Finding the missing units: Identifying under-reporting of alcohol consumption in England

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I, Sadie Boniface confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed:

Abstract

Background: Under-reporting of alcohol consumption is a widespread and persistent problem in surveys worldwide. For Great Britain in 2010, 56% of alcohol sold was reported consumed. Under-reporting occurs for reasons, including, but not limited to: selective reporting, mode effects, recall bias, and under-estimation.

Methods: Secondary analyses of Health Survey for England (HSE) 2008 (n=9,608) and General Lifestyle Survey (GLF) 2008 data (n=12,490) to estimate population level alcohol consumption with under-reporting taken into account. Secondary analyses of the HSE 2011 (n=3,774) to highlight possible risk factors for under-reporting of alcohol consumption in retrospective interview compared with prospective drinking diary. Qualitative semi-structured interviews (n=10) with HSE 2011 drinking diary participants to identify further potential risk factors. Self-completion questionnaire and pouring task with a convenience sample (n=283) to explore under-estimation of home drinking.

Results: After accounting for under-reporting, 40% men and 30% women drank above weekly guidelines, an increase of over 10% points (GLF 2008). On the heaviest drinking day in the last week 75% men and 80% women drank above daily limits, compared with around half in the original survey (HSE 2008). Risk factors for prospective diary measures exceeding those of the retrospective interview were: weekly alcohol intake, number of drinking days, drinking a combination of drink types, and drinking exclusively in licensed premises (HSE 2011). Qualitative interviews identified having a non-routine drinking pattern and not using alcohol units to track consumption as linked to drinking more in the prospective diary than expected. The pouring task did not identify systematic under-estimation of a usual glass; however under-estimation was associated with increasing volume poured.

Conclusions: Under-reporting of alcohol consumption has implications for public health research and policy. In three studies, alcohol-related factors were associated with under-reporting of alcohol consumption whereas demographic and social factors were not. Targeted interventions and policies may reduce under-reporting.

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Finally and most importantly, I would like to thank my parents for everything they have done for me - especially putting me through my Masters degree with three weeks' notice (!) - without which I would certainly not have come to complete this PhD.

A version of Table 1 in the literature review and an abridged version of the secondary analyses presented in Chapter 5 are published in the European Journal of Public Health (published online 27th February 2013. Appendix A). The published article presents one part of the analyses in Chapter 5 ('scenario one'), and was co-authored by Dr Nicola Shelton.

An abridged version of the pouring study presented in Chapter 8 is published in the journal Alcoholism: Clinical and Experimental Research (published online 20th December 2012, Appendix B). The published article presents data on estimation accuracy, but not knowledge of units, nor estimation by glass type or beverage choice. The co-authors are Dr James Kneale and Dr Nicola Shelton.

Table of contents

List of tables

List of Figures

Chapter 1 Introduction to the thesis

Alcohol-related harm is at unprecedented levels and liver disease is the only major cause of mortality and morbidity that is increasing in England while decreasing in the rest of Europe. Yet social surveys continue to find that we are, broadly speaking, a nation of sensible drinkers. In this thesis the 'missing units' will be identified as alcohol consumption that is not reported in these surveys. The aims and methodology that will be used to find the 'missing units' are described, and the structure of this thesis is outlined.

1.1 Introduction

The most recent data for England show that 70 per cent of men and 54 per cent of women drank alcohol in the last week (**1**), and 87 per cent of men and 81 per cent of women drink alcohol at least occasionally (**2**). As a nation of drinkers, it comes as no surprise that drinking is a very visible part of British culture; it is seen in our homes, on our streets, in film and on television. Advertising is widespread, and alcohol policy and research news is featured in print and online media almost daily. The acute and chronic medical conditions associated with alcohol, the costs of these to the NHS, the wider costs to society and to the economy are all well-documented (for instance, see (**3-5**)).

