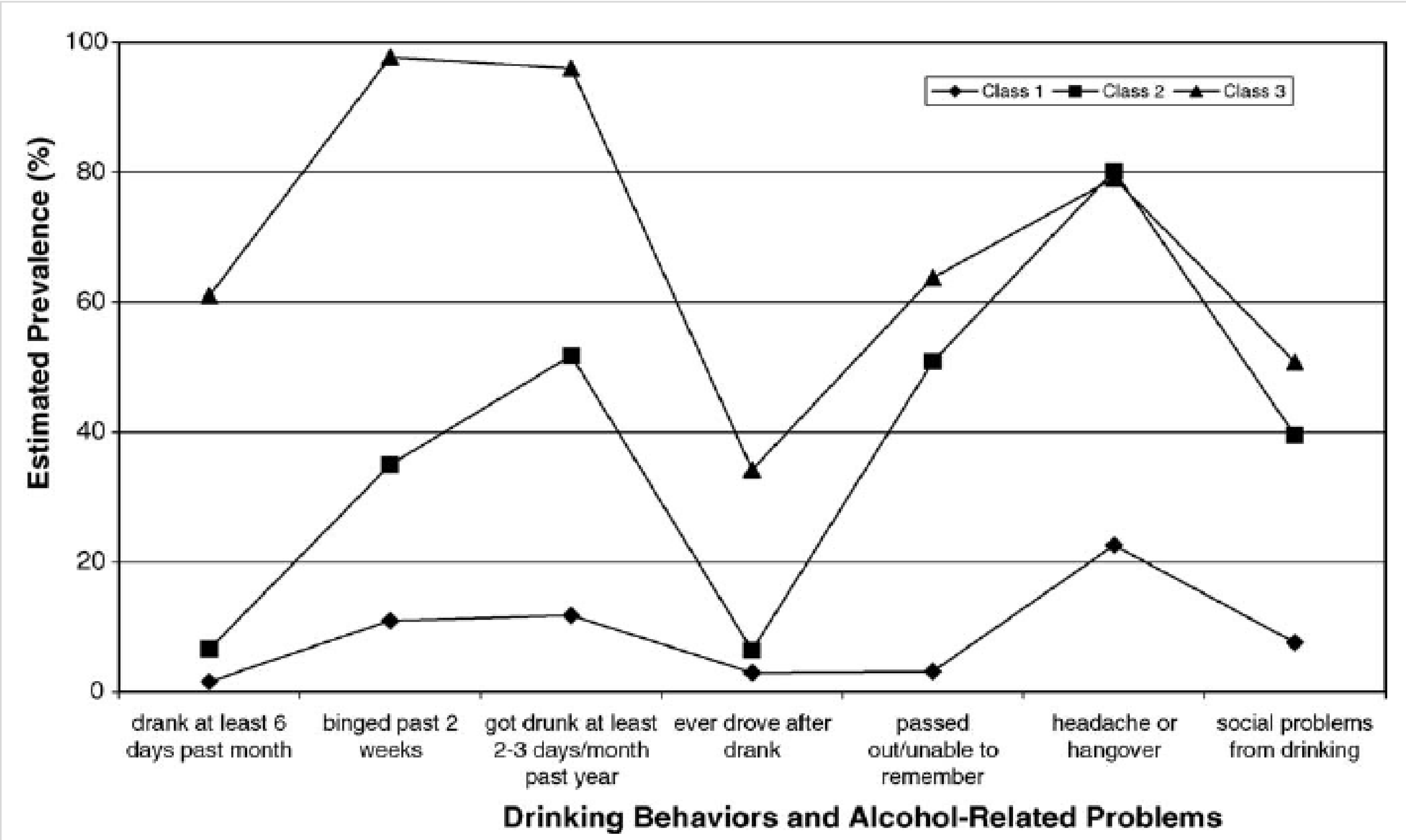

Figure 17: Profile plot of the five latent classes in the Reboussin et al. (2006) survey

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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 of alcohol related behaviour which are described in terms of behaviour of males and females in the group. Only one of their profiles, class two, appears as the same for men and women. This group is the largest of the entire sample at 42%, comprises of 68% females and reflects a low quantity, frequency and problem group. The rest of the groups are presented in Table 21 below for clarity.

Table 21: Illustration of the structure of profile membership of O’Connor and Colder (2005)

Class	% of sample	% F	Quantity	Frequency	Problems
1	3	65	Moderate/High	Very High	F: Very high M: High
3	5	39	Very High	F: High M: Moderate/High	F: High M: Moderate/High
4	15	73	Moderate/High	F: High M: Moderate/High	F: High M: Very High
5	35	59	F: Moderate/High M: Moderate	F: Moderate M: Moderate/High	Moderate

Note: M = males; F = females.

There appeared to be some key gender issues. For females, moderate/high drinking styles create problems ranging from moderate to very high, with the same descriptive terms for the frequency as for the problems (i.e. very high frequency occurs with very high problems). This may suggest the frequency is more pertinent for females. The situation for males is slightly more ambiguous, their pattern of moderate/high quantity and frequency results in very high problems. This appears to be not entirely explained by the consumption (as in class 4). Despite this tentative evidence a continuum of increased consumption and problems, particularly in females, O'Connor and Colder (2005), consider their work to not follow a broad continuum pattern given the differences arising from frequency and quantity in their population. Furthermore, Medina-Mora, Carreño and De la Fuente (1998) found alcohol related problems and consumption to be moderately correlated (r=.61) in the general population of Brazil. However, they identified a group of drinkers who drink less than once a month but do drink heavily on occasion (such as a cultural festival), who may be at very high risk of problems due to intense acute intoxication rather than chronic use.

It is also important to note the questions which estimate alcohol use play a key role in the patterns. Most previous work has focussed on average volumes of alcohol use, i.e. typical frequency and typical quantity. This is a problematic approach as these (tending to be researcher chosen) groups of average volume based on an average number of grams of alcohol or units per week could group together those with a very different drinking style. As San Jose, Van Oers, Van de Mheen, Garretsen and Mackenbach (2000) colleagues conclude, someone consuming one or two glasses per day, everyday, is grouped together with someone drinking seven glasses in one sitting, one or two times per week. Furthermore, it makes it difficult to characterise those with a varied pattern of use in a specified time period. Consequently, the effects on psychological (or other health) status by these patterns depend on effects of the level and length of elevated blood alcohol concentration, or social activities of drinking which could be either protective or potentially damaging. This study also found regular drinkers from their sample of residents of Eindhoven, Netherlands (n=18973) at low quantities were often better off than occasional drinkers. Specifically, those who drank lower quantities but over six or seven days in a week were significantly less likely than the reference class of one to two drinks, one to two days per week to report health burdens (OR=.77). All those drinking 6-7 days per week were less likely to perceive their general health as less than good (OR=.83), to report three or more health complaints (OR= .76) compared to those drinking 1-2 days per week. Thus, the overall effect of drinking alcohol could be better described as relating to drinking patterns rather than average alcohol intake.

A review by Rehm et al. (2003) on alcohol consumption and alcohol related burden of disease concluded average volume of drinking was related to a number of health problems including depression and cancer, however, they only found coronary heart disease (CHD), stroke, diabetes and injury risk to be related to patterns. Almost equivocally increased involvement in alcohol (whether pattern or average volume) increased risk for coronary heart disease, stroke and diabetes. However, some alcohol use patterns illustrated a protective factor for the burden of disease. In compiling their meta-analysis, the definition of 'patterns of drinking' did differ between studies, with a general paucity of literature assessing what these patterns entail. Additionally, the study calls upon researchers to use a standardised approach to measuring alcohol use to both conceptualise typical patterns of drinking and better estimate the impact on society. The authors suggest advances in alcohol pattern estimation, should be able to really determine whether there is an impact.

Rodgers et al. (2000) illustrated there was no linear relationship between alcohol consumption and depression or anxiety. Instead, they hypothesised that the relationship forms a 'U' or 'J' shaped curve. Evidence for this was gathered from their sample of 2,725 Australians aged 18-80 years using the AUDIT questionnaire to measure consumption compared with Goldberg's self-rated anxiety and depression scales (Goldberg et al., 1988) and Delusions-Symptoms-States Inventory (DSSI/sAD; Bedford, Foulds & Sheffield, 1976; Bedford & Deary, 1997). A plot of the estimated marginal means from this study is presented in Figure 18. This graph illustrates an elevated risk of higher means for both the abstainers and the heaviest drinking groups, with lower means for the moderate groups. When the abstaining mean is as high as the highest drinking groups, a U shape curve is formed (e.g. DSSI/sAD depression males). However, when the elevated mean score is lower for abstainers than for the heaviest drinking pattern, a 'J' shape curve is formed (e.g. DSSI/sAD anxiety males). Moving from these line graphs to significant differences between means, female abstainers and hazardous drinkers were significantly higher than low level drinkers in terms of DSSI/sAD depression scores. Scores on Goldberg's depression scale illustrated these groups were significantly different in addition to the occasional drinker. Female anxiety levels are significantly higher for abstainers, hazardous and occasional (Goldberg anxiety scale) and only abstainers and hazardous drinkers for the DSSi/sAD anxiety scale. Males depression and anxiety scores were both significantly elevated in higher level and hazardous drinking (Goldberg) and non-drinkers and hazardous for the DSSI/sAD. In terms of demographic criteria, men had higher AUDIT scores than females, with mean scores of 6.82 and 4.35 respectively. Conversely women had higher anxiety and depression scores. However, both mental health and AUDIT scores decreased with increasing age in females. Whilst this study opened up the debate commenced by Lipton (1994) and Ashley, Ferrence, Room, Rankin and Single (1994) into the protective effects of moderate drinking, and the higher level of depression/stress for both abstainers and heavy alcohol consumers, it would greatly benefit from a more data driven approach to representing patterns using the AUDIT questionnaire. The a priori choice of researcher driven categories is common in this area of research, however, recent methodological advances such as latent class analysis attempt to control for bias in researcher choice of categories.

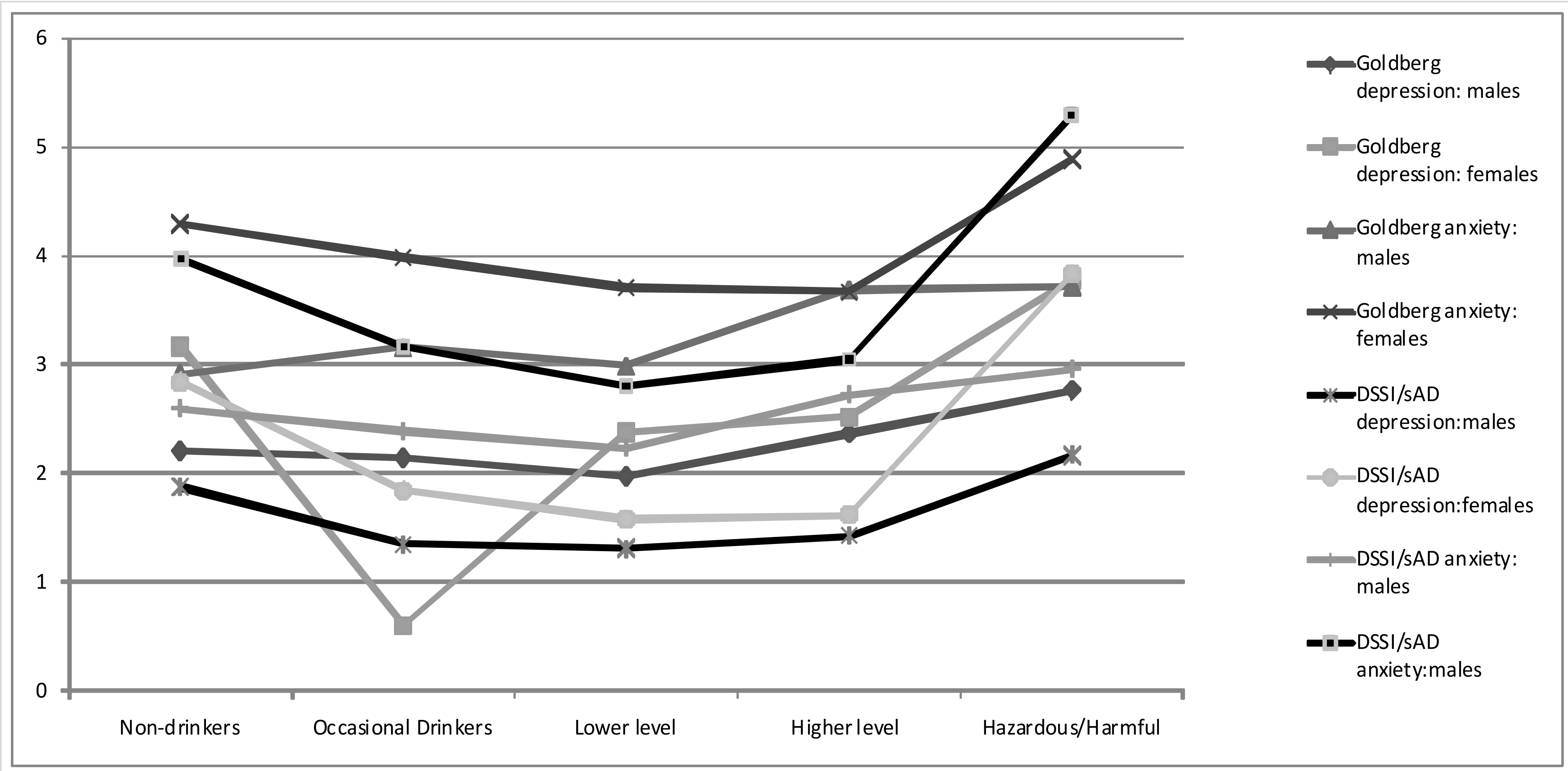

Figure 18: Illustration of the non-linear relationship between alcohol consumption and depression and anxiety scores.

Vanheusden et al. (2008) in a sample of 2,258 young adults aged 19-32 years old in the Netherlands also found a ‘U’ shaped relationship with self-reported depression and anxiety symptomatology. In their five groups of researcher driven alcohol use behaviours (determined from the AUDIT), their non-drinkers (18.2%) and occasional (monthly or less drinkers; 21.7%) both were 1.6 times as likely to report depression and anxiety symptoms as the low level drinking group (those who drink typically one or two drinks per occasion; 36.4%). Higher level drinkers, (13.9% of the sample) who drank three or four drinks per typical occasion were not significantly different to the low-level group. However, they were more likely to report depression or anxiety (OR=1.9). Males were typically more prevalent in the higher drinking groups with females more likely to be in the ‘non’ or occasional drinking groups.

Manninen, Poikolainen, Vartianinen and Laatiainen (2006) in a Finnish study examining drinking patterns, and in particular controlling for heavy drinking occasions assessed Beck Depression Inventory score change across groups (BDI; Beck, Steer & Garbin, 1988; Beck, Ward, Mendelson, Mock & Erbaugh, 1961). They had eight groups of drinkers, lifelong abstainers, former drinkers, two moderate drinking groups, two heavy drinking groups and two hazardous drinking groups where each pair represented with and without binge drinking episodes. The highest BDI scores were found in former drinkers with a mean of 11.8 and in the hazardous binge drinking group a mean of 11.1. The lowest means were found in the lifelong abstainers (7.8), and in the moderate and heavy non-binge drinking groups, 7.9 and 7.1 respectively. There also appeared to be a relationship between patterns, gender, and age on BDI scores. In multinomial logistic regressions using no binge drinking occasions in ages 25-44, males aged 45-64 who had these occasions were 2.3 times more likely to have a BDI over 10. Those without these occasions were 1.52 times more likely. These odds ratios were estimated in addition to some other demographic criteria illustrating males with a BDI over 10 were 1.7 times more likely to be single, 1.7 times more likely to have a chronic disease and 1.6 times more likely to be unemployed (there was no significant effect of education). Females appear to be more likely to have to high BDI scores co-occur with binge drinking episodes, with odds ratios of 1.7 for the 25-44 year old category and 1.9 for the 45-64 year old category (both significant). Non heavy occasions were also significantly elevated in risk for the 45-64 year old category with odds ratios of 1.7, compared with the baseline females with non-binge drinking occasions aged 25-44 years. Again, in terms of the demographic profile of these individuals, there was a significant relationship of marital status, with those with BDI over 10 being 1.4 times more likely to be single and 1.7 times more likely to have a chronic illness. There was no significant relationship with unemployment and education for the female group.

It could be theoretically considered that if there was an increased risk of mental health problems with increased alcohol involvement, individuals may be more likely to seek primary care treatment as they have a need to do so. If conversely, individuals with an elevated risk of mental health problems are less likely to seek treatment; this represents an unmet need for care (Demyttenaere et al., 2004). Relating back to alcohol use, Ogbourne and DeWit (2001) in an Ontario population sample found the only (researcher driven) group of drinkers who visited their GP for the median number of visits per year were female infrequent drinkers (compared with lifetime abstainers) whilst controlling for a range of demographic and mental health variables. However, this was partly due to a relatively high proportion of lifetime abstainers who visited their GP more than the median number of visits (females= 38%; males= 31%). Notably too, males were less likely to visit their GP than females (although this was not tested statistically). Research in a population sample of south east England, found similar results (Cryer et al., 1999). This study which utilised a mail questionnaire, found a frequency-based trend of decreased time between GP visits as alcohol use increased (measured by units). However, significance testing failed to illustrate any significant differences between increased alcohol involvement in females, whilst in males, the overall chi-square value (5.03) bordered on significant ($.05 < p < .10$). However, the only significant odds ratio found for males was between abstainers and safe drinkers, as defined by drinking between one and 21 units per week (the recommended limit for men). Abstainers had a higher likelihood of a shorter time between the last GP visit and the present day (OR=1.1). Notably, this proxy measure of time between GP visits is less of a conclusive measure of the relative use of services in each time period, as an individual could have easily seen their GP recently, but had not seen them for an undefined period after that. Consequently, this evidence should be interpreted with caution as to its ability to measure services use. As for many studies, the categories for comparison were based on a researcher driven approach of average consumption, and as a result, would not take into consideration the differing impact patterns can have on the outcome measure.

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 the heterogeneity of alcohol related behaviours could be described in distinct patterns of drinking based on both the consumption of alcohol and related alcohol use problems. Latent class analysis will be used to identify homogeneous classes, or groups, based on answers to a standardised, frequently used measurement scale (Alcohol Use Disorder Identification Test: AUDIT). Given the building evidence about the importance of patterns of use in assessing alcohol related harm, the nature of the resultant patterns (classes) of use will be further examined by examining associations with key demographic variables and current mental health status. This chapter will investigate the relationship between these patterns and a number of mental disorders including mixed anxiety and depression, generalised anxiety disorder, depression, psychosis, suicide attempts and help seeking from General Practitioners (GPs).

6.3. Methods

6.3.1. Participants, data and sampling

Analyses were performed on participants in the NPMS survey (Singleton et al., 2001a; 2001b) accessed via the UK Economic and Social Research Council Data Archive. Interviews were successfully conducted with 8580 adults living in England, Scotland or Wales using a stratified multi-stage random sampling strategy. As indicated in chapter two, the alcohol section commences with two questions to determine whether an individual uses alcohol even occasionally. Those who stated they did not drink alcohol and clarified they did not use even on rare occasions were then screened out of the section. Consequently, when these individuals were deleted listwise, the effective sample size for this chapter was 7849. The mean age of the sample was 45 years old (SD= 15.43). Over half (54.1%) of the respondents were female and 93% of the sample were of white ethnic origin. Further details of the survey methodology are provided in Chapter 2.

6.3.2. Measures

6.3.2.1. Alcohol use variables

Alcohol use and related problems were assessed using the Alcohol Use Disorders Identification Test (AUDIT: Saunders & Aasland, 1987; Babor et al., 1992b) a widely used questionnaire measuring hazardous drinking. The scale comprises ten items referring to alcohol consumption and alcohol related problems in the past 12 months. The AUDIT was originally designed to measure three conceptual domains (Saunders & Aasland, 1987). The first of these, consumption, contains questions determining how often an individual drinks alcohol (how often), the number of drinks on a typical day (typical amount) and how often an individual drinks six or more drinks in a single occasion (how often 6+ drinks). The dependence section (items four to six) contains questions relating to the frequency of not being able to stop drinking when started (unable to stop), failing to meet expectancies (fail to do), and how often a person needs a drink to get going in the morning (drink in morning). The final four questions, items seven to ten, refer to alcohol related consequences. These include items which ask whether an individual feels guilty after drinking (guilt after drinking), how often a person experiences memory loss after consumption (memory loss), whether the person (or someone else) had experienced an injury related to alcohol use (had injury), and finally whether anyone had suggested the person needs to cut down their alcohol intake (suggest cut down).

Scores on each item, for the purposes of these analyses were collapsed into a dichotomous variable (see section 2.4.2 for details). The baseline category reflected the answers scoring zero on the scale, reflecting ‘never’ for questions one, three, four, five, six, seven and eight, ‘1 or 2 drinks’ for question two, and ‘no’ for questions nine and ten. The second category’ represented all other responses for each of the ten questions. Copies of both the original and modified questionnaires are presented in Appendix 1 for reference purposes.

6.3.2.2. Demographic and Mental Health Variables

The demographic variables used in the regression model were gender (female=0; male =1), employment status (unemployed/economically inactive=0; employed=1), age (continuous variable in the range of 16-74), educational attainment (education beyond GCSE=0; up to GCSE level or below=1), area type where the participant resides (rural=0; urban=1) and whether the participant currently smokes (no=0; yes=1).

The mental health predictors that have been used in this model were measured using the Clinical Interview Schedule Revised (CIS-R; Lewis and Pelosi, 1990). When algorithms are applied this questionnaire, ICD-10 criteria for research diagnoses can be produced (Lewis et al, 1992). The ICD-10 diagnoses of generalised anxiety disorder (GAD), mixed anxiety and depressive disorder (MAD) and depressive episode were included in this analysis as predictors, where ‘0’ represents no diagnosis, and ‘1’ represents a present diagnosis.

Three other related variables will also be investigated, whether an individual had attempted suicide in their lifetime and whether an individual had visited their general practitioner (GP) for a physical or a psychological complaint in the past year. For all three variables, the coding represents ‘0’ for no and ’1’ for yes. Further details on all these predictors are given in chapter two.

6.3.3. <u>Latent class analysis</u>

Patterns of drinking were generated using latent class analysis (see chapter 2 for an in-depth illustration of the LCA method). This is a statistical modelling technique used to estimate the number of classes of an underlying categorical latent variable, accounting for the relationships between categorical observed variables (Haagenars & McCutcheon, 2002). This method creates homogenous 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 percentage estimates) and class-specific AUDIT question endorsement probabilities. Assignment of individuals to classes was based on a probabilistic method and not the most likely latent class (Clogg, 1995).

Fit criteria for the two to nine class latent variable solutions using these observed variables have been presented, and a decision about the best fitting model made on the grounds of fit statistics and the relevance to existing alcohol use theory. The fit statistics of the optimal model will have the lowest values of the three information criterion (AIC, BIC and SSABIC), a Lo Mendel Rubin Likelihood Ratio Test (LRT) where the *k-1* class model is superior (when compared with *k* class model generating $p>.05$), minimal number of significant bivariate residuals, and a suitable entropy value (close to 1). Full details of these criteria and the reference works from which they derived can be found in section 2.5.2.3.

6.3.4. Multinomial logistic regression

The conditional probabilities of class membership for each of the participants will be saved and used as the dependent variable in a multinomial logistic regression. Note that, once again, as similar to chapter three and five the latent class model parameters were fixed after generation of the latent variable. Thus, the latent class analysis is only influenced by the alcohol variables. This procedure will produce odds ratios and confidence intervals illustrating statistical significance of each of the independent variables or predictors (whilst controlling for the other predictors) on the dependent variable (conditional probability of class membership). The conditional probability of being in the lowest alcohol involvement class will be the comparison group. In essence, the odds ratios will illustrate a comparison of the other classes to the lowest alcohol involvement class. This chapter utilised 2Δll testing to determine the model which was both parsimonious and a good fit of the data. Briefly, a model was run which freely estimates the regression parameters. Following this a restricted model will be run which constrains the log odds (and thus the odds ratios) to be the same for a particular independent variable across all classes. The loglikelihood of the models has been compared with the view that if there were no significant differences between the models the more restricted parsimonious model would be preferred. If the two models were significantly different the constraints were sequentially relaxed until there was no significant difference between the competing models. When this occurs, the more parsimonious solution of the two competing models represents the optimal solution. Full details, with a worked example of 2Δll testing are given in chapter 2.5.3.1.

The conceptual model tested in this chapter is presented in Figure 19. It illustrates the ten AUDIT variables from which the latent variable of alcohol use and related problems will be derived. It also illuminates the demographic and mental health variables which will be used to predict membership of the latent variable.