Drinking alcohol is not only frequent and prevalent in our society today, but throughout history as well. Alcohol sales data have been used to describe trends in alcohol consumption over time. Commonly, alcohol sales and alcohol consumption are used interchangeably; however they are two quite different types of data, as we will see in this thesis. For much of the twentieth century alcohol sales were between four and five litres per capita (all ages) (**6**). Through the late 1960s and early 1970s sales rose, such that from the 1970s to the late 1990s alcohol sales were equivalent to between nine and 10 litres per adult (aged 15 and over) (**7**). From the late 1990s until approximately 2007, sales rose above 10 litres for the first time since the Edwardian period, peaking at 11.5 litres in 2004 (**7**). Since 2007 there has been a suggestion of a downward trend. We will return to secular trends in drinking in more detail Chapter 2. What should be noted here is that although trends in alcohol-related outcomes are difficult to track in relation to sales due to the time lag for those outcomes to occur, with the increase in alcohol consumption since the 1970s there does seem to have been a corresponding rise in alcohol-related harm. The Chief Medical Officer Dame Sally Davies's annual report for 2012 identified that liver disease is the only major cause of mortality and morbidity that is increasing in England while decreasing in the rest of Europe (**8**). Professor David Nutt who co-founded the Independent Scientific Committee on Drugs has even described the recent increase in alcohol harm as 'comparable to the Gin Craze in the early eighteenth century' (**9, p92**). Clearly, reducing harmful drinking should be a priority for the public health community in England.

Population groups who are more likely to be drinking at hazardous or harmful levels are identified by national surveys, which use self-reported alcohol consumption data. It was estimated that in 2010 the vast majority of people - 74 per cent of men and 83 per cent of women - drank either no alcohol, or within the lower-risk guidelines (21 units[1] a week for men and 14 for women), in an average week (**10**). Furthermore, just 20 per cent of men and 14 per

[1] This thesis uses the UK definition of alcohol units, equivalent to 10ml (8g) ethanol (EtOH).

cent of women were classified as 'hazardous' drinkers (21-50/14-35 units a week), and 6 per cent of men and 3 per cent of women were drinking at 'harmful' levels (>50/35 units a week) (**10**). Why does England experience so much alcohol-related harm if we are a nation of sensible drinkers? It is not plausible that the harms are exaggerated, as these are based on objective outcomes such as mortality, hospital admissions, and International Classification of Diseases diagnosis codes. Much more likely - and widely recognised by the alcohol research community - is that alcohol consumption data grossly under-estimate actual consumption on a population level. To give some indication of the scale of this problem, the General Lifestyle Survey (GLF) 2010 recorded self-reported alcohol consumption as 11.5 alcohol units per week per adult aged 16+ in Great Britain (**10**). UK alcohol sales measured by HM Revenue and Customs (HMRC) were 10.6 litres pure alcohol per adult 16+ in the financial year 2010/11, equivalent to 20.4 units a week for every adult (**11**). Alcohol consumption as a proportion of total sales – or alcohol 'sales coverage' - was 56%, with 44% of alcohol sales not accounted for (see Section 4.6). In this thesis, this is referred to as 'the missing units'. These missing units in England are investigated, in terms of the extent, consequences, causes, and distribution of under-reporting of alcohol consumption.

In this thesis, the extent of under-reporting of alcohol consumption in England is quantified. The potential consequences of under-reporting for alcohol consumption are examined. Attempts are made to identify population groups and particular drinking patterns or styles that are most strongly associated with under-reporting through mixed-method research. Under-reporting is an issue that we will see has enormous consequences, yet has received relatively little research attention to date. This has been a challenging issue to research; the very nature of the topic implies an absence of data. Existing data have been used in innovative ways, and primary data have been collected to explore additional aspects of under-reporting. This thesis contributes to the methodological debate around measuring alcohol consumption, as well as being of interest to a broad public health audience.

1.2 Aim of the thesis

The overall aim of this thesis is to identify and explain under-reporting of alcohol consumption in England. This will be achieved by addressing several objectives in turn:

i. Quantify the extent of under-reporting.
ii. Consider the implications of under-reporting for estimates of alcohol consumption.
iii. Identify socio-demographic groups, drink types, and drinking habits/styles that are most strongly associated with under-reporting.
iv. Explore the potential for under-estimation of the alcohol content (units) of alcoholic drinks to contribute to under-reporting.

v. Make public health and policy recommendations based on the results.

1.3 Research methodology

This thesis combines analyses of existing data with primary data which were collected specifically for this thesis, and uses mixed methods. The secondary analyses conducted use national health and lifestyle survey data from the Health Survey for England and the GLF. The primary data collection for this thesis is comprised of two studies. The first of these is a series of qualitative semi-structured interviews conducted with drinkers in their own homes. The second is a face-to-face survey comprising a self-completion questionnaire and a pouring task.

1.4 Structure of the thesis

In Chapter 2, the concept of units and drinking guidelines are introduced, and secular trends in the volume and composition of alcohol sales are discussed with reference to academic discourse around public and private drinking. Studies conducted worldwide that have attempted to quantify the missing units are discussed. Extraneous factors that could explain some of the missing units are described and quantified, and it is shown that the missing units can be attributed to under-reporting of alcohol consumption. The literature on the many forms of under-reporting which may take place in social surveys is reviewed systematically, and critically appraised. On the basis of the literature reviewed, Chapter 3 identifies what unanswered questions remain regarding under-reporting of alcohol consumption. These inform the aims of this thesis, and the aims, objectives and hypotheses of each of the empirical chapters.

Chapter 4 defines the concept of the missing units in detail and quantifies the extent of under-reporting of alcohol consumption in England using publicly-available existing data. It will be shown that the difference between consumption and sales data is large, with the missing units consistently amounting to over 40% of all the alcohol sold in England. The potential consequences of under-reporting to this extent for population health are explained, highlighting the importance of work on this issue for public health. The gap in the literature reviewed in Chapter 2 is identified, and the aims and objectives of this thesis are introduced study-by-study. Research questions and hypotheses are formulated.

Chapter 5 and Chapter 6 (Part A) are secondary analyses of national survey data. The surveys used are described in detail at the beginning of each chapter. In Chapter 5, the consequences of under-reporting for alcohol consumption are considered in three putative scenarios. It will be shown that not only do estimates of the prevalence of drinking above Government drinking guidelines increase substantially, but that even assuming equal under-reporting there are different effects for different population groups. In Chapter 6, risk factors for under-reporting are

explored using a comparison of two survey methods: the main survey interview, and a seven-day drinking diary. Statistical analysis examines socio-demographic and alcohol-related factors which are associated with under-reporting (as alcohol consumption which is not captured by the main survey interview, but is captured in the diary).

Chapter 7 and Chapter 8 (Part B) include empirical work designed and conducted specifically for this PhD thesis. The designs of these two studies and data collection procedures are described at the beginning of each of these chapters. In Chapter 7, qualitative interviews aim to identify other socio-demographic and alcohol-related factors, which may be associated with under-reporting, that were not evident from the quantitative study in the previous chapter. In Chapter 8, drink pouring practices are examined with particular reference to home drinking. The extent to which under-estimation of a 'usual glass' of alcoholic drinks could contribute to under-reporting is explored.

Finally, in Chapter 9, the findings from Parts A and B are brought together and summarised. The extent to which this thesis has been successful in finding the 'missing units' is discussed. The implications of this research for national guidance on alcohol consumption are explained with reference to contemporary debate. The public health implications of this research are highlighted, and public health and alcohol policy recommendations are presented. Based on the findings from Parts A and B, future research recommendations are given for areas which remain as research priorities for measurement of alcohol consumption, and where under-reporting is less well-understood.

A brief chapter summary can be found on the title page of each chapter.

Chapter 2 Literature review

Developments in drinking guidelines and trends in alcohol consumption and research provide background and context to this literature review. Evidence from international studies is presented to show that under-reporting of alcohol consumption is a widespread problem. It is shown that the missing units, which comprise over 40% of alcohol sold, can be attributed to under-reporting of alcohol consumption. This under-reporting may take place for several reasons: non-response, selective reporting, mode effects, recall bias, under-estimation, and due to intoxication level. Research on each of these areas of under-reporting is systematically reviewed and critically appraised.

2.1 Introduction

This literature review sets the scene for the empirical chapters of the thesis. In the first part of this literature review, the concept of a unit or standard drink is introduced. Next, secular trends in alcohol sales, and in the composition of those sales, are linked to the debate in the social sciences on priorities in research on drinking. The subsequent sections of this chapter systematically review empirical work that has addressed constituent components of under-reporting. Studies reviewed have had diverse aims and varied methodologies have been used. The majority of studies are from an epidemiological or addiction studies perspective, but studies conducted by researchers in other disciplines – such as academic marketing research – are also included. Each study has relevance for gaining an improved understanding of why alcohol sales coverage is low. This allows for hypotheses to be formed in the following chapter (Chapter 3).