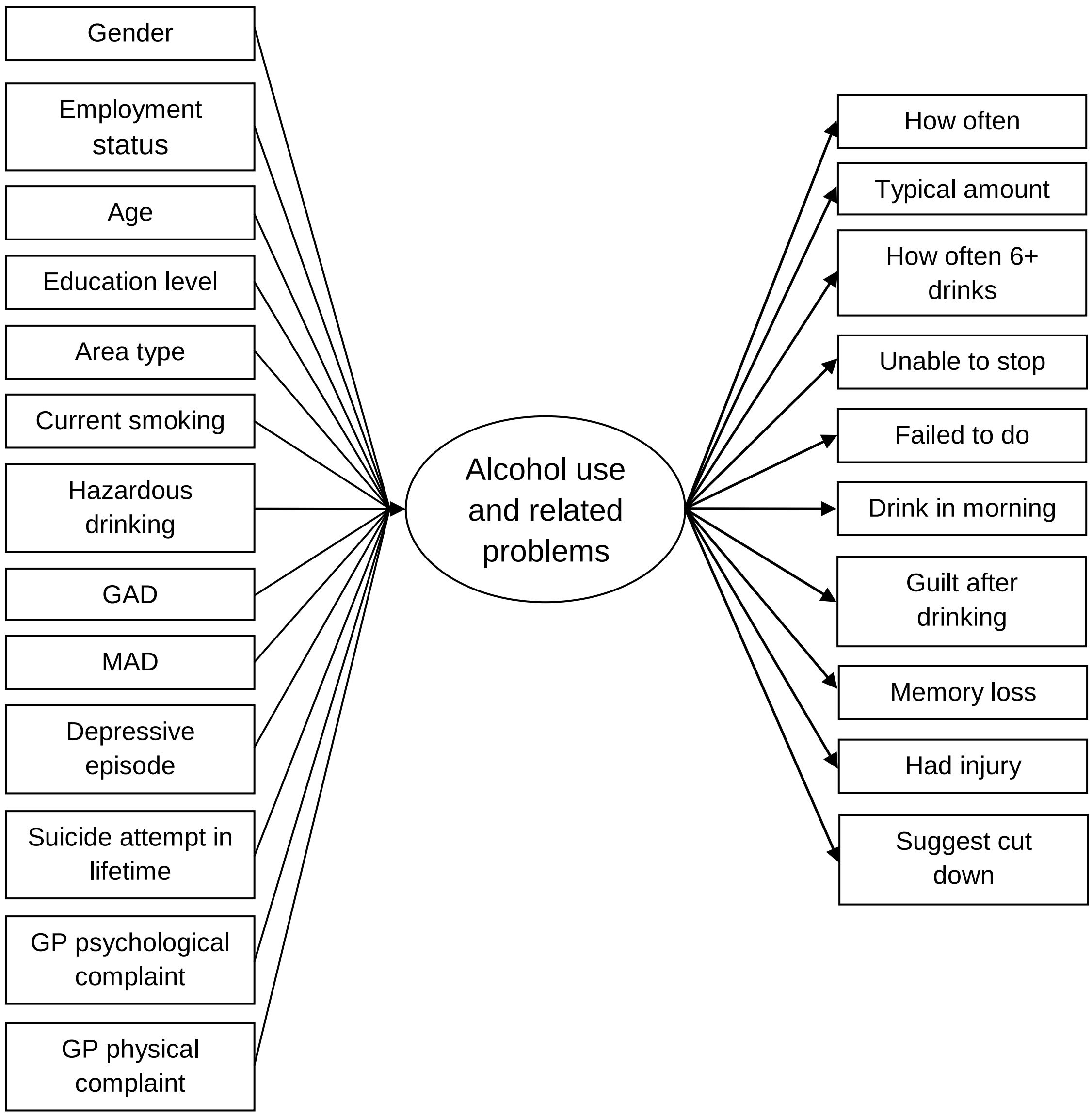

Figure 19: Conceptual diagram of model tested in chapter six.

6.3.5. Software

Data was prepared for analysis using SPSS version 15.0 (SPSS Inc., 2006). Both the latent class analysis and the multinomial logistic regression were performed using Mplus Version 5.01 (Muthén & Muthén, 2007).

6.4. Results

6.4.1. Patterns of response

Patterns of most frequent response to the AUDIT in the sample were given in Table 22. The most common pattern of endorsement represents those who have drunk alcohol in the past year (only). The next most prevalent patterns represent an endorsement of the consumption variables without any alcohol related harm. However, of all the alcohol related harm variables, those most often endorsed were those relating to alcohol related injury, memory loss or requests for an individual to cut down on their alcohol intake. There were 208 different patterns of response for the participants in the study, with the ten most frequent patterns accounting for 77% of the entire sample. Just over 4% of the sample had not drank alcohol in the past year, representing a group of past year abstainers. However, these individuals must at least be very occasional drinkers to have screened into this section. Coupled with the 731 drinkers who screened out of the alcohol section (and were excluded from the latent class analysis), the overall percentage of those who did not drink in the past year was 12.35%.

Table 22: Most frequent patterns of response to the AUDIT questionnaire

Most frequent patterns of response **Alcohol Use**	Frequency %
Drinking in past year	2014 (25.67%)
Drinking in past year, Typical amount three or more drinks, Drink 6+ drinks in past year	1459 (18.60%)
Drinking in past year, Drink 6+ drinks in past year	792 (10.10%)
Drinking in past year, Typical amount three or more drinks	556 (7.09%)
None	329 (4.19%)
Drinking in past year, Typical amount three or more drinks , Drink 6+ drinks in past year, Memory loss in past year	265 (3.38%)
Drinking in past year, Alcohol related injury experienced, Asked to cut down	185 (2.36%)
Drinking in past year, Typical amount three or more drinks , Drink 6+ drinks in past year, Alcohol related injury experienced	183 (2.33%)
Drinking in past year, Alcohol related injury experienced	168 (2.14%)
Drinking in past year, Typical amount three or more drinks , Drink 6+ drinks in past year, Alcohol related injury experienced , Asked to cut down	90 (1.15%)
Total Number of Individuals in the 10 most frequent response patterns	6041 (77.00%)
Total Number of Individuals *not* in the 10 most frequent response patterns	1804 (23.00%)
TOTAL	7845

6.4.2. Latent class analysis

Table 23 shows the fit statistics for the latent class analysis of the ten items of the AUDIT questionnaire. In terms of the LRT the optimal number of classes was 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. The five-class solution had three significant residuals, i.e. three of the most frequent patterns of response have a significant difference between observed frequency of pattern in the dataset, and the expected frequency as proposed by the five-class solution. As the six-class model had no significant residuals, this was additional evidence to illustrate a superior fit to the observed data. In addition, on inspection of the six-class solution in terms of conditional probabilities, it appears that the addition of another class adds a theoretically relevant pattern. Based on this, the six-class solution was considered optimal. The profile plot of the six-class solution is presented in Figure 20.

Table 23: Fit statistics of latent class analysis on the 10 questions of the AUDIT.

Number of Classes	LL (df)	AIC	BIC	SSABIC	Entropy	LRT	p	Number of significant residuals
2	-25442.79 (21)	50927.58	51073.90	51007.17	.73	6436.45	.00	10
3	-24470.82 (32)	49005.64	49228.61	49126.92	.82	1922.50	.00	8
4	-23872.88 (43)	47831.76	48131.37	47994.73	.83	1182.69	.00	5
5	-23743.85 (54)	47595.69	47971.94	47800.34	.74	255.48	.00	3
6	**-23681.40 (65)**	**47492.81**	**47945.70**	**47739.15**	**.73**	**123.63**	**.07**	**0**
7	-23653.03(76)	47458.05	47987.59	47746.08	.74	56.19	.03	0
8	-23640.98 (87)	47455.95	48062.14	47785.67	.73	23.83	.39	0
9	-23628.80 (98)	47453.61	48136.44	47825.01	.69	24.10	.35	0

Note: LL(df) loglikelihood value and associated degrees of freedom; LRT Lo-Mendel-Rubin Adjusted likelihood ratio test value; AIC Akaike Information Criterion; BIC Bayesian Information Criterion; SSABIC Sample Size Adjusted Bayesian Information Criterion.

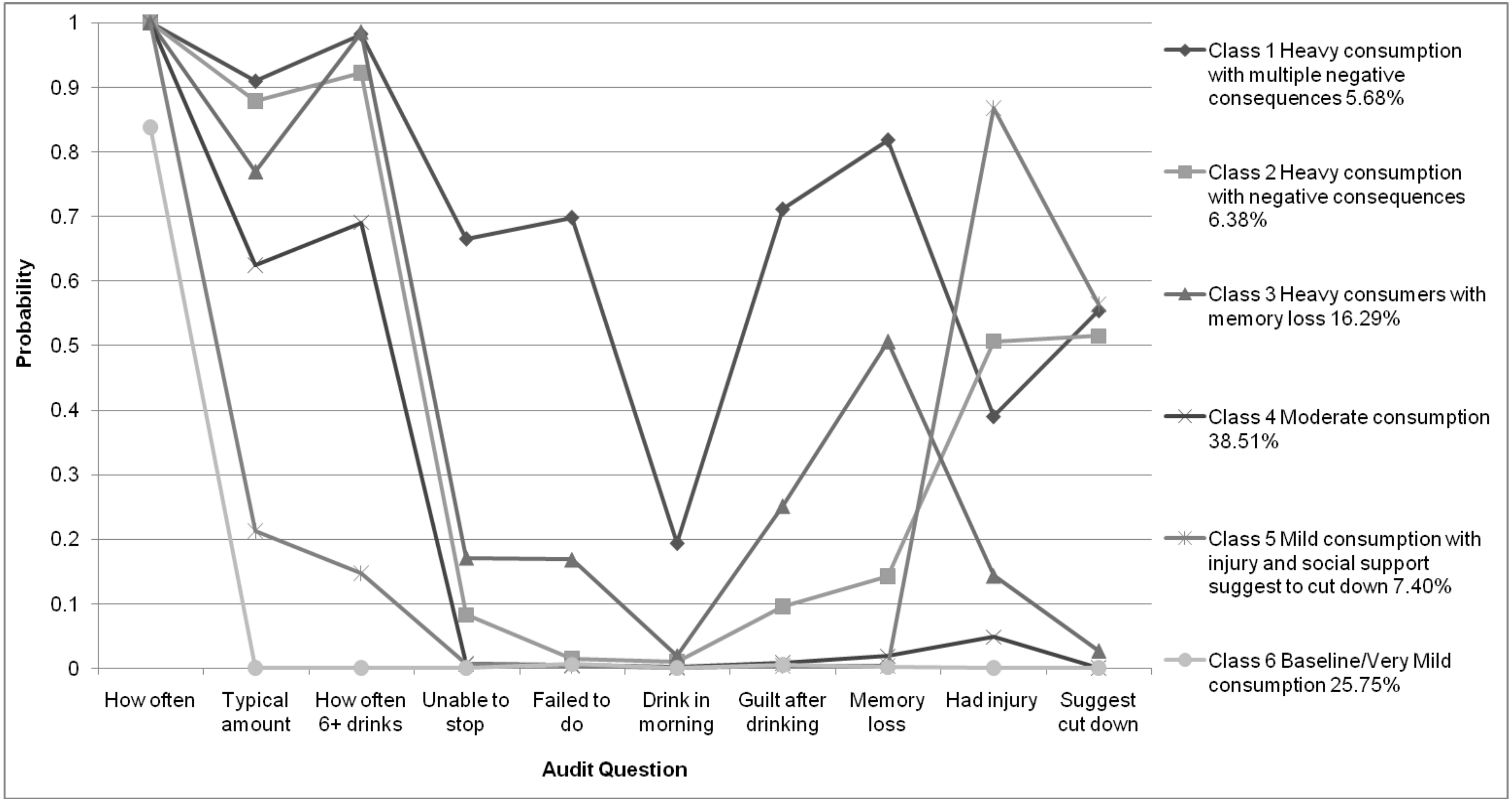

Figure 20: Profile plot of the six alcohol use and related behaviour latent classes.

The largest class was class 4 (38.51%) and was characterised by a moderate probability of having more than three drinks in a typical drinking session, and a moderate likelihood of drinking six or more drinks on occasion. This class had a very low probability of endorsing any of the indicators associated with dependence (items four to six) or alcohol related consequences (items seven to ten). Class 3 was smaller (16.29%) and similar in profile to class 4. However, members of this class were more likely to drink six or more drinks or drink more than three drinks on a typical occasion. Approximately 50% of the individuals in this class had experienced memory loss because of their consumption pattern. In terms of consumption, this class was in an almost intermediary position between the heavy and moderate consumption patterns, however, the high likelihood of endorsing six or more drinks on occasion, suggests it is a heavy consumption class.

Members of class 1 accounted for the smallest proportion of the sample (5.68%), but had the highest probability associated with consumption (items one to three), dependence (items four to six) and alcohol related consequences (items seven to ten). This class also had the highest probability associated with the indicator drinking in the morning, which had a relatively low percentage of use in the total sample of respondents. This profile of heavy use was mirrored in class 2 (6.38%), however, this class had lower probabilities associated with the dependence and consequence indicators. The probabilities associated with the consumption indicators were relatively low for class 5 (7.40%) but high for two indicators associated with negative consequences (items nine and ten). Class 6 (25.75%) represented almost a quarter of the sample and had low probabilities on all items of the AUDIT. This class also included some past year abstainers of alcohol.

6.4.3. Multinomial logistic regression

The fit of the constrained, relaxed and intermediary multinomial logistic regression models are presented in Table 24. The optimal model in the multinomial logistic regression of demographic and mental health variables was model 21, involving 19 modifications to the model.

Table 24: The results of the 2Δll test for the model.

Model	Ll	Df	Model v Model Comparison	*2Δll*	Δ df	p value
1. No constraints	-26196.72	125				
2. Log odds constraints across all predictors	-26739.67	77	2 v 1	1085.90	48	p <.05
3. Constraints on the log odds to be equal except class 2 on age	-26593.03	78	3 v 2	293.28	1	p <.05
4. Constraints as model 3, and class 1 on age relaxed	-26490.39	79	4 v 3	205.28	1	p <.05
5. Constraints as model 4, and class 3 on age relaxed	-26405.37	80	5 v 4	170.04	1	p <.05
6. Constraints as model 5 and class 1 on sex relaxed	-26374.56	81	6 v 5	61.62	1	p <.05
7. Constraints as model 6, and class 5 on sex relaxed	-26326.08	82	7 v 6	96.96	1	p <.05
8. Constraints as model 7, and class 3 on currently smoking relaxed	-26296.67	83	8 v 7	67.44	1	p <.05
9. Constraints as model 8, and class 3 on GAD relaxed	-26283.51	84	9 v 8	58.82	1	p <.05
10. Constraints as model 9, and class 5 on suicide attempt relaxed	-26272.91	85	10 v 9	26.32	1	p <.05
11. Constraints as model 10, and class 1 on currently smoking relaxed	-26262.47	86	11 v 10	21.20	1	p <.05
12. Constraints as model 11, and class 3 on sex relaxed	-26254.48	87	12 v 11	20.88	1	p <.05
13. Constraints as model 12, and class 2 on employment status relaxed	-26247.00	88	13 v 12	15.98	1	p <.05
14. Constraints as model 13, and class 5 on currently smoking relaxed	-26240.98	89	14 v 13	12.04	1	p <.05
15. Constraints as model 14, and class 5 on educational attainment relaxed	-26233.67	90	15 v 14	14.62	1	p <.05
16. Constraints as model 15, and class 5 on GP visit physical relaxed	-26228.46	91	16 v 15	10.42	1	p <.05
17. Constraints as model 16, and class 3 on MAD relaxed	-26224.43	92	17 v 16	8.06	1	p <.05
18. Constraints as model 17, and class 1 on employment status relaxed	-26220.21	93	18 v 17	8.44	1	p <.05
19. Constraints as model 18, and class 3 on suicide attempt relaxed	-26216.93	94	19 v 18	6.56	1	p <.05p
20. Constraints as model 19, and class 4 on GAD relaxed	-26214.70	95	20 v 19	4.46	1	<.05
21. Constraints as model 20, and class 4 on area type relaxed	**-26212.66**	**96**	21 v 20	4.08	1	p <.05
22. Constraints as model 21, and class 3 on depressive episode relaxed	-26210.97	97	22 v 21	3.38	1	**p >.05**

Table 25: Odds Ratios (95% Confidence Intervals) of the optimum multinomial logistic regression model

Predictors	Odds Ratio (95% confidence intervals)				
	Class 1: Heavy consumption with multiple negative consequences	Class 2: Heavy consumption with negative consequences	Class 3: Heavy consumption with memory loss	Class 4: Moderate consumption	Class 5: Mild consumption with injury and suggestion to cut down
Gender (male)	**5.97 (4.86-7.33)**	**3.56 (3.14-4.03)**	**3.56 (3.14-4.03)**	**2.14 (1.92-2.38)**	**1.12 (1.33-1.59)**
Employment status (inactive)	**1.48 (1.32-1.65)**	**1.48 (1.32-1.65)**	**1.93 (1.66-2.23)**	**1.48 (1.32-1.65)**	.98 (.88-1.12)
Age (continuous)	**.93 (.92-.93)**	**.97 (.97-.97)**	**.94 (.93-.94)**	**.97(.97-.97)**	**1.01 (1.00-1.01)**
Educational attainment (GCSE level or below)	**1.22 (1.00-1.50)**	.99 (.88-1.12)	.99 (.88-1.12)	**.82 (.73-.91)**	1.08 (.89-1.31)
Area type (urban)	1.02 (.93-1.13)	**1.26 (1.07-1.47)**	1.02 (.93-1.13)	1.02 (.93-1.13)	1.02 (.93-1.13)
Current smoker (yes)	**4.14 (3.36-5.10)**	**.97 (.96-.98)**	**2.42 (2.10-2.79)**	**.97 (.96-.98)**	**1.25 (1.02-1.53)**
GAD	**2.60 (1.71-3.96)**	**1.67 (1.16-2.40)**	1.08 (.84-1.40)	1.08 (.84-1.40)	1.08 (.84-1.40)
MAD	1.34 (.99-1.82)	.88 (.74-1.04)	.88 (.74-1.04)	.88 (.74-1.04)	.88 (.74-1.04)
Depressive episode	1.02 (.58-1.78)	**.62 (.45-.86)**	**.62 (.45-.86)**	**.62 (.45-.86)**	**.62 (.45-.86)**
Suicide attempt in lifetime	**2.21 (1.48-3.32)**	**1.41 (1.05-1.88)**	**1.41 (1.05-1.88)**	.91 (.69-1.19)	**1.41 (1.05-1.88)**
GP psychological complaint	1.01 (.86-1.17)	1.01 (.86-1.17)	1.01 (.86-1.17)	1.01 (.86-1.17)	1.01 (.86-1.17)
GP physical complaint	1.07 (.95-1.20)	1.07 (.95-1.20)	1.07 (.95-1.20)	.91 (.82-1.01)	1.07 (.85-1.20)

Note: All estimates compared to baseline mild consumption group (Class 6) where values in bold illustrate significant predictors

As the classes' progress in severity of alcohol involvement, Table 25 illustrates an increase in the likelihood of being male compared to the baseline class. Members of class 1 were approximately six times more likely to be male, with an odds ratio of 3.56 for other two heavy consumption classes (2 and 3). Those in classes 4 and 5 were 2.14 and 1.12 times more likely respectively to be male than the baseline class. Classes 1 to 4 had members who were most likely to be economically inactive, with the most likely in class 3 with an odds ratio of almost two. Classes 1 to 4 illustrate a significant decrease in age compared with class 6, suggesting that heavier alcohol involvement was more likely to be found in younger people compared with the baseline mild consumption class. However, those in class five, mild consumers with injury and suggestion to cut down were significantly more likely to be older. Compared to class 6, the members of class 4 had higher educational attainments (more likely to be educated to above GCSE level) and class 1 was characterised by an increased likelihood of being educated to GCSE level or below. The odds ratio for this relationship was 1.22. Except for class 2, no significant effects were found for urbanicity in this sample. Those in this class had a significantly increased likelihood of living in an urban area (OR=1.26). Concerning smoking status class 1 was the most likely to be currently smoking followed by class 3, and 5, however, classes 2 and 4 have an equally lower likelihood to be currently smoking compared with the baseline class.

In terms of mental health outcomes, there appeared to be a protective effect of alcohol use and related behaviours characteristic of classes 2 through 5 for depressive episode. The odds ratio for this relationship was .62. This suggests the risk was approximately halved compared to those in the baseline class 6. There were no significant relationships with depressive episode for the members of class 1. Members of classes 1 and 2 were 2.6 and 1.7 times more likely to have generalised anxiety disorder (GAD). However, those in the class 3, 4 and 5 illuminated no significant relationship with the diagnosis of this disorder. Across all classes, there was no relationship between mixed anxiety and depressive disorder compared to the baseline class. Classes 1, 2, 3 and 5 were characterised by a higher probability of having attempted suicide in the past year. The members of class 1 had the highest likelihood at 2.21 times more likely, and characteristics of classes two through four having the same significant association, all being 1.41 times more likely. Despite the patterns of elevated risk for mental health disorders, the risk of presenting to GP services for either a psychological or physical problem did not differ between the classes. 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 predictors.

6.5. Discussion

The findings reported in this chapter have generated a British population typology which attempts to profile alcohol use based on a standardised measure of alcohol consumption and related problems. This chapter found 208 patterns of response to the AUDIT questionnaire in the observed data. This highlights the variability of alcohol use and related problems in the general population of Great Britain. Thus, inferring valid patterns in alcohol and related behaviour without using a method such as latent variable analysis would be extremely difficult. Overall, including those who screened out of the AUDIT section, 12.47% of the general population of Great Britain did not drink any alcohol in the past year. This was lower than a similar study by Degenhardt and

Hall (2003) who found in their randomly sampled population of Australia a quarter of the sample had not consumed alcohol in the past year. It is also lower than European trends and specific estimates from the UK (EC, 2007; see section 1.2).

Of those who drank alcohol in the past year, the most frequent pattern of endorsement of the AUDIT questionnaire reflected those who drank alcohol, but not more than three drinks per typical occasion, and never six or more drinks in one sitting in the past year. This represented 25.67% of the general population surveyed in this thesis. The most frequent patterns which included an alcohol related consequence involved memory loss, alcohol related injury and pressure to cut down on alcohol consumption. Similar alcohol related consequences loaded highly on their health, legal and dependent dimensions found in a factor analysis of the social consequences of drinking (Gmel, Rehm, Room & Greenfield, 2000).

A six-class solution was found to best describe the patterns of endorsement of the AUDIT questionnaire. These six classes were heavy consumption with multiple negative consequences (class 1), heavy consumption with negative consequences (class 2), heavy consumption with memory loss (class 3), moderate consumption (class 4), mild consumption with injury and suggestion to cut down (class 5) and a final class of baseline or very mild consumption (class 6). Three fewer classes were found in the study by Reboussin et al. (2006). Their analysis was conducted in a sample of adolescent current drinkers, therefore, a little or no consumption class might account for at least one of those classes. Classifications of alcohol use consumption differed somewhat between this chapter and their study. Comparisons could be drawn with their alcohol related consequence of social problems. Their risky and regular problem drinkers had a 40-50% probability of endorsing social problems. This bears some resemblance to the AUDIT question regarding suggestions to cut down on drinking from friends, family or doctors which was most likely to be endorsed by classes 1, 2 and 5. Their social problems from drinking included problems at school, and consequences with friends/parents. In addition, their regular problem drinkers, who had the highest alcohol consumption, were also likely to experience memory loss. Memory loss had a high probability of endorsement for two of the heavy consumption classes found in this chapter (1 and 3).

There were also some key differences between the latent profiles generated by O'Connor and Colder (2005) of US college students. This study found four moderate to high consumption groups representing 58% of their sample. In this chapter, 64.16% of the sample were moderate to high alcohol consumers; however, there was not the same extent of related problems in this group. In contrast, O'Connor and Colder (2005) found their entire moderate to high consumption groups to have a range of moderate to high related problems. Given the moderate consumption group found in this chapter (class 4) did not have a high probability of associated consequences, the comparable percentage might be closer to 25.68% (a reduced proportion which excludes the moderate consumption class). Differences in patterns of consumption and related consequences may be a function of the different characteristics of the populations studied.

Slater et al. (1997) in their cluster analysis of a general population should have been the most similar. This appears to be descriptively true. However, direct comparisons between the groups were difficult as Slater and colleagues did not estimate heavy drinking occasions in their analysis. Given the field has subsequently recognised the importance of heavy drinking occasions in determining the risk of harm in a given pattern (San Jose et al. 2000; Rehm et al. (2003), analyses in this chapter represent a positive step forward, offering new insights beyond what is currently known.

Classes 1, 3, 4, and 6 tended to differ quantitatively rather than qualitatively. This suggests alcohol consumption, dependence and alcohol related consequences lie along a continuum although skewed in relation to the dependence items (items four to six). These items were not highly endorsed by the general population of Great Britain (as might be expected). Support for a continuum with exceptions is commonly found in previous research. Slater et al. (1997) in their cluster analysis found a continuum, but except for the episodic cluster. This cluster drank larger amounts but infrequently, with other clusters having similar numbers of drinks on occasion to number of drinking days per week. O'Connor and Colder (2005) also found a broad continuum but conceded there were some exceptions. Medina-Mora et al. (1998) found a moderate Pearson's correlation of .62 between alcohol consumption and problems. The magnitude of this correlation could suggest the continuum relationship is not always expressed in their population estimates from Brazil. This also shows patterns of use are more useful to understand alcohol related harm rather than average volume of consumption.

Beyond those classes, two classes deviated from the continuum trend. The probabilities of endorsement associated with membership of Class 5 provide clear contradictory evidence. It could be suggested this class represents a group of individuals who do not drink a lot, but drink excessively in certain situations such as festivals or holiday periods (Medina-Mora et al. 1998). Cherpitel, Tam, Midanik, Caetano and Greenfield (1995) in a study of the US

National Population, found those who drink heavily on rare occasions have an elevated risk for injury. They suggest quantity on occasion could be a key factor in risk. The authors propose efforts to prevent accidents should not just be tailored to those who drink in a heavy use pattern. Evidence from this chapter also identifies a need for preventative intervention. This is particularly relevant as heavy consumers tend to be fewer in number than moderate or mild consumers, and thus prevention attempts which are aimed widely may have more effect.