2.2 Aims of literature review

This literature review will:

i. Discuss the nature and definition of a unit or standard drink
ii. Compare secular trends in alcohol consumption with the recent social science research agenda
iii. Quantify extraneous factors in addition to under-reporting that could explain the missing units
iv. Systematically review and critically appraise empirical work that can contribute to understanding low alcohol sales coverage. This can be broken down into four main categories:
    a. Studies of the limitations of using surveys: do non-response bias and social desirability bias contribute? (Sections 2.6.2 and 2.6.3)
    b. Studies of survey methodology: how does survey design affect under-reporting? (Sections 2.6.4 and 2.6.5)
    c. Studies of drink pouring practices: does under-estimation of drinks contribute to under-reporting? (Section 2.6.6)
    d. Studies which have investigated intoxication level using biological or observational methods: what does comparing self-report with more ‘objective’ measures uncover? (Section 2.6.7)

2.3 Background: alcohol units and drinking guidelines

Alcoholic beverages come in varying strengths - or alcohol by volume (ABV) - and serving sizes, and some are diluted by varied amounts. Alcohol consumption has long been measured in social surveys using the concept of a 'unit' (e.g.: UK) or 'standard drink' (e.g.: USA, Australia), rather than as grams of pure alcohol. As higher ABV beverages are usually drunk in smaller volumes, this has been described as an attempt at 'alcohol equivalency' (**12**), facilitating consumers' and health professionals' ability to convert amounts of different drinks into this common metric. One UK unit is equivalent to 10ml (8g) ethanol (EtOH, pure alcohol). Such measures are usually the basis of Governments' drinking guidelines. In the UK, there are separate drinking guidelines for weekly and daily drinking, and these differ for men and women.

A 1990 review of 125 studies by Turner found that the 'standard' drink varies both within and between countries, by size, by ABV, and by the method of conversion used to convert a known quantity of a beverage into a quantity of alcohol (**13**). In 1990, a standard drink varied from 9.2 grams of ethanol in Australia and New Zealand to 23.5 grams in Japan (**13**). Not only were standard drinks inconsistent, but measurement units varied between countries and research groups as well. Turner called for research groups "to define what they mean by a 'standard drink'" and to detail the average alcohol content of these drinks (**13**). The International Centre for Alcohol Policies (ICAP) tabulates international drinking guidelines, and it is clear that a large amount of variation in what constitutes a standard drink, and recommended levels of consumption, still exists (Appendix C). A recent paper by Furtwængler and de Visser drew attention to this issue after finding no consensus in the drinking guidelines of countries worldwide for daily or weekly consumption, or the difference between men and women (**14**), showing that there has been little progress on this since Turner's 1990 review. As such, it must be borne in mind that studies reviewed in later sections of this chapter use time and country-specific measures of standard drinks or units.

As with standard drinks, drinking guidelines are complex and have changed even within a country. Weekly alcohol limits of 21 units for men and 14 units for women were introduced in a Royal College of Physicians report in 1987, and drinking above this level is often termed 'hazardous' (**15**). Drinking more than 50 (men) or 35 (women) units a week is considered to be particularly dangerous, and has been termed 'harmful' drinking (**16**). It has been recommended not to regularly exceed daily limits of 3-4 alcohol units a day for men, and 2-3 units a day for women, by the UK Chief Medical Officers since 1995 (**17**). The Department of Health in England's definition of binge drinking was consuming more than double the recommended limits in one session – eight or more units for men or six or more units for women (**18**). However this definition of binge drinking may be becoming obsolete as it no longer features on the

Department of Health's Alcohol Advice web page (**19**), however it was featured in the Government's 2012 Alcohol Strategy (**4**).

These guidelines have changed over time. Safe limits regarding alcohol consumption were first declared in the UK in 1870, when Anstie stated that "three or four glasses of port wine a day…1.5 ounces of absolute alcohol" was "about the limit of what can be habitually taken…without provoking symptoms of chronic malaise" (Anstie 1870, cited in (**20**)). At 28 units of alcohol a week, or 36g of pure alcohol per day (**20**), this is similar to the safe limits recommended today. In 1979 the Royal College of Psychiatrists gave "reasonable guidelines for the upper limit of drinking" as 56 units of alcohol a week, or 72g per day (Royal College of Psychiatrists 1979, cited in (**20**)). In the 1980s drinking guidelines shifted towards recommending 'safe' or 'sensible' levels of consumption rather than levels likely to cause harm previously used (**20**).

2.4 Context: secular trends in consumption and research

2.4.1 Secular trends in alcohol sales

Secular trends in alcohol sales were discussed briefly in Section 1.1. Here more attention is paid to the detail and the composition of those sales. Overall, alcohol sales for all beverages combined were relatively stable between the early 1970s and the late 1990s at between nine and 10 litres per capita in the UK (aged 15 and over). Around the turn of the century, sales started to increase, peaking at 11.5 litres per capita (aged 15 and over) in 2004. There has been a slight downward trend in alcohol sales since 2007 (Figure 2.1). Alcohol sales in 2009 were 10.2 litres per capita per year, equivalent to 19.6 units every week for every adult aged 15 and over.

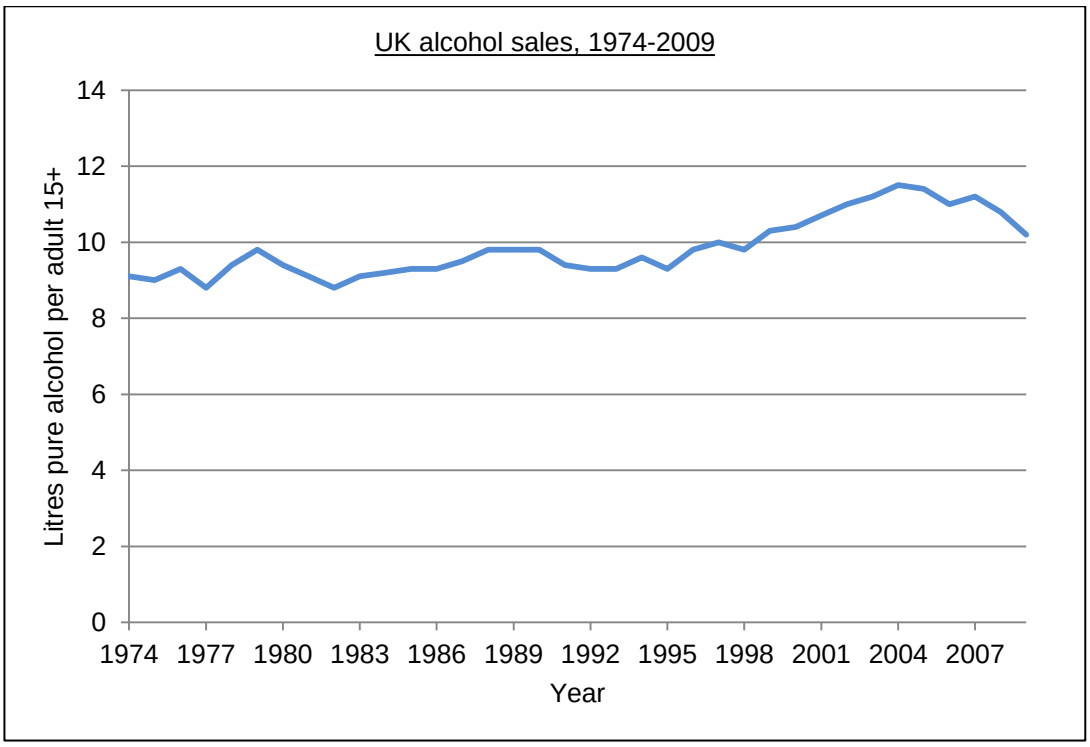


Figure 2.1: Alcohol sales per capita (15+), 1974-2009 (data from BBPA statistical handbook 2010) (7)

However, to fully understand the secular trends in alcohol sales it is necessary to look at a longer time period than that provided by the British Beer and Pub Association above. In this case a rather different picture emerges. If instead the whole of the twentieth century is considered, it becomes clear that from the early 1970s onwards alcohol sales have been at a much higher level than has been observed since Edwardian times (Figure 2.2). In the late 1960s or early 1970s, it seems a new 'era' of drinking was entered. For the majority of the twentieth century, per capita alcohol sales (this time displayed for all ages) were at a much lower level than current and recent years.