Class 2 were characterised by similar consumption probabilities to those in classes 1 and 3. However, the probabilities associated with the traditional dependence indicators (items four to six) were relatively low and the probabilities associated with two negative consequences indicators were relatively high (alcohol related injury and suggestions to cut down). For this class there was 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 heavier drinking classes (Classes 1, 2 and 3) were characteristic of being more likely to be male, young and economically inactive (compared to Class 6). Finding greater consumption of alcohol amongst young males is supported by previous research in Europe (EC, 2007). This study found young males had more frequent drinking occasions, with higher typical consumption and higher occasions of binge drinking. The odds ratio of being male (compared to female) increased with increasing alcohol involvement in this study. Falk et al. (2008) in a general population survey of the US (NESARC) found males were less likely to have abstained from alcohol in the past year (71.8% compared with 59.6% in females). In addition, older respondents were more likely to abstain from alcohol use. Slater et al. (1997) also found their non-drinking group were more likely to be female and older

Between latent classes, there were characteristic significant differences, a finding like Reboussin et al. (2006). This study found a greater likelihood of being male between the heavier regular problem drinker and risky problem drinkers. This represented a decreasing ratio of females to males as extent of alcohol use increased. This pattern was replicated in this chapter. However, Reboussin and colleagues found age patterns to be more variable. Their moderate and heavy group were the oldest with mean ages of 47 and 44 years old respectively. Their youngest group (mean age 29 years) was characterised by drinking in an episodic pattern. In contrast, the youngest individuals in this analysis were most likely to be members of classes 1 to 4. Only the members of class 5 were found to be significantly older than the baseline class 6.

Significant differences were also found between latent class membership and economic activity. Inactivity was significantly associated with all classes compared to those in the baseline class with exception of class 5. The largest association was found in class 3. This is not unsurprising. A study in a sample of unemployed persons by Claussen (1999) illuminated both a significant relationship between alcohol abuse and unemployment. Whilst causal relationships cannot be inferred in cross sectional data such as this analysis, Claussen (1999) suggested unemployment often causes alcohol abuse rather than the converse. Manninen et al. (2006) also found significant differences in employment. Male, heavy alcohol consumers were 1.55 times more likely to be unemployed. This is very similar in magnitude to the relationship between classes 1, 2, and 4 in terms of economic activity. These classes were 1.48 times more likely to be economically inactive than the baseline class. Manninen and colleagues also found this relationship to be exclusive to males. All the classes in this analysis were more likely to be male than the baseline class. Therefore, this supports the reported gender difference. The paper did not find any significant differences with education for either males or females in relation to heavy drinking patterns. This chapter only found a significant relationship between class 1 and class 4 compared to the baseline class 6. The former was 1.22 times more likely to be educated to a GCSE level or below, with the latter associated with higher education. This would appear contrary to European trends in population level alcohol use (EC, 2007). Low education was related to lower consumption in Europe and being currently engaged in education was associated with higher consumption. Only class 2 was significantly related to urban area type. They were 1.26 times more likely to be living in an urban area in comparison to class 6. This is supported by a review of social determinants of licit and illicit drugs (Galea et al., 2004) who found the relationship between alcohol (and other drug use) to be ambiguous. Neighbourhood traits, such as peer or family attitudes were considered to affect alcohol use to a greater extent than urbanicity. Whilst not directly measured, this appears broadly supported by this research.

The results of the multinomial logistic regression based on the psychological variables indicated generalized anxiety disorder and suicide attempts were only associated with classes 1 and 2, characterised by high consumption. This is consistent with the research literature has identified negative psychological consequences of excessive consumption. For example, Rodgers et al. (2000) found elevated mean scores on both the Goldberg and DSSI/sAD anxiety questionnaires for both males and females who drank in a hazardous or harmful way (measured by AUDIT). However, in the context of this study, where three clusters of indicators were modelled (consumption, dependence, & consequences) the psychological outcomes may also be attributable to related affective states guilt, injuries, or social relations (being asked to reduce consumption). The relationship of heavy alcohol consumption patterns with lifetime suicide attempts is reflected in trends found in a US population study by Dawson (1997). This study found a significant relationship between average volume of alcohol and risk for suicide attempts when controlling for demographic criteria.

Depressive episodes were significantly less likely for those drinkers in classes 4 and 5. This indicates 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. Furthermore, moderate drinkers may do other things in moderation which could protect against harm (Lipton, 1994). Class 2 and 3 were also characterised by a decreased risk of depressive episode. These were heavy consumption groups and appear to be contrary to hypothesised relationships. However, Manninen et al. (2006) lend some support. They found males aged 45 to 64 years who engaged in heavy drinking episodes were 2.34 times more likely to have a BDI of over 10. However, males in this age range who did not engage in heavy drinking episodes were also 1.52 times more likely to have a BDI over 10 (these were all compared to a group of males aged 25 to 44 who did not engage in heavy drinking episodes). There were no significant differences in depressive episode risk for heavy alcohol users who were male and aged between 25 to 44 years. Females aged 25 to 44 years engaging in heavy drinking occasions were 1.65 times more likely to have a BDI over 10 compared to females aged 25 to 44 who did not engage in heavy drinking behaviours. Those who did not engage in heavy drinking occasions in this age range were also 1.67 times more likely to have a BDI over 10. Both this paper and the findings in this chapter support the assertion by San Jose et al. (2000) investigations into alcohol related harm should relate to overall patterns of use including heavy drinking occasions and average quantity and frequency.

Increased likelihood for depressive episode or MAD appears likely to relate to alcohol use patterns in a non-linear curve. Whilst some odds ratios were not significant in comparison to the baseline class, their magnitude tentatively suggests the highest risks are in class 1 and the baseline, with lower odds ratios and risk found in classes 2 through 4. GAD and suicide attempts in the lifetime were also likely to be related to alcohol consumption in a non-linear way. However, differences were not significant for classes 4 and 5 (suicide attempts in lifetime) and classes 3 through 5 (GAD) suggesting these are more similar to the characteristics of the baseline class 6. The significant odds ratios found for classes 1 and 2 illustrate the increased harm associated with these patterns of use. Non-linear relationships between alcohol use and anxiety and depression scores were also found in Rodgers et al. (2000). It is impossible to say whether trends in this chapter reflect a ‘U’ shaped or ‘J’ shaped curve, given not all relationships were significant. General patterns of decreasing risk of mental health conditions from class 1 to class 5 lend further support to an underlying continuum of alcohol consumption, dependence, and negative consequences at the population level. However, as mentioned above, such an interpretation warrants extreme caution, as not all effects were statistically significant.

Despite any elevated or decreased risk for mental health conditions in general population alcohol use and related behaviour classes, there was no associated change in treatment seeking. This appears contrary to findings by Cryer et al. (1999) and DeWin et al. (2006). Differences between previous research and this current chapter may be a function of the measurement of alcohol patterns.

In conclusion, this study found support for a population typology of alcohol related behaviour 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 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, it is unclear as to how the results of this chapter might relate to elevate risks of harm caused by illicit polydrug use. Many illicit drug users are also consuming alcohol, regardless of whether they use more than one illicit drug in either simultaneous or concurrent polydrug use patterns. The next chapter will address this problem. It will attempt to create a unified model of alcohol and illicit polydrug use, assessing the relationship with demographic variables and psychological harm.

7. Towards an integrated model: Can heterogeneity in alcohol and illicit polydrug use patterns be expressed in one model?

7.1. Abstract

Results from previous chapters suggest that illicit polydrug use, alcohol use and related behaviours can be described in homogeneous latent classes. However, given most illicit drug users also use alcohol, it is unclear to what extent typologies relate to each other. This final chapter aims to examine this relationship to create a polydrug use model. Data used was from the NPMS survey, a stratified, multi-stage probability sample of the population of Great Britain (n=7849). Four approaches were adopted in assessing the relationship between licit and illicit drug use. These included inspection of observed patterns of use. The second was a correlation between existing latent class structures (from chapters three and six). The third involved estimation of a single latent variable of all nine yearly drug use indicators and 10 AUDIT questions using latent class analysis. The final approach modelled the two (licit and illicit) drug use latent variables separately, but allowed them to vary as a function of each other. Both latent class models were regressed on demographic criteria and variables relating to psychological status. All these approaches illuminated strong links between illicit polydrug use and alcohol. The latent structure of illicit drug use varied when measured with alcohol use variables. Alcohol use latent classes broadly did not change, however, differences were found in relation to current psychological status. This suggests the traditional position of separating the two drugs in research can affect the nature and magnitude of relationships with psychological status.

7.2. Introduction

Chapters three and six have shown illicit polydrug use and alcohol use can be profiled into distinct classes. Three classes best explained the variation in patterns of illicit polydrug use. Six best explained observed patterns in alcohol use and related behaviours. However, almost all illicit drug users use alcohol (see section 1.6 for frequencies), and patterns of polydrug use encompassing both drugs are understudied in the literature. This chapter will first explore reasons why drugs are typically separated. Following this, previous research which has attempted to address this problem will be presented.

One of the key reasons for separation reflects the large volume of research in both fields, thus it is difficult to synthesise these entities together (Courtwright, 2005). However, there are other reasons. The first concerns measurement of alcohol or illicit drugs. Alcohol and illicit drug use are not usually measured in a comparable way. Given the increased frequency of alcohol use in the general population (EU, 2007), it is rare for lifetime dosage to be measured (Bondy, 1996). Given the variability in alcohol use and related behaviour patterns demonstrated in chapter six, any estimate of lifetime alcohol consumption would need to span from zero to a very large number of occasions. Estimating lifetime frequency of drug use would typically be much lower in range. Therefore, even in a basic approach such as lifetime quantity, which does not assess patterns of either alcohol or illicit drug use, the ranges of response are different. When a more sophisticated approach is taken, an increase in the number of variables which would measure patterns will compound this problem.

Secondly, they have been traditionally separated in policy due to their legal status. Primarily, this relates to goals for harm reduction between alcohol and illicit drugs. The most recent alcohol strategy states that “alcohol can play an important and positive role in British culture” (pp.5; Department of Health [DOH], 2007). This contrasts with the perceived impact of drugs on culture. The drug strategy suggests “Drug misuse can damage an individual’s ability to work, to maintain relationships and to care for dependants. Drug misuse – whether legal or illegal – can have a significant negative impact on the development and achievement of young people. This not only affects those who use drugs, but also their families, their children and wider society.” (p. 21; DOH, 2008). This paints a considerably bleaker picture for drug use compared to alcohol use. It is also indicative of the aims of alcohol policy to reflect increased moderation of use, and drug policy broad aims of population abstinence (Cheung, 2000; Riley et al., 1999; Single, 1995)

Third, in any given study, only one of alcohol or drug use may be measured. This may reflect the separation in policy. Thus, if researchers wish to inform policy, they may wish to investigate either alcohol or illicit drugs. Williams and Parker (2001) note the traditional practice of the separation of illicit drug and alcohol research and subsequent policies reduces quantity of robust information on concurrent (and simultaneous) polydrug use.

The percentages of polydrug use presented in section 1.6 demonstrate the use of alcohol and illicit drugs (AOD) is intertwined. Frequently, the use of alcohol is overlooked in the conceptualising of illicit polydrug users (Ives & Ghelani, 2006) and this was reflected in the range of illicit polydrug use. As a result, there may be some individuals using a single illicit drug, who are really illicit and licit polydrug users, and the polydrug use rate is an underestimate.

Illicit polydrug use was related to alcohol consumption from work in this thesis to date. From chapters three and five, the membership of the wider (class

1) and moderate range polydrug use (class 2) were demonstrated to be highly associated with hazardous drinking compared to those in the baseline no drug use (class 3). This is supported by research by Lamers *et al.* (2006). This paper found their two groups ‘ecstasy /cannabis’ and ‘cannabis users’ more likely to be experiencing alcohol problems, measured by the ASI compared with no drug users. This demonstrates a relationship with hazardous or problem drinking for illicit drug users. Allott and Redman (2006) in research focussing on patterns of polydrug use in ecstasy users illustrate a high proportion of ecstasy users used alcohol before (91%), during (81%) and after (60%) their consumption of ecstasy.

Furthermore, this thesis has demonstrated a strong relationship with current smoking status amongst illicit drug and alcohol users. In examining the classes of alcohol users from chapter seven, those in classes 1, 3 and 5 were 4.14, 2.42, and 1.25 times more likely to be currently smoking compared to those in the baseline class. However, two groups are atypical to the pattern, and suggest the likelihood of being a current smoker is not necessarily positively correlated with increased involvement in alcohol use and related problems. These were the heavy consumption with negative consequences (class 2) and the moderate consumers (class 4) who were found to be slightly less likely to be smoking than the baseline low alcohol consumption class (chapter seven).

The relationship found to date between drugs lends some, albeit cross-sectional support for the longitudinal gateway theory. Briefly, this is a progression from alcohol, through tobacco, cannabis and other illicit drugs (Kandel and Faust, 1975). Furthermore, the exploration of AOD patterns should illustrate particularly whether current drug use is related to heavier consumption patterns of alcohol. Given hazardous or problem drinking patterns are proposed to mediate the jump between licit and illicit drugs (Kandel et al., 1992), an association with these and stronger involvement with drug use should be apparent when addressing the complete picture of drug use.

Some of the studies which have attempted to measure AOD use focus on the use of a single drug comparing this to the use of other licit or illicit drugs. For example, O'Grady, Arria, Fitzelle and Wish (2008) in a convenience sample of 520 undergraduate students in the US, compared the illicit drug use consumption between three groups of alcohol consumers. The first of these were light drinkers, those who drank one to four drinks on occasion. The second group were moderate drinkers who drank five to nine drinks on occasion. The final group were heavy drinkers, those who drank 10 or more drinks on occasion. Differences in the odds ratios of lifetime use of illicit drugs were largest between the light and heavy drinkers. The heavy drinking group were 5.21 times more likely to be smoking, 10.11 times more likely to use cannabis, 10.45 times more likely to use analgesics and 9.4 times more likely to be using hallucinogens. In addition, the traditional nightclub drugs of amphetamines, cocaine, and ecstasy were also more likely to be found in the heavy group compared to the light, with odds ratios of 9.68, 8.48 and 7.38 respectively. This is a clear indication of heavy alcohol use and its relationship to lifetime use of illicit drugs. However, this does not infer any extent of use. Illicit drugs could have been tried once or used consistently as there was no indication of the extent of consumption of the illicit drugs. This also demonstrates the problems of comparable measurement in AOD research.

Using alcohol as the primary drug from which to compare licit and illicit polydrug use is common. This is likely due to the percentage of this drug compared to other drugs (see chapter one). Degenhardt and Hall (2003) followed a similar methodology. They examined 10,641 participants in the 1997 National Survey of Mental Health and Wellbeing (NSMHWB), a random sample of the Australian general population. Cannabis and other drug use was more likely in those who used alcohol with odds ratios (adjusted for demographic criteria) of 2.95 and 3.61 respectively compared to those who did not use alcohol. Similarly, this study also found the odds ratios for alcohol use abuse and dependence were highest in those who used cannabis (OR's=2.95; 7.45 and 8.99 respectively) compared to those who did not. This proposes cannabis use may be linked to problems with alcohol use. It would additionally lend support to Kandel et al. (1992) who see hazardous alcohol use patterns as being relevant to change between non-use and use of illicit drugs.

Other approaches to patterns of AOD use have focussed on a single illicit drug. For example, Topp et al. (2004) found key differences in polydrug use focussing on ecstasy use. The authors compared two subsamples from the National Drug Strategy Household Survey (NDSHS) of regular ecstasy users (n=48) and recent ecstasy users (n=199) and a purposively sampled group of regular ecstasy users (n=163). Regular ecstasy users from the purposive sample represented the highest overall frequencies of use (however, this might be explained by the time frame of one year, compared to six months for two the NDSHS groups). The two regular ecstasy user groups had similar alcohol use percentages with the NDSHS group slightly lower at 73% compared to 79% for the purposively sampled group. However, the two regular groups become more distinct when examining percentages of cannabis use; 82% use of the purposive sample used cannabis compared to 62% in the NDSHS. A similar result was found for amphetamines with 85% compared to 52% for the purposive and NDSHS samples respectively. Cocaine use was reported by 44% of the purposive regular users, 26% of the NDSHS regular users and only 7% of the recent ecstasy users from the NDSHS. Cannabis, amphetamines and cocaine were used by 34%, 42% and 7% of the recent NDSHS ecstasy users. As demonstrated above, these percentages were lower than the other two groups. It could be proposed that the greater the frequency of ecstasy use, the greater the frequency of other drugs consumed, including alcohol

There are also demographic differences in patterns of AOD polydrug use. Falk et al., (2008) found the highest level of polydrug use in the past year in their category of males aged between 18-24 years old (19.4%). As age increased the percentage of polydrug use in males decreased, 8% for those aged between 25 and 44 years, 3.6% for those aged between 45 and 64 years and for those aged over 65 years, the percentage of polydrug use was .7%. For females, a similar pattern emerged, although they had notably less polydrug use than the corresponding age groups for males. The percentage of polydrug for those aged 18-24 years was 12.5%, followed by 5%, 2% and .5% for those aged 25-44, 45-64 and 65+ years old respectively.

Topp et al. (1999) studied a group of 329 ecstasy users from Sydney to determine AOD differences in terms of mental health presentation. Note this group all had taken ecstasy in the past 6 months. The following drugs were used by the group at a frequency of 75% of the cohort or higher tobacco, amphetamines, cannabis and alcohol (listed in increasing magnitude). Using multinomial logistic regression, they found being female, using drugs to recover from a session, extensive polydrug use, and stimulant binge episodes were all related to more psychological side effects, accounting for 16% of the variance in the model. The most common side effects reported by this group were irritability, trouble sleeping, depression and confusion. The mean number of problems experienced was 1.2 (SD=1.1). There was also some evidence of primary care help seeking (GP's) in this sample. Of the surveyed individuals, 11% said they had visited their GP for a problem self-attributed to their drug use.

Pederson and Skrondal (1999) found differences in Hopkins Symptoms Checklist scores (HCL: Derogatis, Lipman, Uhlenhut, & Covi, 1974) between groups of illicit drug users. Cannabis only users were significantly higher in their HCL symptomatology than those not using illicit drugs. This group had significantly lower HCL scores than 'amphetamine only', 'ecstasy only' and 'amphetamines and ecstasy polydrug' users. Symptomatology for the no drug use group was significantly lower than all illicit drug use groups. The authors also state all their groups were cannabis users to a large extent. The range of the smallest to largest mean number of symptoms endorsed on the scale for the researcher chosen groups was .57 to 1.53, and consequently the findings must be interpreted in this context. However, AOD use in this sample was common. Therefore, these relationships may have been affected by alcohol use patterns found in this paper. Alcohol use was highest in the 'amphetamines and ecstasy polydrug' group compared to the cannabis only or illicit drug abstainers. The group with the least alcohol consumption did not consume illicit drugs.

Newcomb et al. (1993) in a prospective study of adolescents tracked over 12 years (on four time points) took a different approach. They found adolescent polydrug use could be hypothesised as being part of a continuous latent construct (through factor analysis). Adolescent polydrug use was largely reflective of cannabis use, followed by alcohol, cigarette, cocaine and other hard drug use (in descending order of magnitude of factor loadings). The highest factor loadings of young adult polydrug use (in contrast to adolescent polydrug use) reflected cocaine, cannabis, hard drugs and then alcohol and cigarettes. Adolescent polydrug use was a significant predictor of young adult polydrug use (β=.75). They also found increased polydrug use (the change between adolescent and young adult polydrug use) was a significant predictor of anxiety and suicide ideation. Some individual (observed) drug frequencies were also related to mental health outcomes. Firstly, alcohol and cannabis frequency significantly predicted CES-D scores (β=-.12 and β=.17 respectively). Regarding suicide, increased cannabis use and increased cocaine use were significantly predictive of suicide attempts with β=.15 for cannabis use and β=.14 for cocaine use.

In a later wave of the study, which originated with a sample of seventh to ninth grade students in Los Angeles County (first surveyed in 1976), Earleywine and Newcomb (1997) constructed two further continuous latent variables of concurrent and simultaneous polydrug use through factor analysis. This analysis of drug use and consequences refers to wave 13 collected in 1988 and follow up consequences were also assessed at year 17 wave in 1992. Indicators of concurrent use (presented in order of greatest to least magnitude of factor loadings) were cannabis, other illicit drug, cigarette and alcohol use. Simultaneous polydrug use was measured by six patterns of drug use combination (factor loadings in brackets): cannabis and other illicit drugs (.99), alcohol and cannabis (.86), alcohol and illicit drugs (.84), cigarettes and illicit drugs (.65) cigarettes and cannabis (.63) and cigarettes and alcohol (.55). These continuous factors of simultaneous and concurrent polydrug use were significantly correlated with psychological distress but concurrent polydrug use explained a higher proportion of the variance (3% and 15% variance explained by simultaneous and concurrent polydrug use respectively). Concurrent polydrug use was also related to psychological distress four years later (r=.21). There were no significant relationships with health service utilisation at either baseline or four years later.

A study by Midanik et al. (2007) which also separated polydrug use into simultaneous and concurrent drug and alcohol use patterns using the National Alcohol Survey (n=7612) compared the patterns of ‘cannabis and alcohol’ and ‘other drugs and alcohol‘ with those who did not fall into either of those two groups. Concurrent and simultaneous cannabis and alcohol use was related to being young. Concurrent users were 5.05 times more likely to be aged 18-29 years. Simultaneous users were 5.85 times more likely to be aged 18-29 or 4.63 times more likely to be aged 30-49 years compared to those aged greater than 50 years old. Simultaneous cannabis and alcohol users were significantly more likely have lower educational attainment (OR=2.32). Both concurrent and simultaneous users of other drugs and alcohol excluding cannabis were more likely to binge drink (conceptualised as five or more drinks on occasion). Simultaneous users were 14.17 times more likely to binge drink monthly and 2.77 times more likely to be binge drinking yearly compared to those who did not use other drugs and alcohol. Concurrent users were 1.85 times more likely to binge drink compared with those who did not use other drugs and alcohol in the past year. Simultaneous cannabis and alcohol users also had higher odds ratios for binge drinking than their concurrent counterparts. This group were 3.99 times more likely to binge drink at least yearly and 8.64 times more likely to binge drink monthly. Those who used cannabis concurrently were 1.78 times more likely to drink five or more drinks in a day yearly. Despite these differences in alcohol consumption, all groups were similarly more likely to have depression with odds ratios ranging from 1.8 for simultaneous cannabis and alcohol use (compared to those not simultaneously using cannabis and alcohol) to simultaneous other drug and alcohol use (compared to those who were nor using simultaneously other drugs and alcohol) with an odds ratio of 2.6. This proposes there is a global risk for depression for those using illicit drugs whether concurrently or simultaneously, which might not necessarily be related to binge drinking.

There are a few patterns of licit and illicit polydrug use which have been described in detail in chapter four. However, these will briefly be described for reference. Smit et al., (2002) in their cluster analytic study of 6326 adolescents found three groups of polydrug user. These were an ‘alcohol and tobacco’ cluster, a ‘cannabis, alcohol and tobacco’ cluster, and a ‘cannabis, alcohol, tobacco and other drug use’ cluster. Mitchell and Plunkett (2000) found four groups of combined AOD polydrug use, ‘no use’, ‘alcohol and cannabis’ use, ‘alcohol, cannabis and possibility of other drugs’, and ‘alcohol, cannabis and multiple drugs’ in their sample of American Indian Adolescents. Another study conducted by Whitesell *et al*., (2006) on two American Indian Reservation populations and the National Household Survey of Drug Abuse (n=1244; n=1443 and n=39152 respectively) , found four lifetime groups, ‘abstainers’, ‘alcohol only’, ‘alcohol and cannabis’ and ‘polydrug’ users in their household population. Their yearly groups in the same population found groups reflecting abstention, primarily alcohol, and alcohol and other drugs.

In conclusion, given the potential harm previous research has suggested derives from AOD use, research needs to be more focussed on polydrug use than individual substances (Stockwell, 2007). To date, aside from the Whitesell study above (Whitesell et al., 2006) there have been no studies which have examined this polydrug use problem in the general population using a categorical latent variable modelling framework (latent class analysis). This novel method of deriving empirical patterns will be able to explore the characteristics of a polydrug use latent class structure. Therefore, this chapter has four aims, the first of these is to profile licit and illicit drugs in a model representing AOD polydrug use. The second is to validate these in terms of their demographic profile and determine the characteristics of each classes' membership. Third, the resultant latent classes of AOD polydrug use will be regressed on mental health criteria to determine their relationship with current psychological status, to provide an indication of harm associated with a given polydrug use pattern. And finally, to compare the results to the patterns of alcohol use and illicit polydrug use previously derived in chapters three and six.

7.3. Methods

7.3.1. Participants, data and sampling

Data used in this paper was taken from 7849 individuals in the NPMS survey, a multi-stage stratified sample of households in England, Scotland and Wales (Singleton et al., 2001a; 2001b). This was a reduced subset of the overall 8580 individuals who took part in this survey, representing those who answered both the alcohol use disorders identification test (AUDIT) and the drug use in the past year questions which comprised the latent variable from chapters three, four and six. The mean age of the sample was 45.38 years old (SD=15.61) and 55.12% of the sample were female. Further details of the data, sampling strategy and the participants are given in chapter two.

7.3.2. Measures

7.3.2.1. Alcohol use variables

Alcohol use was measured using the ten item alcohol use disorders identification test scale (AUDIT; Saunders & Aasland, 1987; Babor et al, 1992b). This is a widely used questionnaire measuring hazardous drinking over the past year in a given population. Three conceptual domains are contained in this instrument; alcohol consumption, dependence and alcohol related problems. The first alcohol consumption question measures how often an individual drinks alcohol (how often). If an individual scored one for this question this represented drinking alcohol in the past year, where zero represents less than this frequency. This is followed by a question asking how many standard drinks an individual has on a typical day of drinking (Typical amount; ‘0’ represents one or two and ‘1’ three or more drinks) and how often a participant had six or more drinks on occasion (How often 6+ drinks; ‘0’ represents never; ‘1’ less than monthly or more frequently).

The dependence section also has three questions commencing with “During the past year, how often have you found you were not able to stop drinking when you started?” (Unable to stop), scored as ‘0’ never or ‘1 could not stop drinking when started on an occasion in the past year. The two other questions in this section were asking how often individuals failed to meet expectations due to drinking (Failed to do) and how often in the past year a drink was needed to get going in the morning after a heavy drinking session (Drink in morning). Both were coded as zero for never and one for either alcohol related behaviour having occurred in the past year.

The final section, ‘alcohol related problems’ has four questions. The first two of these cover how often an individual had a feeling of guilt or remorse after drinking (Guilt after drinking) and how often an individual was unable to remember what happened the night before because of a drinking episode (Memory loss). A zero response is equivalent to never and one, the experience happening at least once in the past year. The final two questions of the questionnaire and this section ask whether either the respondent or someone else been injured as a result of an individuals' drinking? (Had injury) or if a relative, friend, doctor or other health professional been concerned about your drinking or suggested you cut down? (Suggest cut down). A zero response for either of these two items reflects this never being true, and one being true at a point in the lifetime which may not necessarily have been during the past year.

In addition, for some analyses using the previously derived latent class structure as presented in chapter seven, the saved conditional probabilities of the model have been used. These were saved in the same order and represented the same patterns of endorsement from the heavy consumption and multiple negative consequences to the baseline very mild consumption (the sixth class).

7.3.2.2. Drug use variables

Measurement of drug use in the past year included the drugs cannabis, amphetamines, cocaine, ecstasy, LSD, mushrooms, tranquillisers, amyl nitrate and a composite heroin or crack variable. These were all binary variables where no use in the past year scored zero and use in the past year scored one.

For the analyses in this chapter which require use of the drug latent class variable generated in chapter four, the conditional probabilities of the three-class solution have been saved reflecting both the same order in which they were presented and the same patterns of endorsement. For ease of interpretation, wide range drug use is now referred to as drug 1, moderate range drug use, drug 2 and no drug use, drug 3.

7.3.2.3. Demographic and mental health variables

All demographic variables used in this chapter reflect those used in chapters three through six, however, a summary has been given below for reference. Gender was represented as female ‘0’ and male ‘1’. Employment status was coded as economically active scoring zero and individuals who were economically inactive scoring one. Other binary variables included educational attainment (beyond GCSE level/statutory education=0; up to GCSE level or below=1), whether the participant was a current smoker (0=no; 1=yes) and area type where the participant lived (rural/semi-rural=0; 1=urban). Age was measured as a continuous variable in the range of 16 to 74 years old.

Predictors illustrating relationships with mental health included diagnoses of generalised anxiety disorder (GAD), mixed anxiety and depressive disorder (MAD) and depressive episode. These were scored as zero for absent, and one if the condition was present. These were measured by answers on the Clinical Interview Schedule Revised (CIS-R; Lewis & Pelosi, 1990). When algorithms are applied to this questionnaire, ICD-10 diagnoses of the three above conditions can be produced (Lewis et al., 1992). Furthermore, questions were asked as to whether an individual has visited their General Practitioner (GP) for either a physical or psychological problem in the past year. This was coded as zero for no visits and one if an individual had made one or more visits in the past year. In addition, whether an individual had attempted suicide in their lifetime has also been used as a predictor, ‘0’ illustrating no attempts, and ‘1’ as one or more attempts.

7.3.3. Statistical methods: frequencies, correlations and latent class analyses

This chapter takes four different approaches to integrating alcohol and drug use into an overall polydrug use model. First to be considered will be observed patterns of illicit drug and alcohol polydrug use. The second approach involves correlating existing latent class structures from chapters three and six[9]. The third model will create one latent variable of all licit and illicit drugs using latent class analysis. Finally, the last latent class model will determine two latent variables, one of illicit drug use, and one licit drug use, although allowing their structure to vary as a function of each other. The methods employed in generating these models will be considered below.

7.3.3.1. Patterns of observed response to nine illicit drug use variables and 10 questions from the AUDIT.

The 10 most frequently observed patterns of response in the data across all 19 indicators will be reported. Should these not contain any of the illicit drug use variables, a table will be presented of observed patterns containing at least one illicit drug. This is possible as frequencies of illicit drug use are low in comparison to estimates of alcohol use in the general population of Great Britain. These will be compared to observed patterns from existing chapters.

7.3.3.2. Correlation of the conditional probabilities of class membership

Before fitting a model of licit and illicit polydrug use, correlations were used to demonstrate the relationship between the posterior probabilities of class membership from the existing latent class models. In practice this represented an estimate the strength of the relationship between the three existing drug

[9] Note that existing latent classes will be referred to in the text as illicit drug class 1, illicit drug class 2 and illicit drug class 3 (for the three class illicit polydrug use solution). Existing alcohol use classes will be referred to alcohol class 1 through alcohol class 6. This was to improve clarity of the results and discussions. The order of the classes remain the same as in the original chapters three and six, where either class 1 represents the class with the greatest involvement in illicit drug or alcohol use and either class 3 (illicit polydrug use) or class 6 (alcohol use) represented the least involvement.

classes, wide range, moderate range and no (illicit) polydrug use (illicit drug 1 to illicit drug 3) with the six alcohol use and related problem classes, heavy consumption with multiple negative consequences, heavy consumption with negative consequences, moderate/heavy consumption with memory loss, moderate consumption, mild consumption with injury and social support suggestion to cut down and baseline or very mild consumption (alcohol class 1 to alcohol class 6). This procedure provided correlation coefficients and an illustration of the significant differences between membership of a given illicit drug latent class with a given alcohol latent class. Note this is intended to be illustrative of similarities rather than providing an interpretable model of polydrug use.

7.3.3.3. Model A: Placing all (19) binary indicators of alcohol and illicit drug use into one latent class model

By placing all the binary indicators from both latent class analyses conducted in chapters' three and six into a single latent variable, a model has been estimated which attempts to account for the heterogeneity in patterns observed across all illicit and licit drugs (see Figure 21). This will create one latent variable with a number of classes which help to explain variation in the dataset. Model parameters generated by the latent class procedure include class specific licit and illicit drug endorsement probabilities, in addition to the class membership probabilities for a given model. As in all previous models, individuals have been assigned to classes using conditional probabilities in contrast to the most likely latent class. Models with two through nine classes have been estimated and reported. Fit criteria used to select the correct model have reflected the lowest values of AIC, BIC, and SSABIC, an LRT where the *k-1* class model is superior (when compared with *k* class model generating p>.05), a minimal number of significant bivariate residuals, and an entropy value close to one. The best fitting structure will also be chosen on the strength of relation with existing literature. More details on the latent class method and fit criteria are presented in chapter three.

7.3.3.4. Model B: Estimation of a confirmatory latent class analysis with two categorical latent variables

The second modelling approach drew upon the latent variable structures of chapters four and seven, using loglinear parameterisation to correlate the two latent variables. A conceptual diagram of the model tested is provided in Figure 22. Rather than using the previous latent class structures, this approach will allow the two latent variables to be estimated as a function of each other. By allowing the structure of the alcohol and drug latent variables to covary, this could affect the membership of the latent classes. Nine separate models were estimated with two to four drug classes and five to seven alcohol use and related problem classes, i.e. two drug and five alcohol classes, three drug and six alcohol classes, four drug and seven alcohol classes, three drug and five alcohol classes, etc. These models were chosen using the three and six class solutions from chapters four and seven as anchor points and testing models with a class removed and added for each latent variable.

As with the one latent variable approach, the estimation procedure will aim to find the best fitting (two latent variable) model which can encapsulate the patterns of response in the dataset. It is assumed these two latent variables have been able to explain the variation in the observed nineteen variables of licit and illicit drug use. They have also used the same fit criteria as the second approach, namely, the lowest values of all three information criterion (AIC, BIC and SSABIC), a Lo Mendel Rubin Likelihood Ratio Test (LRT) where the *k-1* class model is superior (when compared with *k* class model generating p>.05), minimal number of significant bivariate residuals, and a suitable entropy value (close to 1). Full details of these criteria can be found in chapter two.

7.3.4. Multinomial logistic regression

Should a suitable model be found for modelling strategies A and B, multinomial logistic regression has been used to validate and lend weight to these analytical approaches. As with all other chapters, the conditional probabilities of membership of each of the classes for each of the participants have been saved and used as the dependent variable in each model, and as a consequence the latent variable can only be determined by the observed indicators. For model A, an individual's proportional membership of a single latent variable has been saved. For model B, a conditional probability of being in both a given alcohol latent class and a given drug latent class was generated by the model.

Regardless of which model used, the procedure will provide odds ratios and confidence intervals which illustrate the statistical significance of the effect of each of the predictors on the latent class membership whilst controlling for the other predictors. For model A the class with the lowest licit and illicit drug involvement has been used as the comparison or baseline class. For model B, it has been the combined group (as membership of a given illicit drug latent class and a given alcohol use latent class) which has the lowest overall drug use involvement. As with all other chapters employing the multinomial logistic regression method, 2Δ loglikelihood difference testing has been employed to illustrate the differences between groups. This involves running a fully restricted model which constrains the odds ratios to be the same for a particular independent variable across all classes and compare this to a freely estimated model which allows the regression parameters to be calculated as appropriate for each class. The model loglikelihoods were compared for the two competing strategies with the view that if no significant difference was found the more restricted model was preferred. If the freely estimated model and the fully constrained model were found to be significantly different, the restrictions on the fully constrained model would be sequentially relaxed until the most appropriate model was found. Full details, and a worked example of this procedure are provided in section 2.5.3.1.

The conceptual models being tested in both Model A and Model B are provided in Figure 21 and Figure 22. These include the same demographic and mental health predictors as found in chapters to date for comparison.

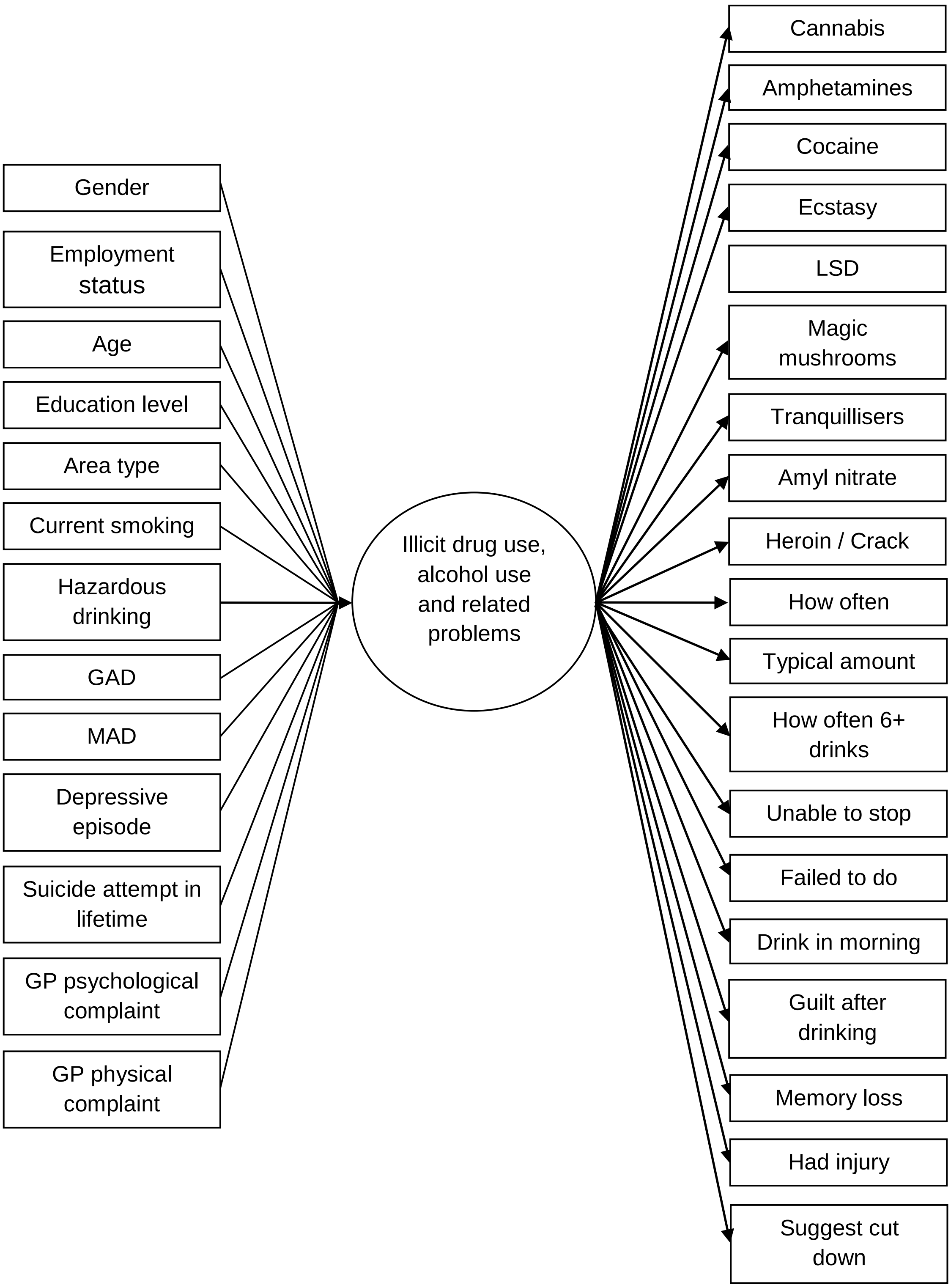

Figure 21: Conceptual diagram of model A tested in Chapter seven.

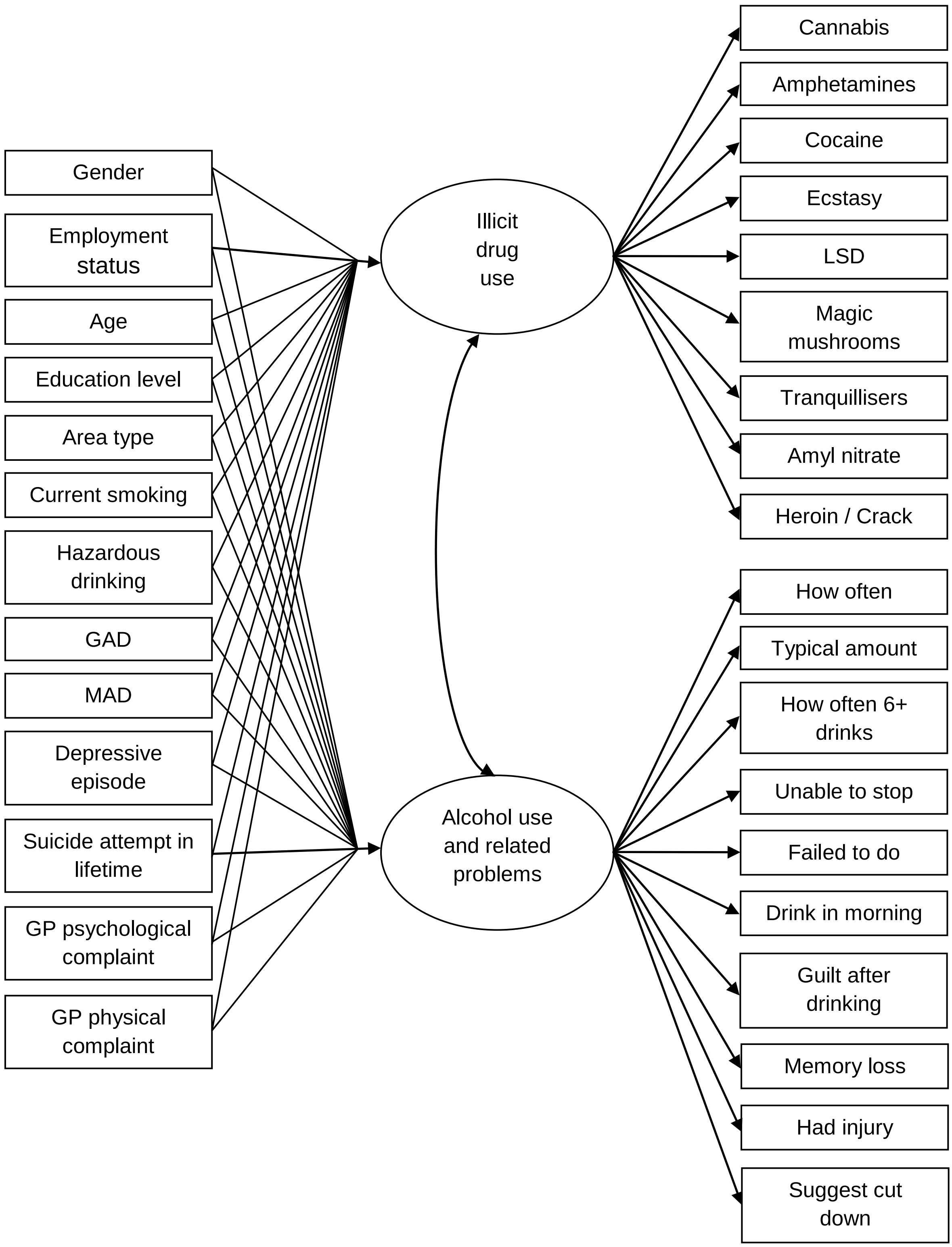

Figure 22: Conceptual diagram of model B tested in chapter seven.

7.3.5. Software

To perform correlations and to prepare data for analysis in this chapter, SPSS version 15 was used (SPSS Inc., 2006). Latent class analyses and multinomial logistic regressions were performed using the Mplus version 5.01 (Muthén & Muthén, 2007) or SPSS version 15.

7.3.5.1. Computational demands

Given the computationally demanding nature of the modelling strategy in both approaches two and three, starts were modified from the default used by this thesis to date. This refers to section 3.5.4 in the methodology chapter which discussed the computation process involved in specifying the parameters of the latent variable for a given number of latent classes. For all the previous models utilising latent class analysis, 100 sets of starting values were used with the best 20 optimised, in order to replicate the best loglikelihood. The model with the best loglikelihood should best explain the variation in a given number of observed variables. Given the advanced nature of the models estimated in this chapter, the solutions that 100 20 starts might generate would be unlikely to replicate the best loglikelihood. Thus, solutions could be considered unreliable. As a consequence of this, the loglikelihood generated by the model could be a local maxima, and a product of the choice of starting values. To combat this problem, the starts require considerable increase in these modelling strategies to attempt replication of the best loglikelihood.

The following commands were used in succession to replicate the loglikelihood representing five sets of analysis where appropriate.

a. Starts = 600 300

b. Starts = 3100 2100

c. Starts = 10000 9000

d. Starts = 20000 19000

e. Starts = 25000 24000

Should the case arise where there were model identification problems after set ‘b’ has been applied, no further increase in starts in the models have been run and the model criteria has been reported with the note of model nonidentification indicated. Problems with model identification are stated by the Mplus programme and are a clear indication of model specification issues. This strategy was employed to maximise the chance of replicating the loglikelihood for these models, whilst maintaining a sense of perspective on whether a model was ever likely to fit the data. If a replication of the best loglikelihood function was achieved of great enough magnitude, the process will cease at that step, to minimise computational time wastage.

7.4. Results

7.4.1. Rates of polydrug use in Great Britain

As illustrated in Table 26, most of those who had used illicit drugs had done so with alcohol. These were all found to be significantly different using either chi-square testing or Fisher’s exact test. Those who were most likely to have been using an illicit substance without alcohol were heroin and crack users 10.00% or tranquillisers with 7.27%. This suggests that the majority of those who use illicit drugs are polydrug users.

Table 26: Rates of illicit drug users who do and do not use alcohol

	Total users in the population		Using alcohol		Not using alcohol	
	N	%	N	%	N	%
Cannabis*	685	8.03	660	96.35	25	3.65
Amphetamines*	134	1.57%	130	97.01	4	2.99
Cocaine*	129	1.51	126	97.67	3	2.32
Ecstasy*	135	1.58	130	96.30	5	3.70
Mushrooms*	42	.49	40	95.24	2	4.77
Tranquillisers*	55	.64	51	92.73	4	7.27
Amyl Nitrates*	44	.51	43	97.73	1	2.27
LSD*	29	.34	28	96.55	1	3.45
Heroin/Crack*	20	.23	18	90.00	2	10.00

*** Found to be significantly different using chi-square or Fisher's Exact test**

7.4.2. Frequency of patterns of drug and alcohol use

The most frequent patterns of response to both the alcohol and drug use variables were given in Table 27. The most common pattern of response was mild consumption of alcohol, with no associated problems or drug use. Notably none of the drug use variables feature in the most frequent patterns of use. In addition to this, the ten most frequent patterns of alcohol use from chapter seven were also reflected in this chapter in the same order as presented in Table 22. For this reason, Table 27 also reflects on the percentage change from the original frequency of pattern of use. The difference illustrates the proportion of individuals who take illicit drugs that were in the original classification from chapter seven (which only considered alcohol use).

From this the biggest proportional change reflected the response pattern 'drinking in the past year, typical amount three or more drinks, drinking six or more drinks in the past year and memory loss in the past year'. The second largest difference was found in a similar pattern of consumption to the most frequent. However, there were some differences. Instead of memory loss in the past year, they had experienced an alcohol related injury. Overall change in percentage between the alcohol use patterns expressed in chapter seven and the same patterns but excluding illicit drug users from the total reflected a 5.5% decrease in the number of individuals in the 10 most frequent patterns of use.

Given no drug users were represented in the 10 most frequent patterns, Table 28 illustrates the most frequent patterns which had some illicit drug use. Note this is for illustration only and will not contribute to the overall fit criteria of the number of significant residuals. This will maintain consistency with other modelling strategies used throughout this thesis. The majority of these were all single users of drugs with the highest proportion being cannabis users (although there was one tranquilliser only group).

Table 27: Most frequent patterns of response to patterns of licit and illicit drug use indicators in the general population.

Most frequent patterns of response **Drug Use**	 **Alcohol Use**	Frequency of pattern (%)	Percentage decrease in corresponding alcohol pattern frequency
No drug use	Drinking in past year	1976 (25.19%)	-1.89%
No drug use	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year	1348 (17.18%)	-7.61%
No drug use	Drinking in past year, Drink six or more drinks in the past year	728 (9.28%)	-8.08%
No drug use	Drinking in past year, Typical amount three or more drinks	541 (6.90%)	-2.70%
No drug use	None	321 (4.09%)	-2.43%
No drug use	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Memory loss in the past year	210 (2.68%)	-20.75%
No drug use	Drinking in past year, Alcohol related injury experienced, Asked to cut down	178 (2.27%)	-3.78%
No drug use	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Alcohol related injury experienced	158 (2.01%)	-13.66%
No drug use	Drinking in past year, Alcohol related injury experienced	162 (2.07%)	-3.57%
No drug use	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Alcohol related injury experienced, Asked to cut down	84 (1.07%)	-6.67%
Total Number of Individuals in the 10 most frequent response patterns		5706 (72.73%)	-5.55%
Total Number of Individuals *not* in the 10 most frequent response patterns		2139 (27.67%)	
TOTAL		7845 (100%)	

(Note: 535 different patterns of response in the dataset).

Table 28: Most frequent patterns of response to patterns of licit and illicit drug use indicators in the general population (including at least one illicit drug).

Most frequent patterns of response		Frequency of pattern	
Drug Use	**Alcohol Use**	in complete dataset (%)	As a proportion of all drug users (%)
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year	74 (9.74%)	.94%
Cannabis	Drinking in past year, Drink six or more drinks in the past year	46 (6.05%)	.59%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Guilt after drinking in the past year	35 (4.61%)	.45%
Cannabis	Drinking in the past year	25 (3.29%)	.32%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Guilt after drinking in the past year, Memory loss in the past year	16 (2.11%)	.20%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Memory loss in the past year	16 (2.11%)	.20%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Alcohol related injury experienced	16 (2.11%)	.20%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Memory loss in the past year, Alcohol related injury experienced	15 (1.97%)	.19%
Cannabis	Drinking in past year, Drink six or more drinks in the past year, Memory loss in the past year	8 (1.05%)	.10%
Tranquillisers	Drinking in past year	8 (1.05%)	.10%
Cannabis	Drinking in past year, Typical amount three or more drinks	7 (.92%)	.09%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Could not stop drinking when started on an occasion in the past year	7 (.92%)	.09%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Could not stop drinking when started on an occasion in the past year, Memory loss in the past year	7 (.92%)	.09%

Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Could not stop drinking when started on an occasion in the past year, Failed to meet obligations in past year, Guilt after drinking in the past year, Memory loss in the past year	7 (.92%)	.09%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Could not stop drinking when started on an occasion in the past year, Failed to meet obligations in past year, Memory loss in the past year	7 (.92%)	.09%
Cannabis	Drinking in past year, Typical amount three or more drinks, Drink six or more drinks in the past year, Failed to meet obligations in past year	7 (.92%)	.09%
Total Number of Individuals in the 16 most frequent response patterns (due to tied ranks)		301 (39.60%)	3.83%
Total Number of Individuals *not* in the 16 most frequent response patterns		459 (60.39%)	96.16%
TOTAL		7845 (100%)	

7.4.3. Correlation of the conditional probabilities of class membership

The Pearson's correlations between the two latent variables are given below in Table 29. Illicit drug classes 1 and 2 correlate to the greatest magnitude with the heavy consumption with negative consequences, alcohol class 2. In addition, illicit drug classes 1 and 2 had a significant correlation with heavy drinking except for alcohol class 1. However, the magnitude of the correlation in some cases was extremely low. Illicit drug class 3 had the strongest association with both the alcohol classes 2 and 6 with $r=-.26$ ($p<.05$) in both cases.