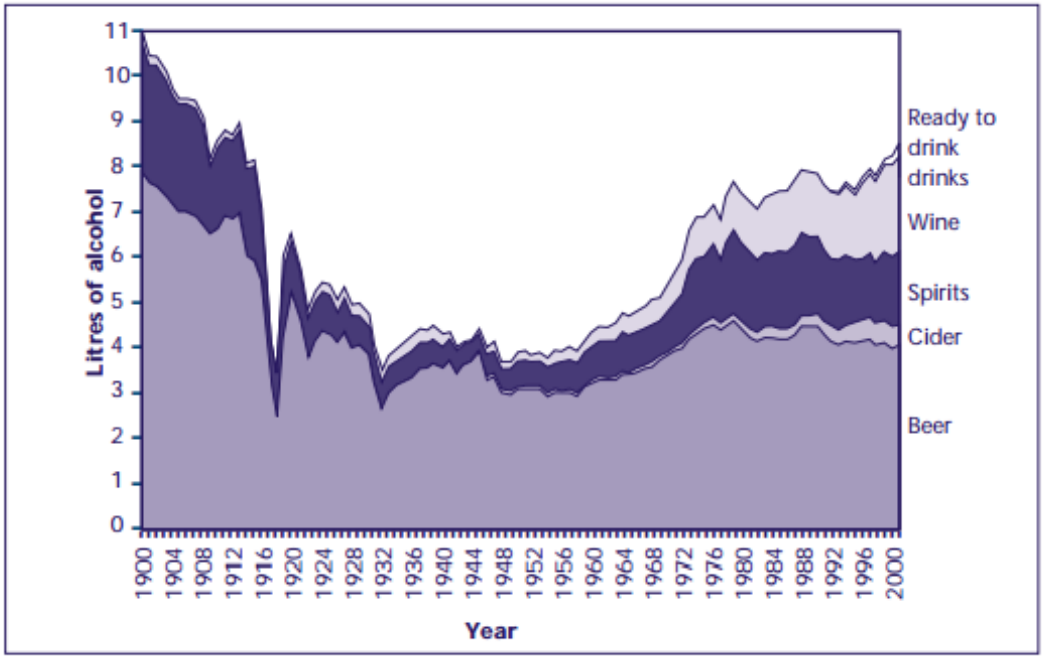


Figure 2.2: Alcohol sales in the UK: 1900-2000 per capita (all ages) consumption of 100 per cent alcohol. Source: Cabinet Office (6).

In Figure 2.2 it is also clear that the proportion of alcohol sales comprised by each drink type has changed substantially. The proportion of alcohol sales that were beer fell, and the proportions of spirits and wine grew considerably. New drinks such as alcopops (or 'ready to drink drinks') have also been introduced, although these comprise only a small proportion of total sales. This suggests that there may have been some important changes in drinking patterns or styles that accompanied the changes in total sales over the twentieth century. Further, the small amount of change in sales over the most recent decade in Figure 2.1 masks a striking change in drinking habits over even this short time period. If the composition of alcohol sales is considered with respect to drink type, it is clear that drinking habits have changed substantially in terms of the types of alcohol consumed. In particular, since the start of the 1990s the percentage share of alcohol sales has fallen for beer, and increased for wine and cider (Figure 2.3).