Table 29: Correlations between the conditional probabilities of class membership of the six alcohol and three drug classes.

Correlations	Illicit Drug Class 1	Illicit Drug Class 2	Illicit Drug Class 3	Alcohol Class1	Alcohol Class 2	Alcohol Class 3	Alcohol Class 4	Alcohol Class 5	Alcohol Class 6
Illicit Drug Class 1: Wide range drug use	1								
Illicit Drug Class 2: Moderate range Illicit Drug use	.14*	1							
Illicit Drug Class 3: No drug use	-.54*	-.81*	1						
Alcohol Class 1: Heavy consumption with multiple negative consequences	.02	-.02	-.02*	1					
Alcohol Class 2: Heavy consumption with negative consequences	.17*	.23*	-.26*	-.04*	1				
Alcohol Class 3: Heavy/moderate consumption with memory loss	.06*	.13*	.03*	.03*	.04*	1			
Alcohol Class 4: Moderate alcohol consumption	-.06*	-.08*	-.09*	-.18*	-.29*	-.23*	1		
Alcohol Class 5: Mild consumption with injury and suggestion to cut down	-.03*	-.04	.04*	.02	-.09*	-.18*	-.25*	1	
Alcohol Class 6: Mild alcohol consumption	-.06*	.11*	-.26*	-.19*	-.40*	-.19*	-.44*	-.19*	1

7.4.4. Model A: Placing all (19) binary indicators of alcohol and drug use into one latent class model

The fit criteria for the two through nine class models are given in Table 30 below. The information criteria disagree in their best fitting model, with the BIC suggesting the seven-class solution, the AIC and SSABIC illustrating a better fit for the eight-class solution. The LRT was also unclear suggesting either the six-class solution or the eight-class solution as superior. With this disagreement, using the rule of parsimony, it might be better to suggest the six-class solution is most appropriate. However, there are eight significant residuals in the 10 most frequent patterns in the database for the six-class solution, compared with two significant residuals for the eight-class solution. In addition, upon inspection of both the six and eight class models, it would appear the additional two classes add extra information of theoretical relevance. Given the large proportion of the database this represents, the eight-class solution was preferred and has been presented here.

Table 30: Fit statistics of latent class analysis on the 19 variables representing illicit drug and alcohol use.

Number of classes	LL (df)	AIC	BIC	SSABIC	Entropy	LRT	p	Number of significant residuals
2	-30217.97 (39)	60513.94	60785.67	60661.74	.82	7542.96	.00	10
3	-29080.78 (59)	58279.57	58690.66	58503.17	.87	2275.53	.00	10
4	-28493.08 (79)	57144.15	57694.60	57443.55	.86	1159.25	.00	7
5	-27987.57 (99)	56173.14	56862.94	56548.33	.86	1002.42	.00	6
6	-27874.81 (119)	55987.62	56816.77	56438.61	.76	223.44	.01	8
7	-27784.11 (139)	55846.22	56814.72	56373.00	.76	180.19	.09	6
8	**-27719.57 (159)**	**55757.14**	**56865.00**	**56359.73**	**.77**	**127.89**	**.03**	**2**
9	-27886.80 (179)	56131.59	57393.95	56825.12	.72	55.59	.43	3

Note: LL(df) loll (df) loglikelihood value and associated degrees of freedom; LRT Lo-Mendel-Rubin Adjusted likelihood ratio test value; AIC Akaike Information Criterion; BIC Bayesian Information Criterion; SSABIC Sample Size Adjusted Bayesian Information Criterion.

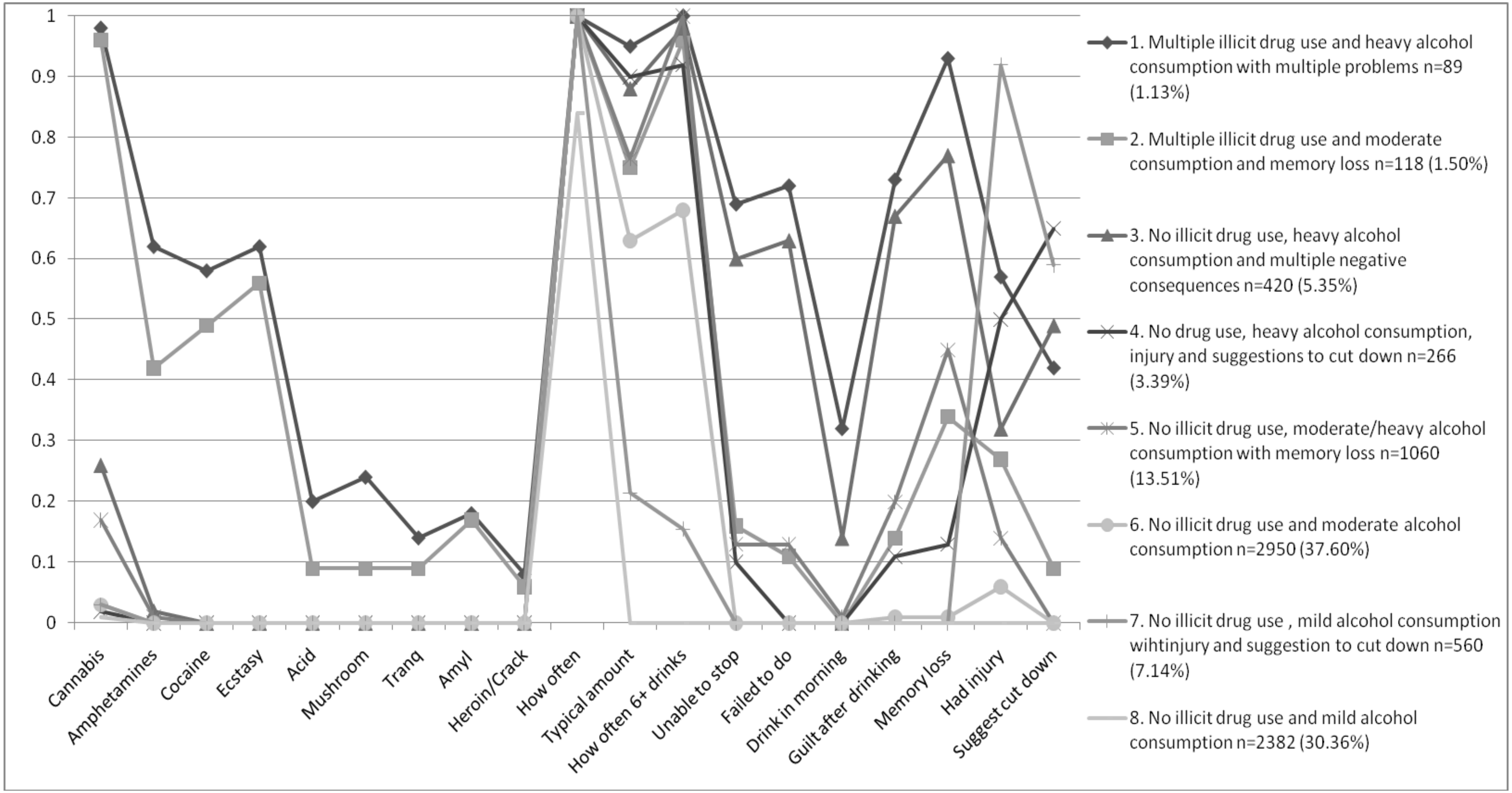

Figure 23: Profile plot of the eight latent classes from 19 observed variables relating to alcohol and illicit drug use

Given the complexity of the solution, each class in the solution will be examined in turn[10]. Polydrug class 1A was the least frequent pattern in the model. It was characterised by multiple illicit polydrug use, having the highest probability of all illicit drugs, particularly, cannabis, amphetamines, cocaine and ecstasy. In terms of alcohol use, they were like alcohol class 1, characteristic of heavy alcohol use consumption with multiple problems.

Polydrug class 2A had a slightly lower probability of illicit polydrug use as class 1A. Characteristically, class 2A were slightly more likely to endorse ecstasy use in the past year than amphetamine use, with a probability of just over 55% compared to 42%. Cannabis use was also commonly endorsed. Alcohol use in this class reflected moderate levels of consumption with a moderate probability of memory loss.

Polydrug class 3A appeared to have a low probability of all illicit drug use. However, there was some indication of a low probability of cannabis only use, in just over a quarter of the membership. In terms of their alcohol use, they were likely to be heavy consumers of alcohol with multiple negative consequences. Some of the key features were being unable to stop drinking when started, failing to meet expectations, guilt after drinking and memory loss. However, this class had a slightly lower probability of endorsing these items in comparison with polydrug class 1A.

The remainder of the latent classes had extremely low probabilities (if at all) of endorsing any illicit drugs. Polydrug class 4A was characteristic of the previously reported heavy alcohol consumption, injury and suggestion to cut down class found in chapter six. Polydrug class 5A was characteristic of no illicit drug use, heavy alcohol consumption and memory loss. The largest class in the

[10] All latent classes in this approach will be named polydrug class 1A to polydrug class 8A for ease of comparison with other classes from different models.

latent class structure was polydrug class 6A. It was characteristic of no illicit drug use and moderate alcohol consumption. Polydrug class 6A also had low probabilities of any negative alcohol consequences in the past year. No illicit drug use, mild alcohol consumption with injury and suggestion to cut down characterised polydrug class 7A. Polydrug class 8A had the lowest probability of use of all the illicit drug and alcohol use variables. They also had the lowest probability of endorsing any alcohol related consequences in the past year.

In summary, there were only two classes which endorsed illicit drug use to any extent. Polydrug class 1A endorsed the widest range of illicit drugs. Polydrug class 2A primarily focussed on cannabis, but also was characteristic of the use of ecstasy, cocaine, and to a lesser extent, amphetamines. The pattern of response to the alcohol variables remained relatively constant in Figure 23 to those in Figure 20. However, two previous groups seem to split into those who take drugs and those who do not; these were the heavy consumption with multiple negative consequences (alcohol class 1) and the heavy consumption with memory loss (alcohol class 3).

To validate the model with demographic and mental health criteria, the results of the two times loglikelihood difference testing were presented below in Table 31. The optimal model, ‘model 29’ required 27 modifications for optimal fit.

Table 31: The results of the 2Δll test for the model.

	Ll	*Df*	*Model v Model Comparison*	*2Δll*	Δ *df*	*p* value
1. No constraints	-30063.85	243				
2. Log odds constraints across all predictors	-30813.68	171	2 v 1	1499.66	72	p <.05
3. Constraints on the log odds to be equal except class 7 on age	-30680.11	172	3 v 2	267.14	1	p <.05
4. Constraints as model 3, and class 6 on age relaxed	-30487.23	173	4 v 3	385.76	1	p <.05
5. Constraints as model 4, and class 4 on age relaxed	-30418.36	174	5 v 4	137.74	1	p <.05
6. Constraints as model 5, and class 1 on currently smoking relaxed	-30378.98	175	6 v 5	78.76	1	p <.05
7. Constraints as model 6, and class 2 on currently smoking relaxed	-30339.20	176	7 v 6	79.56	1	p <.05
8. Constraints as model 7, and class 7 on sex relaxed	-30307.95	177	8 v 7	62.50	1	p <.05
9. Constraints as model 8, and class 6 on sex relaxed	-30256.65	178	9 v 8	102.60	1	p <.05
10. Constraints as model 9, and class 2 on age	-30223.14	179	10 v 9	67.02	1	p <.05
11. Constraints as model 10, and class 3 on currently smoking relaxed	-30204.95	180	11 v 10	36.38	1	p <.05
12. Constraints as model 11, and class 1 on age relaxed	-30182.53	181	12 v 11	44.84	1	p <.05
13. Constraints as model 12, and class 6 on suicide attempt relaxed	-30170.09	182	13 v 12	24.88	1	p <.05
14. Constraints as model 13, and class 5 on sex	-30160.62	183	14 v 13	18.94	1	p <.05
15. Constraints as model 14, and class 1 on GAD	-30154.22	184	15 v 14	12.80	1	p <.05
16. Constraints as model 15, and class 7 on current smoking relaxed	-30145.22	185	16 v 15	18.00	1	p <.05
17. Constraints as model 16, and class 3 on GAD relaxed	-30138.81	186	17 v 16	12.82	1	p <.05
18. Constraints as model 17, and class 6 on educational attainment relaxed	-30132.57	187	18 v 17	12.48	1	p <.05
19. Constraints as model 18, and class 6 on currently smoking relaxed	-30125.12	188	19 v 18	14.90	1	p <.05
20. Constraints as model 19, and class 6 on GP visit physical relaxed	-30119.28	189	20 v 19	11.68	1	p <.05
21. Constraints as model 20, and class 7 on employment status relaxed	-30114.12	190	21 v 20	10.32	1	p <.05
22. Constraints as model 21, and class 1 on sex relaxed	-30108.81	191	22 v 21	10.62	1	p <.05
23. Constraints as model 22, and class 3 on MAD relaxed	-30104.79	192	23 v 22	8.04	1	p <.05
24. Constraints as model 23, and class 5 on employment status relaxed	-30100.90	193	24 v 23	7.78	1	p <.05

25. Constraints as model 24, and class 5 on educational attainment relaxed	-30097.02	194	25 v 24	7.76	1	p <.05
26. Constraints as model 25, and class 4 on educational attainment relaxed	-30093.73	195	26 v 25	6.58	1	p <.05
27. Constraints as model 26, and class 3 on suicide attempt relaxed	-30091.00	196	27 v 26	5.46	1	p <.05
28. Constraints as model 27, and class 4 on GAD	-30088.45	197	28 v 27	5.1	1	p <.05
29. Constraints on model 28, and class 2 on suicide attempt relaxed	**-30085.98**	**198**	29 v 28	4.94	1	p <.05
30. Constraints as model 29, and class 2 on MAD relaxed	-30084.27	199	30 v 29	3.42	1	**p >.05**

Table 32: Odds Ratios (95% Confidence Intervals) of the optimum multinomial logistic regression model..

Predictors	Odds Ratio (95% confidence intervals) for Polydrug classes						
	1A: Multiple illicit drug use and heavy alcohol consumption with multiple problems	2A: Multiple illicit drug use and moderate consumption and memory loss	3A: No drug use, heavy alcohol consumption and multiple negative consequences	4A: No drug use, heavy alcohol consumption, injury and suggest cut down	5A: No drug use heavy alcohol consumption with memory loss	6A: No drug use and moderate alcohol consumption	7A: No drug use mild alcohol consumption with injury and suggest cut down
Gender (male)	**10.62 (6.64-16.99)**	**4.80 (4.13-5.58)**	**4.80 (4.13-5.58)**	**4.80 (4.13-5.58)**	**3.26 (2.86-3.72)**	**2.10 (1.89-2.33)**	**1.28 (1.07-1.53)**
Current smoker (yes)	**20.85 (12.44-34.94)**	**11.83 (8.03-17.44)**	**3.53 (2.90-4.31)**	**2.39 (2.07-2.75)**	**2.39 (2.07-2.75)**	**1.81 (1.60-2.05)**	**1.28 (1.04-1.58)**
Educational attainment (GCSE or below)	**1.22 (1.06-1.41)**	**1.22 (1.06-1.41)**	**1.22 (1.06-1.41)**	.88 (.73-1.06)	.90 (.79-1.02)	**.81 (.73-.90)**	**1.22 (1.06-1.41)**
Area type (urban)	1.04(.94-1.15)	1.04 (.94-1.15)	1.04 (.94-1.15)	1.04 (.94-1.15)	1.04 (.94-1.15)	1.04 (.94-1.15)	1.04 (.94-1.15)
Economic activity (inactive)	**1.50 (1.34-1.67)**	**1.50 (1.34-1.67)**	**1.50 (1.34-1.67)**	**1.50 (1.34-1.67)**	**1.89 (1.63-2.18)**	**1.50 (1.34-1.67)**	1.07 (.87-1.31)
Age	**.86 (.84-.87)**	**.86 (.84-.97)**	**.93 (.93-.94)**	**.97 (.96-.98)**	**.93 (.93-.94)**	**.97(.97-.98)**	**1.01 (1.00-1.02)**
Depressive Episode	**.66 (.48-.92)**	**.66 (.48-.92)**	**66 (.48-.92)**	**.66 (.48-.92)**	**66 (.48-.92)**	**66 (.48-.92)**	**66 (.48-.92)**
GAD	**5.49 (2.73-11.03)**	1.07 (.83-1.37)	**2.25 (1.49-3.39)**	**1.83 (1.23-2.72)**	1.07 (.83-1.37)	1.07 (.83-1.37)	1.07 (.83-1.37)
MAD	.88 (.74-1.04)	.88 (.74-1.04)	1.30 (.97-1.74)	.88 (.74-1.04)	.88 (.74-1.04)	.88 (.74-1.04)	.88 (.74-.1.04)
Suicide attempt in lifetime (yes)	**1.37 (1.03-1.83)**	**2.73(1.60-4.64)**	**2.29 (1.55-3.39)**	**1.37 (1.03-1.83)**	**1.37 (1.03-1.83)**	.89 (.68-1.17)	**1.37 (1.03-1.83)**
GP psychological complaint	1.02 (.88-1.19)	1.02 (.88-1.19)	1.02 (.88-1.19)	1.02 (.88-1.19)	1.02 (.88-1.19)	1.02 (.88-1.19)	1.02 (.88-1.19)
GP physical complaint	1.08 (.96-1.21)	1.08 (.96-1.21)	1.08 (.96-1.21)	1.08 (.96-1.21)	1.08 (.96-1.21)	**.89 (.81-.99)**	1.08 (.96-1.21)

Note: all estimates compared to baseline polydrug class 8A. OR (95% CI) in bold indicate predictors significant at .05 level.

The results of the multinomial logistic regression are presented in Table 32. Two variables displayed a continuum of increased likelihood with reference to the baseline class, being male (representing an increase in likelihood from polydrug class 7A (OR=1.28) to polydrug class 1A (OR=10.62). Equally, the heavier the involvement in polydrug use the greater likelihood a person was to be currently smoking. This was particularly likely for members of polydrug class 1A and 2A who used illicit drugs in addition to their drink patterns (OR= 20.85 and 11.83 respectively). Members of polydrug class 1A, 2A, 3A and 7A were more likely to be educated up to statutory level (GCSE) but not beyond. In contrast, polydrug class 6A were characterised by higher educational attainment than the baseline class. There was also a significant relationship with economic inactivity with all classes except polydrug class 7A. Polydrug classes 1A, 2A, 3A, 4A and 6A were characterised as 1.50 times more likely to be economically inactive. Polydrug class 5A had a slightly higher likelihood of economic inactivity. The members of this class were 1.89 times more likely than the baseline class to be economically inactive. Most of the classes are also significantly younger than the baseline class; again, the exception to this is polydrug class 7A, the members of whom were significantly likely to be older than the reference class (OR=1.01). The classes which would appear to be the youngest in relation to the baseline class were those including illicit drug use (polydrug classes 1A and 2A).

Mental health presentations such as depressive episode was equally less likely for all classes compared to the baseline category of polydrug class 8A. However, there was an increased risk of generalised anxiety disorder for members of polydrug classes 1A, 3A and 4A with odds ratios of 5.49, 2.25 and 1.83 respectively. All classes except for class 6, the no drug use and moderate alcohol consumption class, were characterised by an increased risk to have attempted suicide in their lifetime. Despite this increased risk, there was no difference in treatment seeking amongst the latent classes for either psychological or physical complaints, for all classes except polydrug class 6A. This group was significantly less likely to have visited their GP regarding a physical complaint in the past year in comparison with those in baseline polydrug class 8A.

7.4.5. Model B: Estimation of a confirmatory latent class analysis with two categorical latent variables

The fit criteria for model B are given in Table 33. All the models which contained four drug classes, in addition to all the models which contained seven alcohol classes had serious model identification problems which were not solved by increasing the starts in the model. This suggests these more complex solutions do not represent the patterns in the data well. This provided four solutions where there were no such model identification problems. From these, the lowest AIC, BIC, and SSABIC were found in the three drug and six alcohol class solution. This also displayed reasonable entropy and found only one significant residual in the 10 most frequent patterns of use.

However, even using the greatly increased number of starts, up to 25000 24000, could not replicate the loglikelihood in this model (and the other models which identified, the two drug and six alcohol, three drug and five alcohol and the two drug and five alcohol models). In addition, through personal correspondence (Muthén 2008; personal communication 16/07/2008; Appendix 2), it was suggested if the individual latent class solutions, i.e. the three drug class solution found in chapter four, and the six alcohol class solution found in chapter seven, had replicated loglikelihoods then it could be suggested the model is unlikely to be particularly representative of the patterns contained in the data. Whilst this was some cause for concern, in the last three sets of starting values (as stipulated in the methodology, corresponding to sets c, d, and e) the same optimum loglikelihood value was found which had the same optimum seed. This would suggest some stability of the model solution, and given there was a decrease in the difference between the best loglikelihood and the next best in the sets c, d, and e, might suggest persevering with the increasing starts might find a converging solution with a greatly increased number of starts beyond set e. Even so, the resultant three drug class and six alcohol class solutions were presented in the following graphs (Figure 24 and Figure 25). Examination of the patterns of alcohol use in this analysis suggests a similar pattern of endorsement as presented in chapter six in Figure 20[11]. Any minor differences were reflected in the frequency of individuals in the classes. There were fewer moderate consumers in this chapter and more baseline, mild consumers of alcohol compared to the latent class structure found in chapter six.

[11] All latent classes in this graph are named Alcohol latent class 1B to Alcohol latent class 6B when referred to in the text. This is to help distinguish from alcohol latent class patterns which have been found in chapter six. Illicit drug use latent classes from model B will be named illicit drug class 1B to illicit drug class 3B to distinguish from class structures found in chapter three. Combined polydrug use classes will be named polydrug class 1B through polydrug class 18B

Table 33: Fit statistics of latent class analysis on the two latent variable solution representing illicit drug and alcohol use.

	LL (df)	AIC	BIC	SSABIC	Entropy	Number of significant residuals
3d 6a	**-27729.80 (104)**	**55667.60**	**56392.24**	**56061.75**	**.83**	**1**
2d 6a	**-27906.31 (89)**	**55990.62**	**56610.73**	**56327.91**	**.79**	**4**
4d 6a	-27716.68 (119)	55671.36	5650.51	56122.35	.82	N/A
3d 5a	**-27774.70 (105)**	**55759.40**	**56491.00**	**56122.35**	**.83**	**4**
2d 5a	**-27964.99 (77)**	**56083.98**	**56620.48**	**56375.79**	**.80**	**2**
4d 5a	-27774.70 (105)	55759.40	56491.00	56157.33	.85	N/A
3d 7a	-27687.24 (117)	55608.49	56423.70	56651.90	.82	N/A
2d 7a	-27865.76 (101)	55933.52	56637.25	56316.29	.80	N/A
4d 7a	-27670.96 (133)	55607.92	56534.62	56111.97	.80	N/A

LL(df) loglikelihood value and associated degrees of freedom; LRT Lo-Mendel-Rubin Adjusted likelihood ratio test value; AIC Akaike Information Criterion; BIC Bayesian Information Criterion; SSABIC Sample Size Adjusted Bayesian Information Criterion and bold indicates the ability to replicate the loglikelihood in the model without model identification problems, d= drug class a= alcohol class

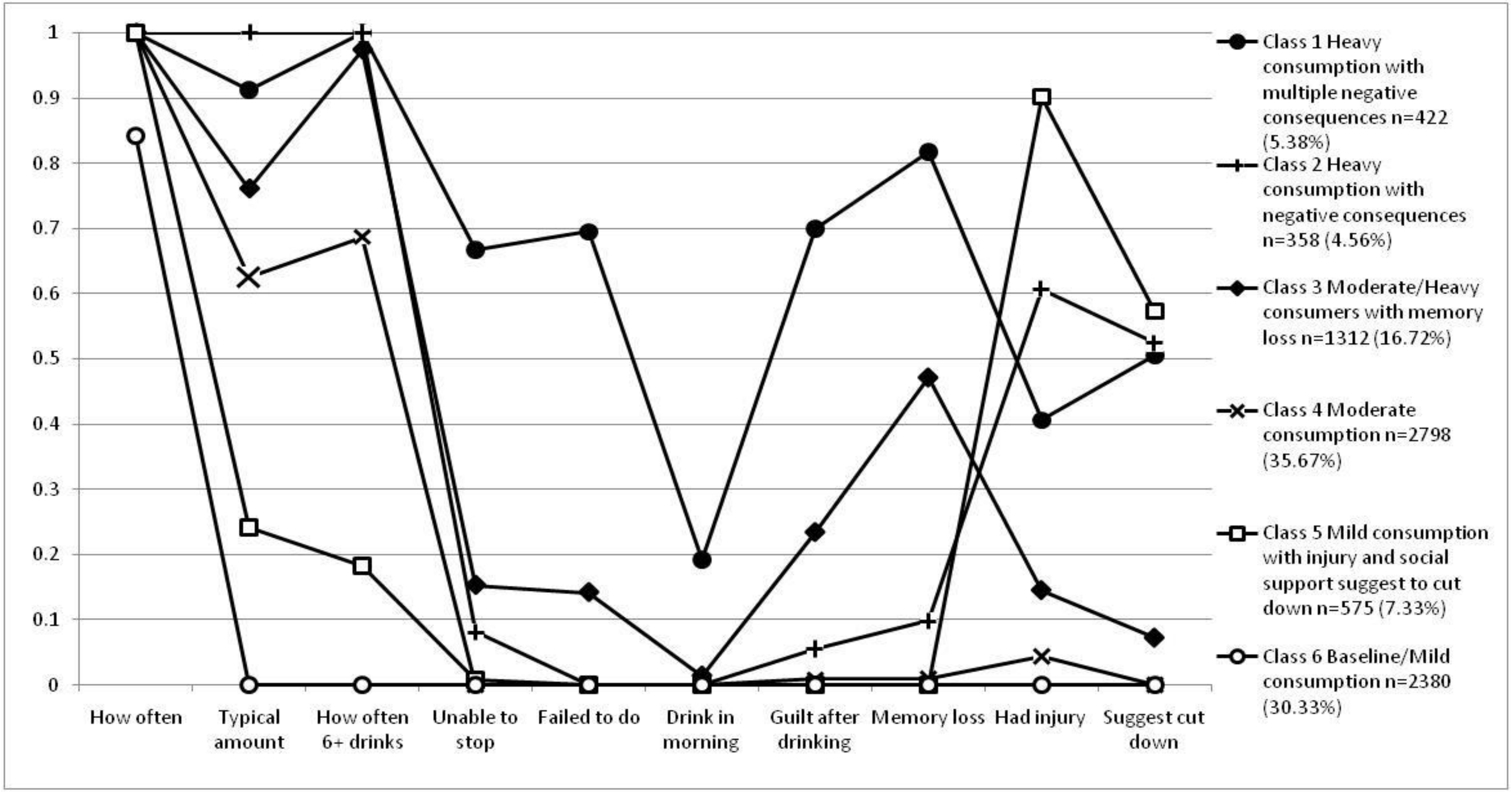

Figure 24: Profile plot of the six alcohol use and related behaviour latent classes for the six alcohol class, three drug class solution.

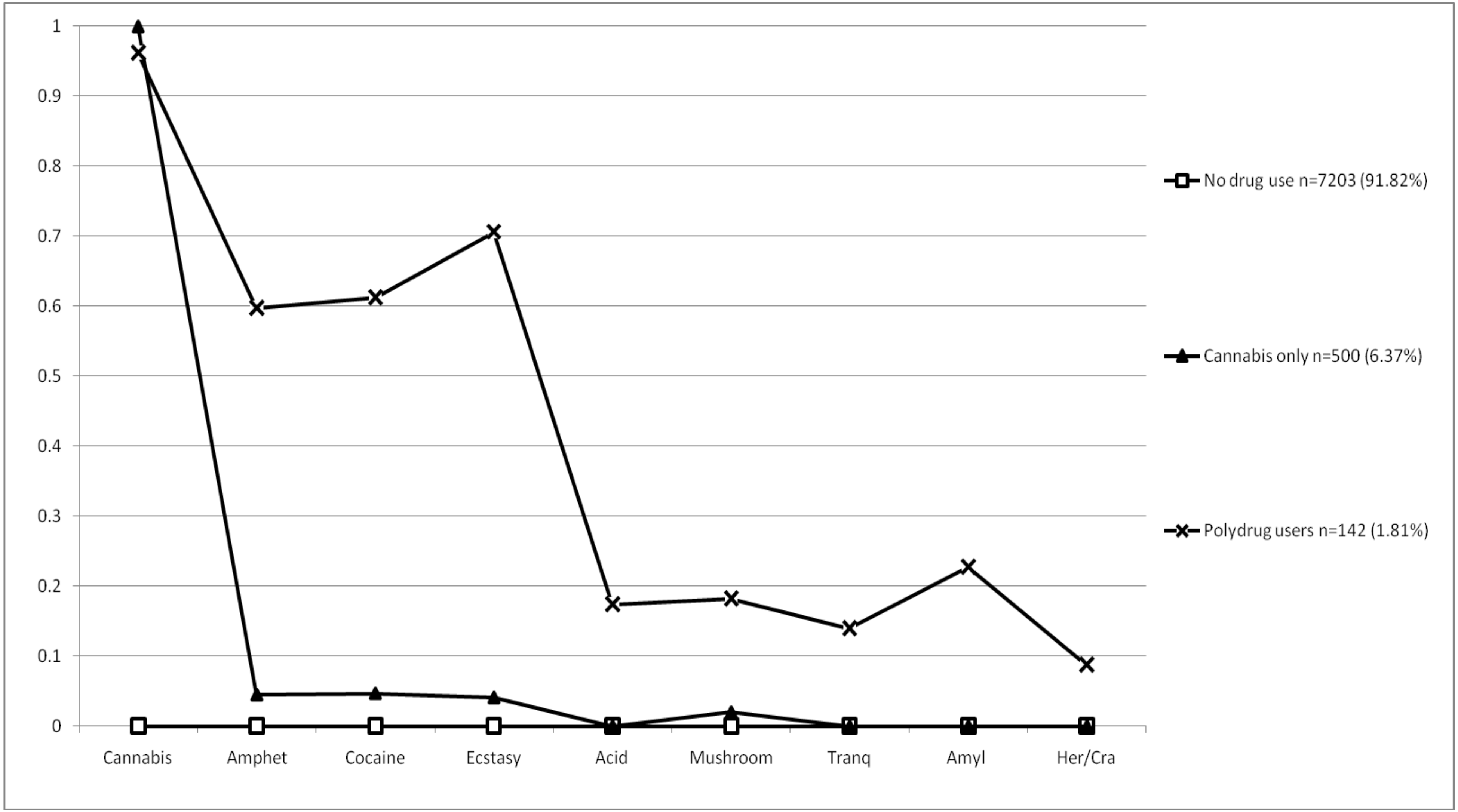

Figure 25: Profile plot of the three illicit drug latent classes for the six alcohol class, three drug class solution

In contrast, Figure 25 illustrated the drug classes have separated somewhat in their presentation when estimated allowing the correlation with alcohol use variables to influence membership. This makes a clear distinction between cannabis users only (illicit drug class 2B), and users of a wider range of drugs (Illicit drug class 1B). Consequently, this class can now be considered to represent cannabis use only. Both the polydrug using class and the cannabis only class are almost certainly using cannabis. However, illicit drug class 1B has a greater likelihood of endorsing the other traditional club drugs of amphetamines, cocaine and ecstasy than any of the other classes. Illicit drug class 1B has similar endorsement probabilities to the graph presented in chapter three (Figure 14) representing patterns of endorsement of items in illicit drug class 1.

In addition to the frequencies of being in each class of a separate latent variable for both alcohol and drug use, in this model structure, the percentages of individuals who share membership of a given drug and alcohol class can also be assessed. This information was presented in Table 34. Of the drug use categories, the most frequent illicit polydrug class 1B also had heavy consumption with multiple negative consequences (polydrug class 1B). The most common pattern of alcohol use and related problems in the cannabis only illicit drug 2B class was the heavy consumption with memory loss (polydrug class 9B). The no illicit drug use class 3B was most frequently associated with little or no alcohol use (polydrug class 18B).

Table 34: Frequency of being in a given polydrug class.

	N	%
Polydrug class 1B: Wide range polydrug use, heavy alcohol consumption and multiple negative consequences	73	.93
Polydrug class 2B: Wide range polydrug use, heavy alcohol consumption, injury and suggestion to cut down	12	.15
Polydrug class 3B: Wide range polydrug use, heavy consumption and memory loss	52	.66
Polydrug class 4B: Wide range polydrug use with moderate alcohol consumption	2	.03
Polydrug class 5B: Wide range polydrug use, mild alcohol consumption, injury and suggestion to cut down	1	.01
Polydrug class 6B: Wide range polydrug use with little/mild alcohol consumption	2	.03
Polydrug class 7B: Cannabis only use, heavy alcohol consumption and multiple negative consequences	118	1.50
Polydrug class 8B: Cannabis only use, heavy alcohol consumption, injury and suggestion to cut down	2	.03
Polydrug class 9B: Cannabis only use, heavy consumption and memory loss	296	3.77
Polydrug class 10B: Cannabis only use with moderate alcohol consumption	63	.80
Polydrug class 11B: Cannabis only use, mild alcohol consumption, injury and suggestion to cut down	17	.22
Polydrug class 12B: Cannabis only use with little/mild alcohol consumption	4	.05
Polydrug class 13B: No drug use, heavy alcohol consumption and multiple negative consequences	231	2.95
Polydrug class 14B: No drug use, heavy alcohol consumption, injury and suggestion to cut down	344	4.39
Polydrug class 15B: No drug use, heavy consumption and memory loss	964	12.29
Polydrug class 16B: No drug use and moderate alcohol consumption	2733	34.84
Polydrug class 17B: No drug use, mild alcohol consumption, injury and suggestion to cut down	557	7.10
Polydrug class 18B: No drug use and little/mild alcohol consumption	2374	30.26

The multinomial logistic regressions used in this thesis have been consistent to date; however, when applying the same methodologies as given in chapters four, six and seven, model identification issues were presented. The following warnings were given by the Mplus program.

> "*THE MODEL ESTIMATION DID NOT TERMINATE NORMALLY DUE TO A NON-ZERO DERIVATIVE OF THE OBSERVED-DATA LOGLIKELIHOOD. THE MCONVERGENCE CRITERION OF THE EM ALGORITHM IS NOT FULFILLED. CHECK YOUR STARTING VALUES OR INCREASE THE NUMBER OF MITERATIONS. ESTIMATES CANNOT BE TRUSTED. THE LOGLIKELIHOOD DERIVATIVE FOR PARAMETER 111 IS -0.31322729D+02."*

Given this difficulty in using the conditional probabilities in the regression model, an a posteriori decision was then taken to use the most likely latent class in place of the conditional probabilities for each of the eighteen groups (composed of one of the drug classes and one of the alcohol classes). In this way, the multinomial logistic regression could be conducted in SPSS where a given baseline category could be specified. Taking this approach could enable the loss of the lowest endorsed groups in sequence, until a model was able to be identified. SPSS does not have the capabilities to model conditional probabilities in the same way to Mplus. Persevering with use of the conditional probabilities, but losing those groups which have too low a conditional probability would have meant the eighteen conditional probabilities for an individual's membership in one of the eighteen groups would not sum to one, and the logistic regression would be both impossible in Mplus, and theoretically questionable.

However, the logistic regression in SPSS using the most likely class ran into problems with low levels of endorsement in suggested models giving rise to the following warning:

‘The loglikelihood value cannot be further increased after max number of step-halving. The NOMREG procedure continues despite the above warning(s). Subsequent results shown are based on the last iteration. Validity of the model fit is uncertain.’

To combat this issue, the iterations for the model were increased; however, problems remained. Consequently, the class with the lowest number was removed until the model was able to terminate normally. This involved the removing of classes four, five, six, eight, and twelve in order of increasing magnitude, and represents what might be considered as a reduced model to guide the reader towards what some of the characteristics of the larger groups might be like. The results of this are given in Table 35. Note the table with all odds ratios presented both significant and non-significant are presented in Appendix 3.

Table 35: Odds Ratios (95% Confidence Intervals) of the multinomial logistic regression of the twelve most frequently endorsed classes.

	Polydrug class 1B	Polydrug class 2B	Polydrug class 3B	Polydrug class 7B	Polydrug class 9B	Polydrug class 10B	Polydrug class 11B	Polydrug class 13B	Polydrug class 14B	Polydrug class 15B	Polydrug class 16B	Polydrug class 17B
Gender (male)	**13.49 (7.66-23.77)**	**7.03 (2.07-23.89)**	**8.58 (4.65-15.85)**	**8.47 (5.57-12.89)**	**4.67 (3.57-6.11)**	**2.88 (1.72-4.82)**	**4.27 (1.59-11.43)**	**6.13 (4.55-8.25)**	**5.41 (4.21-6.94)**	**4.08 (3.45-4.82)**	**2.55 (2.26-2.88)**	**1.25 (1.03-1.53)**
Currently Smoking (yes)	**2.47 (2.16-2.82)**	**2.48 (2.16-2.84)**	**2.47 (2.16-2.83)**	**2.47 (2.16-2.82)**	**2.47 (2.16-2.82)**	**2.47 (2.16-2.83)**	**2.47 (2.15-2.83)**	**2.40 (1.89-3.04)**	**2.46 (2.14-2.82)**	**1.91 (1.60-2.27)**	**2.47 (2.16-2.82)**	
Educational attainment (GCSE level or below)					**1.21 (1.00-1.48)**							**1.29 (.1.11-1.50)**
Area type (urban)	**1.95 (1.06-3.58)**				**1.42 (1.06-1.91)**				**1.38 (1.07-1.77)**			
Employment status (inactive)		**.23 (.07-.77)**										**.78 (.67-.90)**
Age	**.83 (.81-.86)**	**.84 (.79-.91)**	**.82 (.79-.85)**	**.87 (.86-.89)**	**.87 (.86-.88)**	**.90 (.88-.92)**	**.88 (.84-.93)**	**.93 (.92-.94)**	**.96 (.95-.97)**	**.93 (.92-.93)**	**.96 (.96-.97)**	**1.01 (1.00-1.02)**
Depressive episode		**8.30 (1.25-53.31)**							**.40 (.16-.97)**	**.55 (.31-.97)**	**.49 (.32-.73)**	.
GAD	**7.83 (3.54-17.36)**			**3.15 (1.46-6.79)**			**12.43 (3.31-46.70)**	**2.41 (1.39-4.17)**	**1.93 (1.15-3.24)**			
MAD	**2.82 (1.38-5.75)**	**5.28 (1.25-22.26)**		**2.01 (1.14-3.56)**	**1.61 (1.08-2.39)**			**1.72 (1.12-2.64)**			**.74 (.60-.92)**	

Suicide attempt in lifetime												
GP psychological complaint												
GP physical complaint										**1.29 (1.09-1.51)**	**.86 (.76-.97)**	

Note: Significant OR (95% CI) are given in bold. A table with all significant and non significant odds ratios (95% confidence intervals is provided in Appendix 3

All classes were significantly more likely to be male, with the most likely being polydrug classes 1B, 2B, 3B, 7B and 13B compared with the characteristics of polydrug class 18B. Additionally members of all classes were between 1.91 and 2.47 times more likely to be a current smoker compared with polydrug class 18B. An exception was polydrug class 17B which showed no significant relationship. Additionally, only polydrug class 17B was more likely to be older than the polydrug class 18B, with all others more likely to be younger.

Regarding education, polydrug classes 9B and 17B were more likely to be educated up to GCSE level. The only significant relationships with economic activity were found in the members of polydrug classes 2B and 17B, which were significantly more likely to be economically active than the baseline class. Those classes which were characterised as significantly more likely to be living in an urban area were polydrug classes 1B, 9B and 14B.

There was a lower likelihood of having a depressive episode for the members of polydrug classes 14B, 15B and 16B. However, those in polydrug class 2B were eight times more likely to have a depressive episode diagnosis than the baseline. There was also an elevated risk of a generalised anxiety disorder diagnosis found characteristic of polydrug classes 1B, 7B, 11B, 13B, and 14B. These classes were eight, three, twelve, two and two times more likely respectively. A higher probability of having mixed anxiety and depressive disorder were also found to be characteristic of polydrug classes 1B, 2B, 7B, 9B and 13B. Members of polydrug class 16B were less likely to have mixed anxiety and depressive disorder with odds ratio of .74 compared with the baseline class. There were no significant relationships between members of polydrug classes with reference to the baseline polydrug class 18B in presenting to GP services with a psychological problem, or an increased risk of suicide attempts in the lifetime. However, the members of polydrug class 15B were more likely to visit their GP for a physical complaint, and the members of polydrug class 16B significantly less likely to present to services.

7.5. Discussion

From the four strategies employed in this chapter, it is clear alcohol and illicit drug use patterns are related. This section will commence with a comparison of observed patterns of alcohol and illicit polydrug use. Following this, each of the models will be discussed in turn. First to be discussed will be the correlation method, followed by model A and model B. These will be discussed in the context of previous research, including the results from previous chapters in this thesis.

7.5.1. Patterns in observed response to alcohol and illicit drug use

Patterns of observed responses in alcohol and illicit drug use share some characteristics to observed responses in Table 12 and Table 22. A lower percentage of the Great British population were illicit drug users than alcohol users. It is unsurprising the ten most frequent patterns did not contain illicit drug use. Patterns of alcohol use reported in Chapter six were the same as found in Table 27. However, the frequencies of these patterns changed, through inclusion of illicit drug use variables. The percentage decrease represents the cost in the univariate approach or the traditional separation of alcohol and illicit drug use in research. Two of the largest differences were found in those who endorsed all three consumption items (how often, typical amount and how often 6+ drinks) and either memory loss in the past year (decrease=20.75%) or alcohol related injury (decrease=13.66%).

This raises some additional questions. Midanik et al. (2007) found 10% of their sampled population were alcohol and cannabis polydrug users in the past year. If these individuals reported in this chapter were using alcohol and illicit drug on a single occasion, it is possible these negative consequences could be attributed to both alcohol and illicit drug use. Response to the AUDIT questionnaire could be affected by polydrug use, if the polydrug use was simultaneous. Midanik et al. (2007) found simultaneous alcohol and cannabis in 7% of their sample, representing 70% of all alcohol and cannabis polydrug use. Given this frequency, the effect of illicit drug use on the AUDIT warrants further attention.

In patterns of observed response containing at least one illicit drug (Table 28) cannabis and tranquilliser use appear most frequently. The most common pattern was characteristic of cannabis and alcohol use in the past year, drinking three or more drinks typically, and drinking six or more drinks on an occasion in the past year. It represented almost one tenth of all illicit drug users in the dataset. Alcohol related memory loss and alcohol related injury were the most common negative consequences. Those who were illicit polydrug users had a much less typical pattern of alcohol use. No illicit polydrug users featured in the most frequent observed patterns of use. In addition, the 16 most frequent patterns only accounted for 39.60% of all drug users. Patterns of licit and illicit polydrug use appear to be greatly variable. Consequently, it may be suggested that deriving suitable researcher chosen categories of alcohol and drug polydrug use would be extremely difficult, and that advanced methodologies such as latent class analysis can model these adequately.

7.5.2. <u>Correlations between existing latent class structures</u>

From examination of correlational relationships between illicit polydrug use and alcohol use classes, it would appear drug class1 and drug class 2 were related to heavy consumption patterns. This is particularly evident in alcohol class 2. This was similar to findings in Lamers et al. (2006). They stated heavy drinking was associated with wider ranges of drug use such as those found in illicit drug use classes 1 and 2. However, illicit drug class 2 was also positively related to both alcohol class 3 and alcohol class 6. The relationship with alcohol class 6 was unexpected, given the approximately equally magnitude of correlational relationship with alcohol class 3. From this correlation method, it is suggested studies with an alcohol focus could be suitably estimated outside the context of drug use. However, it would appear if drug use is the focus, alcohol should be taken into consideration.

7.5.3. <u>Results of Model A</u>

Eight latent classes' best explained patterns of response to the data in Great Britain. Two of these had some degree of illicit drug use, and thus were likely to be polydrug users (Polydrug classes 1A and 2A). The total memberships of these two classes were 2.64%. This is somewhat like the percentage found in Table 11 for individuals using two or more illicit drugs (2.76%). These classes appear characteristic of illicit polydrug use. They would also appear to be similar in illicit drug profile. Polydrug class 1A is characterised by slightly higher estimates of illicit drug use than polydrug class 2A and was associated with the heaviest level of alcohol related problems. The remaining six classes were similar to the profiles found in Figure 20. Two of the alcohol classes appear to split into those who take drugs and those who do not; these were alcohol classes 2 and 3.

The association of illicit polydrug use with heavy alcohol consumption was expected given previous literature. Lamers et al. (2006) suggested ecstasy and cannabis use, both of which are characteristic of polydrug classes 1A and 2A were related to higher ASI scores. This supports the finding that drug use was related to alcohol problems. Heavy alcohol consumption was also related to illicit drug use in a study by O'Grady et al. (2008). This study found heavy alcohol use significantly related to likelihood of use of a range of illicit drugs. Namely, these were cannabis, hallucinogens, amphetamines, cocaine and ecstasy.

Midanik et al. (2007) found concurrent users of cannabis and alcohol were 1.78 times more likely to binge drink. This is reflected in the patterns in Model A. There is also some support for the gateway theory. Kandel et al. (1992) suggested hazardous consumption of alcohol mediated the difference between those who used illicit drugs and those who did not. Given all classes with illicit drug use were found to be related to heavier consumption, this is somewhat supported. However, it is noted progress to illicit drug use is not inevitable, as many heavy alcohol users did not use illicit drugs in the past year. It is also beyond the scope of this research to identify trajectories, which characterises the gateway theory, however, it is important to note how there is some cross-sectional support.

The latent classes found in model A will now be compared to previous latent class solutions. Mitchell and Plunkett (2000) found four classes of user, 'abstainers', 'predominantly alcohol', 'alcohol and cannabis' and 'pleural' drug users. The first two of these classes are represented in Model A (polydrug classes 3A-8A). However, the patterns of illicit drug use do not appear to follow the trends proposed by this paper. There was no cannabis only class, and the percentage of inhalant use was much higher in the study by Mitchell & Plunkett (2000) compared to this solution. Classes of ecstasy users derived in Carlson et al. (2005) were dissimilar to classes found in Model A. For example they found a ‘limited range’ class which was characteristic of moderate levels of drinking (as measured by lower than mean drunkenness days), ecstasy and cannabis use. No such class was found in Figure 23. As has been stated in chapter three, latent classes based on ecstasy polydrug use do not seem to reflect general population trends.

There are some similarities to Whitesell et al. (2006). This was the only study using this latent class analysis on licit and illicit drugs in a general population sample. Comparing with their yearly use patterns (see Figure 12). Their alcohol and cannabis polydrug use class had a lower probability of cannabis use, and a much lower probability of cocaine, ecstasy and amphetamine use. However, this class was more likely to use hallucinogens than either polydrug class 1A or 2A. Their alcohol only class was similar to polydrug class 3A, particularly the magnitude of cannabis use. This was reflected in their lifetime alcohol only class (see Figure 11). Their lifetime alcohol and cannabis class had similar probabilities of endorsement of cocaine, alcohol and cannabis to polydrug class 2A. However, their lifetime polydrug class was dissimilar to findings in Model A, having much higher probabilities of endorsement of all drugs.

In terms of demographic differences, this model found young males most likely to be in polydrug class 1A and 2A. This is consistent with Falk et al. (2008) who found increased age was associated with decreased AOD polydrug use. Males were also more likely to be polydrug users in this study. The odds ratios reported in Table 32 display a broad trend of increased likelihood being male and young as move from polydrug class 7A to 1A compared with the baseline class. This is also reflective of trends reported in chapter three and six. Relationships with lower educational attainment were found for polydrug classes 1A, 2A, 3A and 7A. Higher educational attainments were significantly associated with polydrug class 6A. Previous research suggests illicit drug use was associated with lower educational attainment (Lieb et al., 2002; Smit et al., 2002). However, lower consumption rates were found in European adults who had a lower level of education (EC, 2007). This may in part explain the finding of polydrug class 7A, but not characteristics of polydrug class 6A. Economic inactivity was more likely for all classes compared to 8A. Polydrug class 7A was not related to economic activity. Illicit polydrug use modelled in chapter three did not have any significant relationship with economic activity. However, chapter six found relationships with economic inactivity for all classes with the exception of alcohol class 5. This change may well be a consequence of the new measurement model and lends support to the inclusion of alcohol in models of illicit polydrug use. There were no differences in urban trends in all classes compared to the baseline class which is comparable to previous research (Forsyth & Barnard, 1999; Galea et al., 2003) and findings in this thesis.

Current smoking status was strongly associated with both the alcohol and illicit polydrug classes (1A and 2A). This is also cross-sectionally supportive of the gateway theory which suggests illicit drug use is preceded by tobacco and alcohol use. Odds ratios found for the remaining polydrug classes were somewhat different to those in chapter six. The membership of the heaviest alcohol class 1 was associated with current smoking to a similar degree as the membership of polydrug class 3A. This was also reflected in comparisons of those in alcohol classes 3 and 5 with those in polydrug classes 5A and 7A.

However, the remainder were slightly different. Alcohol classes 2 and 4 were less likely to be smokers in chapter six. The equivalent polydrug classes 4A and 6A were significantly more likely to be smokers with odds ratios of 2.39 and 1.81 respectively. This suggests relationships into alcohol and smoking should also take into consideration illicit drug use.

All classes were equivalently less likely to have depressive episode than the baseline polydrug class 8A. This is supported by previous research in illicit drug use (De Win et al., 2006; Guillot, 2007; Hopper et al., 2006; Kelly & Parsons, 2008). Manninen et al. (2006) found some evidence for an ambiguous relationship between alcohol use and BDI scores which supports the findings of this chapter. This paper illustrated heavy drinking occasions were not related to elevated BDI scores particularly in males. Lipton (1994) in assessing benefits of moderate alcohol consumption suggested other moderating behaviours might assist with reducing the risk of depression. However, given the polydrug use classes did not differ significantly in their decreased risk, it would appear all polydrug use patterns were engaging in higher levels of such behaviours compared to the baseline polydrug class 8A. This is unlikely to be the case. However, research by Shaper (1995) and later Green and Polen (2001) into the 'unhealthy abstainer' suggest people may quit or reduce their drinking due to other illness. The decreased risk could be less of a function of increased use, and more of a function of the characteristics of the baseline group which we compare all others to. However, recent research by Rehm et al. (2008) suggested inclusion of irregular lifetime light drinkers with lifetime abstainers as a baseline category was recommended. San Jose et al. (2000) suggested patterns of alcohol use might help illuminate relationships with depression, however, this chapter has not illustrated any stronger link than was found in chapter six.