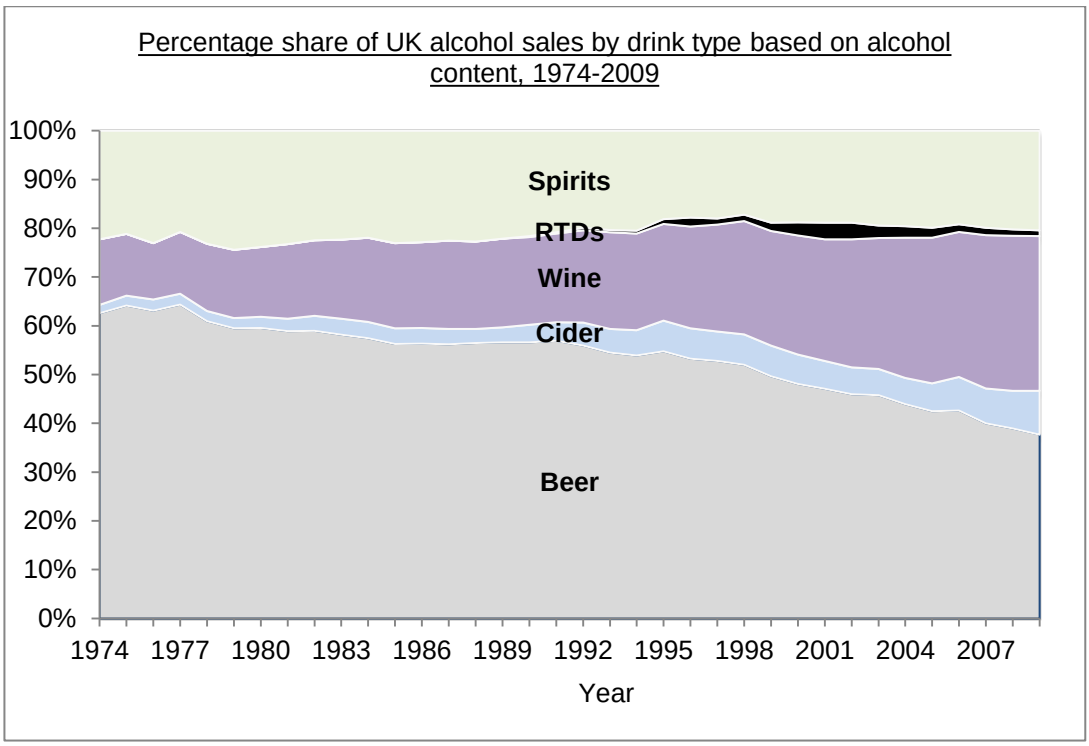


Figure 2.3: Sales by drink type as a percentage of total alcohol sales (BBPA statistical handbook 2010) (7)

Note: RTDs = ready to drink drinks, such as coolers and flavoured alcoholic beverages

This is linked to marked changes that have taken place over this time period with respect to consumption via on-trade versus off-trade channels. 'On-trade' sales "comprise those in pubs, hotels, wine bars, restaurants and clubs", while 'off-trade' sales "comprise specialist off-licences, grocers, supermarkets and all other shops" (**7**). In 2000 approximately half of all alcohol sales were in the off-trade by but 2009 this was two-thirds (**7**). For each drink type, the proportion of sales that is through off-trade channels has increased over the last decade (Figure 2.4 (see also Appendix D for corresponding decrease in proportion of sales in the on-trade)). The off-trade - broadly speaking 'the home' - is now the dominant drinking venue for wine, spirits, cider, and ready to drink drinks (RTDs). The single largest component by volume of off-trade sales is wine. In 2009 off-trade alcohol sales were 39.5% wine, 26.9% beer, 24.2% spirits, with the remainder comprising cider and RTDs (see Appendix E).

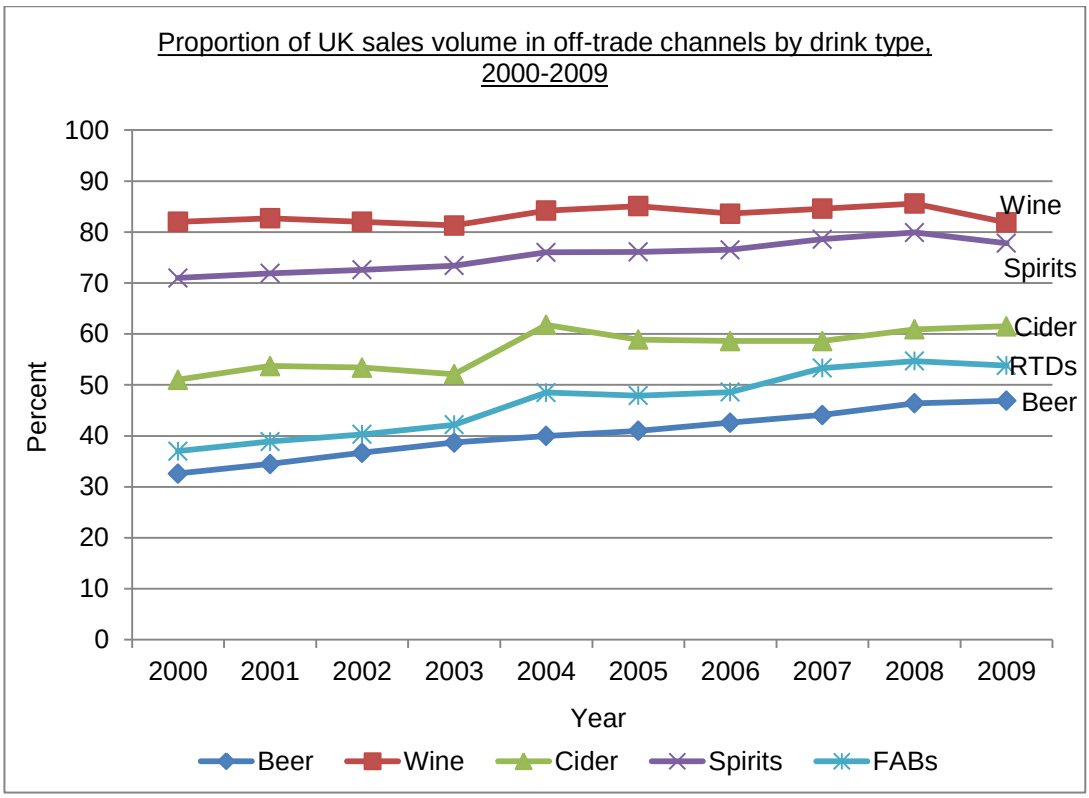


Figure 2.4 Off-trade sales volume as a percentage of total sales for each drink type (BBPA statistical handbook 2010) (7)