No significant relationships were found between MAD and any of the polydrug classes in model A. Similar findings were reported in chapter six. However, MAD was significantly related to any illicit polydrug use in chapter three (OR=1.51). This difference between models is further evidence polydrug use should be measured in terms of licit and illicit drugs. The relationship between the polydrug classes and GAD confirms this. Any illicit drug use (from chapter three) was not significantly related to GAD. However, those in alcohol class 1 and 2 were significantly more likely to have GAD currently with odds ratios of 2.60 and 1.67 respectively. Comparable polydrug classes 1A and 3A (which were similar to alcohol class 1) were significantly more likely to have GAD (OR=5.49 and 2.25 respectively). The odds ratios of those in polydrug class 1A demonstrate the presence of polydrug use elevates the risks considerably compared to those who just use alcohol. Those in alcohol class 2 had a comparable odds ratio to members of polydrug class 4A regarding GAD risk. Elevated risks for anxiety for both illicit drugs and alcohol use are supported by previous research (Keyes et al., 2008; Patton et al., 2002; Rodgers et al., 2000).

The likelihood of an individual attempting suicide in their lifetime was significantly related to membership of alcohol classes 1, 2, 3 and 5. This is comparable to those in polydrug classes 3A, 4A, 5A and 7A. However, patterns of alcohol consumption and related problems found in the members of alcohol classes 1 and 3 were also found in polydrug classes 1A and 2A. The risk for suicide attempts were lower for those in polydrug class 1A (OR=1.37) compared with the corresponding alcohol class 1(OR=2.21). However, the risk was elevated for those in polydrug class 2A (OR=2.73) compared with the members of the corresponding alcohol use class (2; OR=2.73). Dawson (1997) also found significant differences between average alcohol volume and elevated risk of suicide attempts. This was supported by Baigent (2005) who found increased AUDIT scores correlated highly with suicide ideation. Elevated risk of suicide attempts were also found in wide range polydrug users in a study by O'Boyle and Brandon (1998). Whilst this paper was in a treatment sample, it would appear to be supported by findings in this chapter. Finally, there were no differences in treatment seeking between models in chapters five, six and the current chapter.

In summary, if researchers are interested in the measurement of psychological status in relation to drug use, polydrug use needs to be taken into consideration. Measurement models in chapters three and five also included hazardous drinking as a predictor. However, key differences in current psychological status were found across polydrug use patterns which were different to those reported to date. This was particularly evident for MAD, GAD and suicide attempts in the lifetime. San Jose et al. (2000) suggest patterns of alcohol use are important in determining risks of harm. This model has demonstrated patterns of alcohol use should also be considered when assessing harm attributed to alcohol and illicit polydrug use.

7.5.4. Results of Model B

The best fitting model in Model B was comprised of three illicit drug classes and six classes of alcohol use and related problems. The three illicit drug use classes differed from patterns found in chapter three (Figure 14). Illicit drug class 1 from chapter three had high probabilities of cannabis, amphetamines, cocaine and ecstasy, with probabilities of greater than .7 for all drugs. Those in the polydrug user class had a similar probability of endorsing cannabis use, but a lesser probability of endorsement of the other drugs, particularly ecstasy. Members of drug class 2 in chapter three had a low probability (in the range of .3-.4) of consuming amphetamines, cocaine and ecstasy. However, in this chapter a ‘cannabis only’ class emerged. These were all cannabis users, with extremely low probabilities of any other use. Profiles found in chapter three, in light of new evidence, appear to be closer to a continuum of illicit polydrug use. The latent class structure found in this chapter illustrates more distinct qualities. Model A, might also appear to also be indicative of a cannabis only trend, although the probability of endorsement was relatively low for the classes in question, due to their varying patterns of alcohol use. The frequency in this cannabis only cluster is similar to those reported in Table 12. The dataset contains 5.36% of individuals who used cannabis only (observed patterns of use). This is slightly less than the corresponding percentage of 6.37% in the cannabis only class. Additionally, chapter four supports this classification. Assessment of the strength of involvement in four common drugs suggested drug class 2 was characterised by cannabis use and lifetime experimental use of other drugs. These differences were not so pronounced in the profiles assessed in chapter three. However, this chapter in assessment of the drugs and alcohol section together that this became clear.

Latent classes of alcohol use and related behaviour found in chapter six were similar to those expressed in a combined model of alcohol and illicit polydrug use. Some percentage differences were found in terms of size of latent classes, this was particularly evident for alcohol classes 4 and 6. There were a greater number of baseline mild consumers of alcohol and fewer moderate consumers in Figure 24 compared to broadly similar classes in Figure 20.

However, these are not standalone latent variable structures. The two latent variables are combined in classes found in Table 34. The most frequent class which had an illicit polydrug use pattern was polydrug class 1B, which had an alcohol use pattern similar to alcohol class 1 (from chapter six). The most common pattern of alcohol use and related problems in the cannabis only class was polydrug class 9B; similar to alcohol use in alcohol class 3. The no drug use class was most frequently associated with little or no alcohol use patterns characteristic of alcohol class 6 (polydrug class 18B).

The association of heavy alcohol consumption and illicit drug use whether cannabis only or wide range polydrug use is supported by previous literature. Lamers et al. (2006), O'Grady et al. (2008) and Midanik et al. (2007) all found similar links. Again this provides some support for the gateway theory, in there were no users of other drugs which were not highly likely to be cannabis users. However, it is clear progression from cannabis to other drugs is not inevitable, given the presence of the cannabis only class.

Classes found in this analysis will now be compared to those from other latent class analyses. A study by Mitchell and Plunkett (2000) into the polydrug use patterns found in an American Indian adolescent sample found four classes of use. These were 'abstainers', 'predominantly alcohol', 'alcohol and cannabis' and 'pleural' drug users. The first three classes are supported by findings in this chapter. There were few similarities with the illicit drugs used in the 'pleural' drug user class. This was characterised by high levels of 'inhalant' and 'other' drug use, which were not directly comparable to polydrug classes in Model B.

Carlson et al. (2005) applied latent class analysis to a sample of ecstasy users living in Ohio. They found three classes of ecstasy polydrug use; 'limited', ‘moderate’, and ‘wide’ range. None of the classes were congruent to the latent classes found within this model.

Whitesell et al. (2006) derived latent class patterns of both lifetime and yearly polydrug patterns in a US population sample. Lifetime patterns of alcohol and cannabis polydrug use in this paper were also reflective of polydrug use in this chapter (in terms of endorsement probability of alcohol cannabis and cocaine). Characteristics of their lifetime polydrug use class, however, were not synonymous to classes in this chapter. In terms of yearly patterns, considerable evidence was found in this chapter for alcohol use only. However, this thesis has consistently demonstrated patterns of alcohol use and related behaviours over the past year vary considerably within a general population sample. Their alcohol and drug use class was mostly dissimilar to those found in this chapter; the exceptions were the endorsement probabilities of amyl nitrate (inhalants) and tranquillisers. The structures found within this chapter are perhaps a little more complex than other work in AOD populations, primarily because this chapter has considered extent and consequences of alcohol use.

As the severity of alcohol use increases in Table 35, so too does the odds ratio associated with the likelihood of being male. However, this increase in odds ratio is compounded by illicit drug use. For example, class 1B, 7B and 13B were all characteristic of the same alcohol use pattern (heavy consumption with multiple negative consequences). However, the odds ratio ranges from 13.49 for polydrug users to 6.13 for those who did not use drugs. Cannabis only users in polydrug class 7B were 8.47 times more likely to be male. These trends are also found when examining class membership and age. The youngest individuals in the dataset were also more likely to be polydrug users. This was reflected in both Model A and recent research by Falk et al. (2008) using data from the NESARC population survey.

All polydrug classes entered into the multiple regression model were significantly more likely to be current smokers than the baseline polydrug class 18B. However, the magnitude of the odds ratio did not increase as a function of increased polydrug use. This was somewhat surprising. Pedersen and Skrondal (1999) found their illicit polydrug users were approximately seven times more likely to have been currently smoking compared to those who did not consume illicit drugs. In addition, attempts to create typologies of polydrug use which have included tobacco demonstrate increased involvement with alcohol use and illicit drugs are indicative of an increased likelihood to be either smoking (Smit et al., 2002) or nicotine dependent (Lynskey et al., 2006).

Lower educational attainment was significantly associated with membership of polydrug classes 9B and 17B compared with the baseline polydrug class 18B. The relationship with 17B, a mild alcohol consumption group is supported by population studies into European adults (EC, 2007). Polydrug classes 2B and 17B were significantly more likely to be in employment compared to the baseline class. This differs from some results to date. Comparisons with chapter six illustrate economic inactivity was significantly related to all classes except alcohol class 5 (which was a component part of polydrug class 17B). If this holds in the presence of illicit drug use measurement, the majority of the remaining classes should all be significantly related to economic inactivity. Model A which found a similar class to polydrug class 17B (polydrug class 7A) also found significantly lower associations with economic inactivity. However, this relationship does not explain the greatly decreased risk of economic activity found in polydrug class 2B. This may be indicative of a ‘work hard, play hard’ class which fits with Parker and Williams (2003) study into the lifestyles of young people. They found young adults could maintain employment and good relationships, yet still polydrug use at the weekend. No relationship was found with any illicit drug use compared to the baseline no drug use class in chapter three. This represents a distinct shift in trends as a function of the measurement model used. Similarly differences were found in urbanicity in Model B which had not been previously found in this thesis. Polydrug class 1B, 9B and 14B were all significantly more likely to be living in an urban area compared to the baseline class. Whilst previous research had broadly found no relationship, Wadsworth, Simpson, et al. (2004) found illicit drug users were less likely to be living in a rural area. Another study comparing two regions in a geographical area found no difference in illicit drug users and non-illicit drug users (Forsyth & Barnard, 1999). Galea et al. (2003) in a review of the literature found little relationship between urbanicity and patterns of drug, alcohol and tobacco use lending further support for this finding in model B.

Examining the relationship between model B and depressive episode illustrates a significantly decreased risk for those in polydrug classes 14B, 15B, and 16B. The risks are approximately halved compared to those in the baseline polydrug class 18B. However, polydrug class 2B was characterised by a greatly increased risk to any illustrated to date in this thesis with an odds ratio of 8.30. This is considerably larger than the odds ratio found in chapter five (2.85) which referred to an increased risk for any drug use. However, no other elevated risks for this condition were found. The reason any drug use elevated the risk in chapter five may be a function of their patterns of alcohol use rather than their drug use patterns.

Despite finding no significant differences in risk of MAD in Model A, some differences were found in Model B. Those with no drug use and moderate alcohol use patterns (members of polydrug class 16B) were significantly less to be experiencing this condition. However, elevated risks were found for those in polydrug classes 1B, 2B, 7B, 9B and 13B. The largest odds ratios were characteristic of polydrug classes 1B and 2B with 2.82 and 5.28 respectively.

Differences were apparent when assessing the relationship with GAD. Polydrug classes 1B, 7B, 11B, 13B and 14B were all characterised by higher risk of GAD compared to those in the baseline class. The highest risk was found for the members of classes 1B and 11B. These were characteristic of 'polydrug use, heavy alcohol consumption and multiple negative consequences', and 'cannabis only use, mild consumption with injury and suggestions to cut down'. The latter has the greatest risk of this psychological status with an odds ratio of 12.43. This was considerably higher in magnitude than any of the risks identified with polydrug classes 1A to 8A, and those found in chapters five and six. Additionally, it does not appear to follow trends in the literature for either alcohol use patterns or cannabis use. For example, Degenhardt and Hall (2003) found no significant relationship with cannabis use and anxiety disorder. Newcomb et al. (1993) found an elevated risk for alcohol and cannabis to be found in CED-D (depression scores) but not anxiety.

There were no significant differences in suicide attempts during the life course for all polydrug 'B' classes entered into the analysis compared to the baseline class. This is contrary to previous findings. Dawson (1997) and Baigent (2005) identified a link with average alcohol consumption and increasing AUDIT scores, which was not replicated in Model B. Furthermore, O'Boyle and Brandon (1998) identified a relationship between increased involvement in (illicit) polydrug use and suicidal behaviours.

Finally, as was found in previous models in this thesis, there was limited evidence of any increased treatment seeking in Model B. This was despite any increased risk for poorer psychological health for a number of the classes. However, there were two exceptions; polydrug classes 15B and 16B. The former were characteristically more likely to visit their GP for a physical problem in the past year and the latter were characteristically less likely to visit their GP in the past year for a physical complaint (compared to the baseline polydrug class 18B). In explanation of this finding, perhaps moderation patterns typical of alcohol class 4 are evidence of a healthier lifestyle, or overall better health from moderate drinking and no illicit drug use (Lipton, 1994). It is unclear what characteristics of polydrug class 15B explain the elevated risk due to similarities between other classes

In summary, Model B has afforded new insights into polydrug use patterns in Great Britain. Many of these were unexpected given results of previous research and analyses presented in this thesis. However, this could be a function of the distinct way in which alcohol and illicit drug use were modelled together.

7.5.5. Which model explains the patterns best?

Both Model A and Model B demonstrate differences which highlight the benefits of modelling illicit and licit drugs together. However, the following is a brief discussion on the relative merits of both models and which might be most appropriate to adopt in other population samples. The approaches were different in not only the way in which the latent variable was measured, but in the methods used to perform the multinomial logistic regression. Model A used the same methodology as used in previous chapters, three, five, and six. However, given the low percentages of some polydrug ‘B’ classes, this method was not possible to replicate.

Using conditional probabilities in regression gives a better estimate, as variation in observed patterns of response can be captured by the conditional probability of class membership. However, returning to the issue of nomenclature highlighted in the introduction, when generating latent structures to explain a phenomenon, labels are assigned which succinctly describe patterns within the data. From these labels inferences are made about behaviours in classes. Not all studies will be able to use latent class methodologies, as a relatively large sample size is required. However, they can still infer relationships with previously found latent classes based on their broad descriptors. Since these broad descriptors are key to summarising the findings, perhaps there is not a problem in using these for analysis purposes.

Consequently, exclusion of classes with low responses eliminates some of the atypical patterns which would be expected in the data. However, one of the key advantages to latent class analysis is inclusivity and a person-centred approach (DiStefano & Kamphaus, 2005). Perhaps given the diversity of the general population in terms of the percentage of alcohol and drug use in the past year, dissimilarities should be expected by the very nature of patterns of consumption.

However, model B does not appear to be widely supported by previous literature. This could be a function of the methodological issues in previous research and their ability to be compared to latent variable models which exploit patterns of use in data better than researcher chosen categories or it could resemble a poor fit to reality. It is also of note the best loglikelihood did not replicate in this model. This could be a function of the computing power available for this research, and thus improved computing power may be able to get the solution to replicate. Model A was somewhat better supported by patterns in previous research. Generally, it would appear to be the more robust of the two approaches. Therefore, it could tentatively be suggested this model should be taken as the best representation of the data. However, this should be interpreted with caution and future research is needed using the techniques described in this chapter to lend any weight to a given ‘gold standard’ approach, to be adopted by the research community. However, despite which model was concluded ‘best’ in explaining patterns in the dataset, it is apparent from all models tested that the traditional separation in the literature is no longer appropriate. Typologies of illicit drug use differ depending on whether typologies of alcohol use are measured at the same time. When examining psychological status, both illicit and licit drug use appear affected by whether the illicit drugs and alcohol use are included in the model. Therefore, anyone interested in changes in psychological status for illicit drug use or alcohol use separately, should model both, and ideally in a latent class framework.

8. Discussion

8.1. Introduction

Primarily this research has sought to explore and enhance the understanding of the polydrug use phenotype at the general population level. This chapter will firstly review how the methods used within this thesis have accounted for polydrug use. This will be followed by a summary of the results in the context of the aims specified in the introduction. The limitations of the study will be highlighted in the context of the hypothesised contribution to the literature. This will finish with exploring avenues for future research arising from this work, and implications for policy.

8.2. Accounting for polydrug use: advantages to the latent class methodology

Latent class analysis is a methodology which is well suited to describing polydrug use. Specifically, a number of issues which affect research due to polydrug use were identified in section 1.5. Firstly, lack of isolation of one drug from another makes it difficult to draw conclusions on single drugs. Second, the wide variety of possible combinations of polydrug use makes it difficult to categorise individuals into common groups, chosen by inspection of patterns. Latent class analysis can address both of these problems. The method provides a conditional probability which can indicate membership of a given class by a given pattern, even if this pattern is rare in the dataset. When these are regressed on other variables, these conditional probabilities enable relationships to be estimated which account for the lack of isolation.

Furthermore, the data used for analysis was a large, multi-stage, randomly sampled survey which had a wide variety of patterns of response. Notably, there were 78 patterns of illicit drug use response, 208 patterns of response to the AUDIT questionnaire and 535 patterns of polydrug use. Given these figures, it is wholly unsurprising researcher driven categories that have not been statistically validated are unable to account for the variability in their sample of interest. Researchers should be aware choosing categories examined response patterns are likely to be inadequate in conceptualising variability.

Another reason why polydrug use affects drug research regards the differing number of drugs being used. This analysis attempted to include as many drugs as possible in the analysis which would not affect model identification. This also maximises the number of possible patterns in the data and retains as much original information from the dataset as possible. Those with a low probability of use within the sample (typically less than seven in 8580 individuals) were excluded. They represent very low percentages of use in the general population. It was also difficult to combine tobacco consumption in the same way as drug use and alcohol use. These were both measured in a yearly time frame which was not captured for tobacco use. However, exclusion from the latent class analyses had some utility. In these analyses current smoking status was used as a predictor throughout. This was advantageous, as strong relationships of polydrug use with smoking are apparent, and thus it is an excellent means by which to validate latent class structures. However, given the potential for harm, further research may wish to seek a way to include current smoking. This makes most sense where smoking status is measured in a consistent way to the other variables.

Differing definitions of polydrug use affect comparability across studies. As section 1.5.1 has illustrated, polydrug use has been defined in many ways. However, this thesis has defined polydrug use clearly to facilitate better comparisons with similar work. This has been kept constant throughout chapters. General population work is useful to identify key trends in polydrug use, however, it is also important to examine percentage rates amongst key subpopulations which are particularly prevalent in drug use such as ‘club drug’ users (such as Kelly, et al., 2006). The methodologies used in this thesis are robust in the context of polydrug use, therefore, latent class analysis may be able to elucidate patterns of use in the context of higher frequencies of drug use. With the advantages afforded by this methodology in mind, how the chapter meets the overall aims of the thesis will now be assessed.

8.3. Can the variability in polydrug use patterns be accounted for?

Chapter three revealed 30% of those who used illicit drugs in the past year from the population of Great Britain were illicit polydrug users. Three classes emerged from observed patterns of illicit polydrug use response, wide range, moderate range, and no drug use. The wide range class predictably had the smallest membership. The classes represented ranges of drug use rather than focussing on named drugs of use. They were ‘wide range’, ‘moderate range’ and ‘no use’ classes. These were also found to have quantifiable differences in terms of the involvement of each of the component drugs in the pattern (chapter four). This was further evidence of the utility of the latent class procedure to measure polydrug use adequately and the validity of the solution.

Alcohol was conceptualised in six latent classes representing alcohol use and related behaviours in the past year. These were broadly based on a continuum of increased consumption and problems. However, one of the mild consumption classes differed, through a higher than expected relationship with negative consequences; in particular, alcohol related injury and suggestions to cut down on alcohol use.

Finally, two integrated models were proposed. The first of these found an eight class solution for a single latent variable measured by nine illicit drug variables and 10 AUDIT questions. Two of the classes were typically using illicit drugs, with a range of drugs being used. The illicit drugs most likely to be used were cannabis, amphetamines, cocaine, and ecstasy for both of these groups. This represented a departure from the illicit polydrug use classes, as the wide range polydrug use pattern was the primary pattern expressed. Both of these classes were characterised by heavy alcohol consumption, one with multiple negative consequences, and one with memory loss. Largely, the structure of alcohol use and related behaviours remained unchanged in this model, but the percentages of each pattern differed. This was not unexpected given some of the alcohol use patterns now included illicit drug use.

The second integrated model also found differences between previously found structures. In particular, the structure of illicit drug use changed dramatically when estimated in the presence of alcohol use. The wide range pattern found in chapter three remained, but with slightly lower probabilities of use for all illicit drugs except cannabis. The moderate range class found in chapter three did not appear to be robust when measured with alcohol use behaviours. Instead, a cannabis only class appeared to best describe the data. Support for this comes from the findings of chapter five which found the original illicit drug class 2 was characterised by cannabis use, and low lifetime usage of other drugs. As with model A, the structure of alcohol use remained the same, however, there were larger percentages of the baseline group at the expense of the frequency of the moderate range group. If alcohol use is the focus, it may be relative to examine it on its own; however, where illicit drug use is the subject of interest, it is more advantageous to consider it in the light of alcohol use.

Returning to the illustration of ecstasy research in the introduction (section 1.6.1) it is clear research into drugs whilst failing to account for polydrug use at the illicit level, ought to consider alcohol use in addition to the drug of interest. Recent papers highlight polydrug use continues to be described as a limitation of research, rather than key to the conclusions drawn. These commonly attribute any found relationships with a single drug (for example, Keyes et al., 2008) where polydrug use may be at work. In addition, for those classes which are polydrug users, there may be some overlap between consequences attributed to alcohol in the AUDIT. For example, the questionnaire contains an item on memory loss attributed to alcohol use. Where an illicit drug is concurrently used with alcohol, this may increase the risk of a 'blackout' experience. The AUDIT questionnaire asks only about alcohol use, and it may be that in studies where illicit drug use is not gathered, alcohol could be held primarily accountable where a polydrug pattern could be responsible. In this way, a single alcohol focus could also be considered unable to account for polydrug use. Future research may wish to consider the impact of drug use on the alcohol related consequences of the AUDIT.

8.4. Are these valid in terms of relationships with demographic variables?

It is considered structures generated from latent classes should be a close fit to the data but also theoretically meaningful in the context of previous research. To further validate the latent class structures using variables other than those relating to drug use, the classes were compared to demographic criteria known to be associated with polydrug use. One of the key findings was the elevated risk of hazardous alcohol consumption, particularly in the wide range illicit polydrug use class, compared to the baseline class. This was a clear indication of the strong relationship between alcohol use and illicit drug use. There were also differences in age with the youngest being the most likely to be in the wide range polydrug use class, compared to both the moderate range polydrug class and the baseline no use class. Significant relationships with other demographic variables appeared to be indiscriminately related with any illicit drug use regardless of the range of use. Any illicit drug use was related to being male, a current smoker, and low educational attainment.

Chapter six, also found significant demographic differences with alcohol use classes. Heavier rates of consumption were associated with being male and young. In addition, moderate to heavy consumers were also more likely to be characteristic of economic inactivity compared to the baseline class. Lower educational attainment was related to the class with the heaviest alcohol involvement, and higher educational attainment was significantly associated with moderate consumption. Current smoking patterns were only related to heavy consumption with multiple negative consequences and heavy consumption with memory loss.

However, relationships with demographic variables differed when polydrug use was measured as a unified concept. Odds ratios relating to gender illustrated illicit drug and alcohol polydrug users were most likely to be male, and the magnitude of this odds ratio greatly increased. In addition, the two illicit drug use classes in model A (polydrug classes 1A and 2A) were characterised by odds ratios of around 20 and 12 times more likely to be currently smoking. This would partly explain some of the differences found between patterns in the alcohol use only solution. Those with increased polydrug use involvement were also more likely to be young; a finding comparable to those of earlier chapters.

8.5. How does polydrug use relate to psychological status?

In terms of relationships with poorer psychological health, chapter five described illicit polydrug use classes as significantly associated with depressive episode, mixed anxiety and depression and suicide attempts during the lifetime compared to the baseline class. However, any illicit drug use appeared to elevate the risk, rather than relating to the range of drugs used. This suggests relationships with psychological status may be more attributed to illicit drug use than illicit polydrug use. However, it appears illicit drug users are aware of this risk, and even in some cases attempt to prevent harm through protective behaviours (Verheyden, Maidment, et al., 2003).

When alcohol use behaviours were modelled separately, an increased risk for generalised anxiety disorder in the heavier consumption classes was found, and classes 1, 2, 3 and 5 were found to more likely to have committed suicide in the past year. In the integrated model, wider range polydrug use was related to mixed anxiety and depressive disorder. The relationship with generalised anxiety disorder is less clear than in the illicit drug or alcohol only latent class solutions. The wide polydrug range class with heavy consumption and multiple negative consequences is almost eight times as likely to have this condition, as is the cannabis and no drug use classes with the same group of alcohol use. The anomalous class here is the cannabis class with mild consumption, with injury and suggestion to cut down, which could perhaps not be predicted by a heavier involvement in drugs leading to more problems hypothesis which has the highest probability of all classes. Parrott, Milani, Parmar and Turner (2001) suggest where ecstasy and cannabis use are combined they are less likely to have somatic symptoms, and the suggestion cannabis use has some kind of protective effect perhaps not supported by the relationships illustrated in the wide range group (Daumann et al, 2004). Degenhardt et al. (2004) has further suggested cannabis is not related to anxiety; however, the presented integrated model would suggest the converse. The lack of differences found between groups of drug user in the illicit drug use patterns found in chapter six, might be due to the lack of adequate modelling of alcohol use in a polydrug context. Sumnall et al., (2004) found that elevated anxiety levels were found for users of alcohol, amyl nitrate and tobacco use. Furthermore, Semple, McIntosh and Lawrie (2005) have suggested that risk is increased with early adoption of drug use, however, incorporation of age of initiation into drug use did not feature in this investigation, however, it may be an avenue for further study. It could be tentatively suggested from the evidence by Kushner, Sher and Beitman (1990) that generalised anxiety disorder may well occur at the same time or after problem drinking.

Given the elevated risk of suicidal behaviours in the past year for both the alcohol use and illicit polydrug use latent class solutions it is surprising to note in the integrated model there was no relationship with suicide ideation of any significance. This is contrary to findings by O’Boyle and Brandon (1998) which suggests wider drug use involvement is implicated in the elevated risk of suicidal behaviour.

8.5.1.1. No relationship with depression

This research found a decreased risk or no relationship compared with the baseline group for the alcohol use classes measured separately. In the illicit drug use only model, any drug use was elevating the risk to approximately twice that of the baseline, no drug use. Lyvers (2006) makes an important point about drug use, do we really want to find drug (and ecstasy use in particular) to be bad for the users? Evidence given since the popularisation of the internet, anti drugs sites scare tactics are ignored, and cast doubt on the credibility of research; whereas pro-drug sites and their plethora of incomplete anecdotal or false information is equally problematic (Maxwell, 2005). This is reflected in a recent study by Keyes et al. (2008) who stated the lack of a finding with depression suggested given the ‘percentage of depression is not elevated in current ecstasy users warrants further investigation into a possible delayed effect of ecstasy on a full-spectrum depression diagnosis’ pp.143. In this way, perhaps we should consider another explanation, one of which might be polydrug use, social support, gender differences or many other factors. As described by Topp et al. (2004) state we have a duty to provide the most accurate and methodologically sound to those who choose to use, and to those who do not. This is not least because the potential for harm is one of the primary concerns for those who choose to quit (Verheyden, Henry, et al., 2003). Additionally, If you consider your ecstasy use as problematic, you are more likely to have problems as measured by the Brief Symptom Inventory (Soar, Turner & Parrott, 2006), demonstrating almost an expectancy effect for users. Consequently, researchers need to be objective to their findings.

8.5.1.2. Lack of treatment seeking

Although a risk of psychological disorders is apparent in the context of polydrug use, it is also clear that there is not an associated risk of relevant help seeking. This is a common problem (Kessler et al., 1996). Often some of the reasons to explain this is a low perception of need, less severe symptomatology and the absence of comorbid mental health and drug use disorder (Mojtabai, Olfson & Mechanic, 2002). Furthermore, given the individuals who are experiencing this increased likelihood of harm are more likely to be young. A recent study illustrated in a New Zealand birth cohort that only 7% of young adults with an alcohol problem were presenting for treatment. Males were also more likely in this cohort to fail to see need to seek treatment, or to consider it might get better on its own (Wells, Horwood & Fergusson, 2007). Finally, Topp et al. (2004) suggested those experiencing problems related to ecstasy use may modify their own behaviour without assistance.

8.6. Methodological concerns and additional findings

As with any study, there are some methodological concerns which affect the conclusions. These will be detailed below.

8.6.1. High risk populations

In the analysis of household surveys, there is the potential to miss some of the high-risk individuals, such as those who are homeless or vulnerably housed (Ramsey & Percy, 1997). However, this research is concerned with the global picture of use in the general population of Great Britain and there will be still be individuals in this dataset who use licit and illicit drugs. Additionally, the methodologies used in this work are equivalently appropriate to application in more specific populations which are of higher risk, such as the NPMS conducted on a sample of homeless individuals, or in prisons.

8.6.2. Characteristics of responders and non-responders

There might also be differences in responders and non-responders, just as this work has found differences in those who had participated in this research. However, it is unclear as to what these might be. Those who use illicit drugs may be less likely to participate in studies of this kind. Unhealthy lifestyle choices are not always related to non-response with a study finding males who were not hazardously drinking had a higher rate of non-response (Hill, Roberts, Ewings & Gunnell, 1997). Other studies have found no differences in alcohol use and attrition rates (Cunradi et al., 2005) and heavier smoking and alcohol use in absent school students versus present students (Bovet et al., 2006). Whilst there is some conflict in the literature on the characteristics of non-responders, assessments in the methodology section of this thesis described lower levels of response to the drug items compared with the DMD of the same year. However, the NPMS estimates did appear to be like DMD 2007/8, suggesting the research may reflect more contemporary trends. Little research to date has focussed on those who do not complete randomly sampled household surveys using a similar methodology to the OCPS, particularly in terms of their drug and alcohol use, and further research in this area may be useful to inform the field.

8.6.3. Sample size and surveyed group considerations

It is also understandable on occasion the sample size will not be appropriate to conduct latent variable analyses. However, in an Mplus webnote, Muthén (2002) illustrated through Monte Carlo simulation studies in latent growth analyses that latent variable analysis is possible even in relatively modest sample sizes. The Monte Carlo method would additionally be able to assist any researchers to inform whether using latent class methodologies on a given sample size would result in lower quality parameter estimates and inadequate power.

Analyses of specific social situations in which drug use might occur, for example rave or nightclub populations will likely have higher percentage rates, and may find different patterns of use, given the effects of drug, set and setting (Zinburg, 1984). Exploitation of these methods would be useful to compare to this research. Results from chapter eight have suggested that rave or nightclub populations could be hypothesised as an expansion of the use found in the Great British population, providing a more general form of drug use, from which there might be some more defined subsets. Research by Topp et al. (2004) has suggested results from purposive sampling and general population surveys have similarities, although these were assisted by differing time frames.

8.6.4. The issue of nomenclature

In contrast to using the term 'ecstasy' user or ecstasy polydrug user, researchers may wish to name their groups in a way which encapsulates the spectrum of use. This should be applied either as a collective of the most likely drugs reported, or as an indication of the range of drugs. This problem with naming is not exclusive to the drug use literature, but where any latent variables are being described (Bollen, 1989; Cliff, 1983) whether generated from a latent variable analysis or just simply a latent conceptualisation.

For names to be accurate, they might also be unfavourably long, and not very catchy. As mentioned in section 2, it is simpler and more memorable to call groups 'ecstasy users', than, for example 'ecstasy, amphetamine, cocaine, cannabis, tobacco, mushrooms and LSD user'. Care must be taken to fully assess the properties of any described empirically or researcher driven classes, and as this thesis has shown, the names can and do change according to what is known about their membership. Chapter three found wide range, moderate range and no drug use, but upon further investigation the nomenclature changed. The moderate range illicit polydrug user became a cannabis only user when measured with alcohol use in chapter seven.

8.6.5. Abuse and Dependence

The patterns of usage in this thesis do not extend to either alcohol or drug abuse or dependence. Whilst this is an important area for research, it is also important to describe patterns of use for the whole population of Great Britain to assess a more global view for policy and other purposes. The inclusion of abuse or dependence measurements would provide a cyclical argument given progress into the abuse or dependent questions of the questionnaire was through crossing a threshold in the use section. But, as a guideline, Gmel, Heeb and Rehm (2001) described the depth of involvement in terms of the frequency of use of drugs is often a good illustration of the experience of problems.

8.6.6. Who are the baseline group?

Midanik et al., (2007) suggest it is obvious to create a typology comprised of zeros across all drug use indicators. However, in this thesis we sought to conceptualise patterns from the data, and as stated by Simon and Mattick (2003), baseline groups with some psychoactive substance use are not rare. The baseline group in chapter four comprised of some cannabis only users, however, differences were still found in relation to demographic and mental health criteria compared with this baseline group. Furthermore, Lyvers (2006) suggests control groups should be matched in terms of their IQ, age, educational attainment, or other demographic criteria. In regression models, such as the multinomial logistic regressions performed in this thesis, the effect of variation in these variables are controlled for when assessing the contribution of the variable of interest. Lyvers (2006) also suggests in drug research, alcohol use should also be matched. Yet, this research has illustrated the patterns of alcohol use in drug users may be extremely variable, even amongst a group of drug users with a homogeneous pattern of use. Latent variable analyses offer an opportunity to both capitalise on the differences found in the population, providing models which are more accurate representations of real life, and control for these differences when examining at other variables.

8.6.7. Relationship with the gateway theory

To briefly summarise, this considers drug use as a developmental issue, considering a progressive sequence of alcohol, tobacco, cannabis and other drugs (Kandel & Faust, 1975). It has been further suggested that there is little progress to illicit drugs without the use of cannabis first (Kandel et al., 1992), and this may also be potentially mediated by problem drinking (Donovan & Jessor, 1983). The relationship of the illicit drug only latent variable, illustrates a predictably greater risk of smoking, and hazardous drinking as measured by a score of eight or more on the AUDIT also appeared to be characteristic of the wide and moderate range polydrug users in comparison to the baseline group. When patterns of alcohol use behaviours were assessed in greater depth as in chapter eight, it would appear heavier alcohol consumption was related to illicit drug use (over and above cannabis only use) in the eight-class solution.

The two latent variable solution also provided some evidence to support the theory with the wide range polydrug users having a generally heavier pattern of alcohol use consumption; although there were five individuals that did not fit this pattern (3.5% of the total group). By comparison, the cannabis only group were also traditionally associated with heavy alcohol use, with the most prevalent in the heavy/moderate consumption with memory loss group. This would suggest it is not an inevitable that heavy consumption would lead to further drug involvement. There is also evidence that cannabis use can also be associated with moderate to mild consumption with almost 17% of the cannabis using group in polydrug classes 10B through 12B. Like Midanik et al*.,* (2007) there were no classes found which either had hard drug (i.e. illicit excluding cannabis) without cannabis and alcohol. Kandel et al. (1992) further iterate one of the characteristics of individuals' progression in drug history might be mediated by firstly, their age of initiation into the drug, and finally the extent of their use. Whilst it was not possible to assess the age of initiation into drug use, there is tentative support for this in the research of this thesis. Those using illicit drugs are more likely to be younger than the little or no alcohol consumption and no illicit drugs groups. As it is beyond the scope of this research to confirm this may be an avenue for further study. Research also suggests that individuals tend to mature and grow out of drug use as they progress in age (Carlson et al., 2005; O'Malley, Bachman & Johnston, 1984; Substance Abuse and Mental Health Services Administration [SAMHSA], 2007; Von-Sydow et al., 2002). It is worth noting however, that given the gateway theory is essentially longitudinal in it's nature, there can only be limited evidence to support it through cross-sectional research.

8.6.8. Females: A group of abstainers?

This research unequivocally found that men were more likely to be licit and illicit polydrug users, and to a higher extent than the baseline groups for respective chapters. So, what does this tell about the experiences of females with regard to drug use? As mentioned previously males are more likely to be taking illicit drugs (Chivite-Matthews et al., 2005; Collins et al.,1998; Webb et al., 1996), but the finding that the gap is narrowing by Newbury-Birch et al. (2000) and Wadsworth, Simpson et al. (2004) does not appear to be replicated by this group.

As suggested by Measham (1995) the experiences of females using drugs cannot be discounted. This is supported by Hinchcliff (2001) who states the need for pleasure or altered states is as valid and normative for women as for men. Perhaps more research focussed on women, or the replication of these methodologies but allowing the determination of the latent variable to be a function of gender (as predictor) might provide a better expression of the experiences of women. In addition, women are more likely to experience the midweek low (Curran & Travill, 1997) and have a higher rate of injury at equivalent consumption rates to males (McLeod et al., 2004).

8.6.9. Polydrug use; both worthy of study, and better accounted for by latent variable analyses

This research has described distinct patterns of polydrug use in the general population. Through exploring these, estimates of the relationship between polydrug use and psychological status can be determined. As Byquist (2006) has stated “it is now more appropriate to speak of different types of polydrug user than the users of only one drug” (p. 216).

However, it is worth revisiting the definition of polydrug use as either simultaneous or concurrent considering the findings. Whilst the early considerations of polydrug use suggested the nature of this could only be adequately described as concurrent use, it may be additionally likely that those who consume illicit drugs are likely to be simultaneously combining this with alcohol. Evidence to support this includes the statistic that 99% of illicit drug users have also used alcohol in the past year. Given that alcohol is consumed more often than illicit drug use (for the majority), it may be less relevant to assume all alcohol consumption occasions have also involved illicit drug use. This is supported by the finding that 10% of alcohol users in the past year were illicit drug users. Perhaps it is less relevant as a distinction than previously considered in section 1.5.1

Latent variable analysis can model to exact probabilities in the variability in expression of reported drug use. Furthermore, the reliance of single drug research to assess demographic risk factors and poorer psychological health has been shown to be unable to account for polydrug use in their conclusions. The measurement of illicit drug and alcohol use patterns separately has been considered as related to serious consequences for study outcomes. Consequently, if an AOD approach is adopted, the research field can better estimate how patterns, rather than drugs can impact individuals' lives. This is already an approach adopted by clinical practitioners seeking to treat multiple drug abuse or dependence. The symptoms that are shared (and also unique) to a particular drug or drugs are treated for maximum chance of achieving goals for treatment (Gossop *et al.,* 2002). In addition, the phenotypes derived in this person-centred approach could also inform the search for genetic markers for drug use, or to inform prevention and harm minimisation intervention strategies.

Further research might wish to assess whether these phenotypes endure in other populations or over time.

8.7. Further recommendations for research to assess changes in contextual drug use over time

Aside from some of the recommendations given above, there are additional recommendations for further study. It is recommended changes in contextual drug use over time are assessed. This research has provided a guide to the polydrug patterns of use from a study with data collected in 2000. In the introduction, recent European trends were assessed in relation to both alcohol and illicit drug use. Cross-sectional views of drug and alcohol percentage rates naturally fluctuate over periods of time (Collins et al., 1998), and there has been evidence of this in European drug trends with some drugs falling in and out of popularity, for example the increase in cocaine use (EMCDDA, 2008). However, there have been fewer notable explorations of trends either measuring a cohort over time, or shifts in cross-sectional measurement. A longitudinal analysis of the work contained in the NPMS surveys including the next wave of data being currently collected, would enable a wider reflection of trends in the past 20 years. As nationally representative data from a random, stratified sample, this would provide interesting information on trends in the UK using standardised measurements. Furthermore, analysing data from EMCDDA situation of the drug use situation in the EU and Norway, which is provided yearly in a similar manner, would be able to first illustrate whether patterns are consistent over time or over different countries. This would expand both the knowledge and implications of polydrug use in Europe. However, this would only provide trends in illicit polydrug use rather than polydrug use as a general concept. The importance of addressing this issue of trends is an important indicator to highlight needs for policy, but also to assess the impact of policy and attitudinal shifts in terms of their impact on polydrug use.

In addition, with the problems of causation arising from cross sectional research, this approach may be able to flesh out the relationship between drug use, harm and demographic criteria in a way which better estimates causation. For example, longitudinal research may be able to assess the viability of the self-medication hypothesis (Khantzian, 1997); the assertion that depression is often medicated with stimulants, and anxiety with depressants such as alcohol or heroin. It can be stated from this research polydrug use and harm are not independent of each other.

In conclusion this research has described theoretically valid homogenous subgroups of alcohol and drug use present in the general population, which can approximate to and aim to understand the concept of polydrug use. It is also plausible, methodologies such as this, may assist with the demystifying some of the disparities in both the relationship of drugs with demographic criteria and psychological harm. However, to imply causation, further research, preferably longitudinal analyses using this method would help illuminate the impact of polydrug use further. As Neale et al., (2006) state ‘Efforts to understand the causes of drug misuse – and thereby to prevent and reduce its negative effects – depend critically on our ability to measure it’ p.1011. It is sincerely hoped the methodologies contained in this thesis are adopted where possible, to aim to both account for, and open the debate on the nature of polydrug use, the persons who engage in it, and the consequences for the individual.

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Appendix 1: The Audit Questionnaire

1. How often do you have a drink containing alcohol? (How often)
- Never
- Monthly or less
- 2–4 times a month
- 2–3 times a week
- 4 or more times a week

2. How many standard drinks containing alcohol do you have on a typical day when drinking?
- 1 or 2
- 3 or 4
- 5 or 6
- 7 to 9
- 10 or more

3. How often do you have six or more drinks on one occasion?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

4. During the past year, how often have you found that you were not able to stop drinking once you had started?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

5. During the past year, how often have you failed to do what was normally expected of you because of drinking?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

6. During the past year, how often have you needed a drink in the morning to get yourself going after a heavy drinking session?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

7. During the past year, how often have you had a feeling of guilt or remorse after drinking?
- Never

- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

8. During the past year, have you been unable to remember what happened the night before because you had been drinking?
- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

9. Have you or someone else been injured as a result of your drinking?
- No
- Yes, but not in the past year
- Yes, during the past year

10. Has a relative or friend, doctor or other health worker been concerned about your drinking or suggested you cut down?
- No
- Yes, but not in the past year
- Yes, during the past year

MODIFIED AUDIT (CHAPTER SIX)

1. How often do you have a drink containing alcohol? (How often)
    - (0) never; (1) monthly or more

2. How many standard drinks containing alcohol do you have on a typical day's drinking? (Typical amount)
    - (0) 1 or 2; (1) 3 or more

3. How often do you have six or more drinks on occasion? (How often 6+ drinks)
    - (0) never; (1) less than monthly or more frequently

4. During the past year, how often have you found that you were not able to stop drinking when you started? (Unable to stop)
    - (0) never; (1) less than monthly or more frequently

5. During the past year, how often have you failed to do what was normally expected of you because of drinking? (Failed to do)
    - (0) never; (1) less than monthly or more frequently

6. During the past year, how often have you needed a drink in the morning to get yourself going after a heavy drinking session? (Drink in morning)
    - (0) never; (1) less than monthly or more frequently

7. During the past year, how often have you had a feeling of guilt or remorse after drinking? (Guilt after drinking)
    - (0) never; (1) less than monthly or more frequently

8. During the past year, have you been unable to remember what happened the night before because you had been drinking? (Memory loss)

- (0) never; (1) less than monthly or more frequently

9. Have you or someone else been injured as a result of your drinking? (Had injury)

- (0) no; (1) yes

Has a relative or friend, doctor or other health worker been concerned about your drinking or suggested you cut down? (Suggest cut down)

- (0) no; (1) yes

Appendix 2: Personal Communication Muthén , 2008.

From: Mplus Product Support [mailto:support@statmodel.com]

Sent: Wed 16/07/2008 22:05

To: 'Smith Gillian'

Subject: RE: latent class models (Licence No: SABC50058807)

Gillian,

Here are Bengt's comments:

"It is often the case that difficulty in replicating the best loglikelihood suggests that the model is more complex than the signals in the data can support. Have you been able to replicate your best loglikelihood in the separate analyses of the 2 sets of items? 6 classes seems like a lot for only for 10 binary items - was that solution well replicated? If yes on both those questions, perhaps the joint model does not fit the data well. Perhaps there are some items in the 2 sets that are directly related, beyond the correlation via their latent class variables. You can request Tech10 to study significance of such bivariate residuals."

Linda

Linda K. Muthen

Muthen & Muthen Phone: (310) 391-9971

3463 Stoner Ave. Fax: (310) 391-8971

Los Angeles, CA 90066 website: www.statmodel.com

From: Smith Gillian [mailto:GW.Smith@ulster.ac.uk]

Sent: Monday, July 14, 2008 10:23 AM

To: support@statmodel.com

Subject: latent class models (Licence No: SABC50058807)

Hello,

I have run two separate latent class models of drug use (3 classes: 9 binary indicators) and alcohol use (6 classes: 10 binary indicators) using Mplus. I am attempting to correlate the latent variables upon each other to determine how the structure may/may not change, and how the latent classes relate to each other. I have been unable to replicate the loglikelihood even when I have upped the starts to 5000 with 3000 optimisations, and thus I do not trust the solution. I have also tried to run similar models illustrating ranges of classes from 2-4 for drug use and 5-7 for alcohol use to determine whether this might be an issue that is a result of the structure of the latent variables changing in the presence of the other latent variable, but find the same problem for these models. I note that in the attached model, there are a number of loglikelihoods that have been replicated on many occasions but these are not the 'optimum' loglikelihood e.g. -34129.64. Should I continue to up the starts or perhaps try using something like the optseed command using some of these loglikelihoods. Is there a cut off point to which you have to accept a solution cannot be found?

With kindest regards,

Gillian

Appendix 3: Table illustrating the results of the multinomial logistic regression of the twelve most frequently endorsed classes.

	Class one	Class Two	Class three	Class seven	Class nine	Class Ten	Class eleven	Class thirteen	Class fourteen	Class fifteen	Class sixteen	Class seventeen
Gender (male)	**13.49 (7.66-23.77)**	**7.03 (2.07-23.89)**	**8.58 (4.65-15.85)**	**8.47 (5.57-12.89)**	**4.67 (3.57-6.11)**	**2.88 (1.72-4.82)**	**4.27 (1.59-11.43)**	**6.13 (4.55-8.25)**	**5.41 (4.21-6.94)**	**4.08 (3.45-4.82)**	**2.55 (2.26-2.88)**	**1.25 (1.03-1.53)**
Currently Smoking (yes)	**2.47 (2.16-2.82)**	**2.48 (2.16-2.84)**	**2.47 (2.16-2.83)**	**2.47 (2.16-2.82)**	**2.47 (2.16-2.82)**	**2.47 (2.16-2.83)**	**2.47 (2.15-2.83)**	**2.40 (1.89-3.04)**	**2.46 (2.14-2.82)**	**1.91 (1.60-2.27)**	**2.47 (2.16-2.82)**	1.18 (.93-1.50)
Educational attainment (GCSE or below)	1.30 (.89-1.89)	2.47 (.72-8.53)	1.40 (.90-2.17)	1.19 (.81-1.73)	**1.21 (1.00-1.48)**	.88 (.53-1.46)	1.92 (.88-4.17)	1.14 (.91-1.43)	1.01 (.85-1.21)	1.00 (.99-1.01)	1.00 (1.00-1.01)	**1.29 (.1.11-1.50)**
Area type (urban)	**1.95 (1.06-3.58)**	2.08 (.45-9.67)	1.30 (.69-2.45)	1.24 (.81-1.89)	**1.42 (1.06-1.91)**	.67 (.51-1.47)	3.18 (.72-14.10)	1.09 (.81-1.47)	**1.38 (1.07-1.77)**	1.00 (.85-1.19)	.97 (.86-1.09)	1.10 (.91-1.33)
Economic activity (inactive)	.77 (.53-1.13)	**.23 (.07-.77)**	.72 (.46-1.11)	.71 (.46-1.09)	.83 (.68-1.30)	1.00 (.92-1.08)	.52 (.24-1.13)	.88 (.70-1.10)	.99 (.83-1.18)	1.00 (.99-1.01)	1.00 (.99-1.00)	**.78 (.67-.90)**
Age	**.83 (.81-.86)**	**.84 (.79-.91)**	**.82 (.79-.85)**	**.87 (.86-.89)**	**.87 (.86-.88)**	**.90 (.88-.92)**	**.88 (.84-.93)**	**.93 (.92-.94)**	**.96 (.95-.97)**	**.93 (.92-.93)**	**.96 (.96-.97)**	**1.01 (1.00-1.02)**
Depressive episode	1.77 (.62-5.06)	**8.30 (1.25-53.31)**	1.38 (.29-6.46)	1.12 (.40-3.16)	1.07 (.51-2.27)	.96 (.22-4.20)	3.39 (.72-16.04)	1.68 (.88-3.19)	**.40 (.16-.97)**	**.55 (.31-.97)**	**.49 (.32-.73)**	.89 (.48-1.64)
GAD	**7.83 (3.54-17.36)**	2.23 (.19-26.51)	1.75 (.39-7.92)	**3.15 (1.46-6.79)**	1.29 (.65-2.58)	.94 (.22-4.07)	**12.43 (3.31-46.70)**	**2.41 (1.39-4.17)**	**1.93 (1.15-3.24)**	1.47 (.98-2.20)	1.01 (.74-1.37)	.82 (.49-1.38)
MAD	**2.82**	**5.28**	1.93	**2.01**	**1.61**	1.31	2.17	**1.72**	1.05	1.00	**.74**	.79

	(1.38-5.75)	**(1.25-22.26)**	(.82-4.53)	**(1.14-3.56)**	**(1.08-2.39)**	(.60-2.84)	(.46-10.31)	**(1.12-2.64)**	(.69-1.59)	(.75-1.34)	**(.60-.92)**	(.55-1.13)
Suicide attempt in lifetime	.96 (.61-1.51)	1.00 (.97-1.03)	.94 (.55-1.61)	1.00 (.97-1.02)	.94 (.73-1.23)	.85 (.52-1.40)	.78 (.32-1.92)	1.00 (1.00-1.00)	1.00 (.95-1.05)	1.00 (.99-1.01)	1.00 (1.00-1.00)	.99 (.93-1.07)
GP psychological	1.04 (.87-1.25)	.60 (.10-3.45)	1.04 (.87-1.25)	1.04 (.84-1.30)	1.04 (.88-1.24)	1.04 (.88-1.24)	.43 (.10-1.83)	1.04 (.88-1.24)	1.00 (.69-1.47)	.84 (.65-1.10)	1.04 (.88-1.24)	1.04 (.86-1.25)
GP physical	1.03 (.66-1.61)	.70 (.22-2.28)	1.04 (.62-1.77)	.78 (.53-1.15)	1.05 (.82-1.34)	1.16 (.71-1.88)	1.26 (.52-3.07)	1.02 (.81-1.28)	.95 (.75-1.21)	**1.29 (1.09-1.51)**	**.86 (.76-.97)**	1.06 (.67-1.30

Note: Significant OR (95% CI) are given in bold