In addition to the proportion of each type of alcoholic drink that is consumed in the off-trade increasing over time, the total quantity of alcohol sold in the off-trade has increased also (Figure 2.5, data available from 2000 onwards, although anecdotally it is known that this shift began several dacedes previously). Off-trade alcohol *spending*, however, has remained fairly constant. In contrast, on-trade sales expenditure has been decreasing since the late 1970s, and on-trade sales volume has been decreasing at a corresponding rate. This suggests it is becoming increasingly affordable to drink at home with correspondingly little change in the affordability of drinking in pubs and restaurants etc. These recent shifts in the composition of alcohol sales have led to the off-trade becoming the dominant channel for alcohol sales: two thirds of all alcohol sales were in the off-trade in 2010 (**7**).

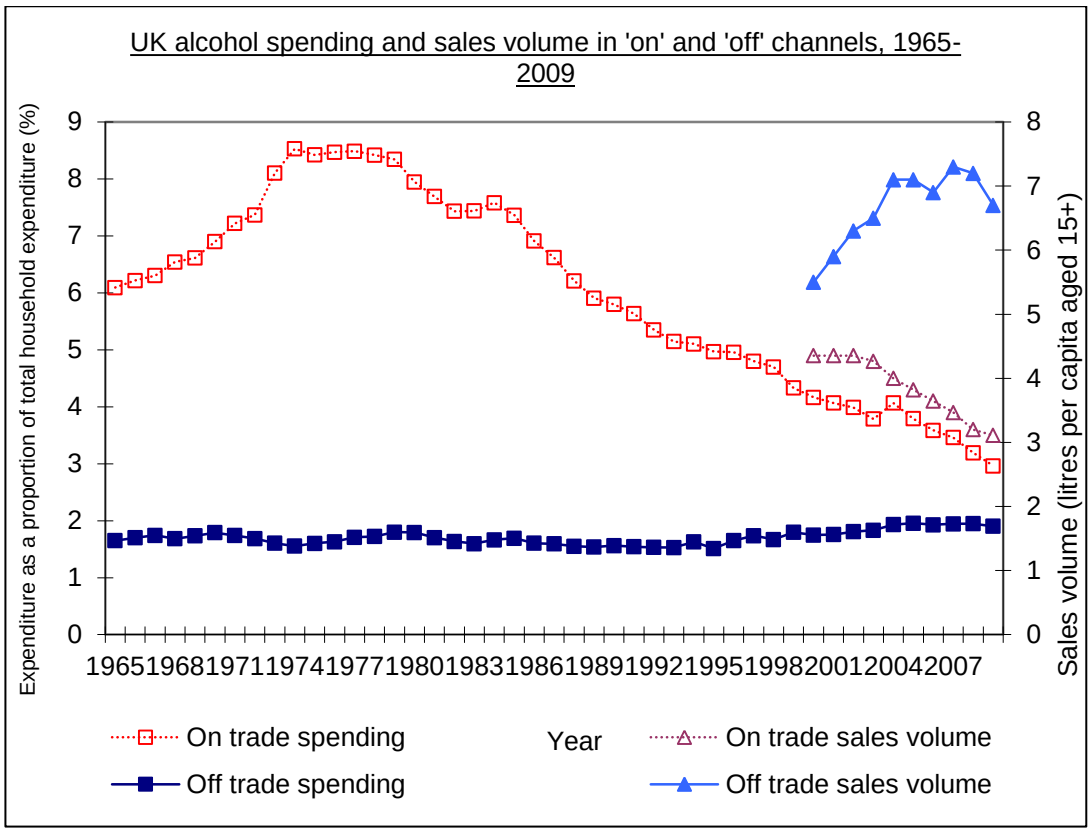


Figure 2.5: UK alcohol sales volume and value, 1965-2009 (BBPA statistical handbook 2010) (7)

2.4.2 Have alcohol research and policy kept up to date with changing consumption patterns?

The changes in the composition of alcohol sales, particularly since the year 2000 are likely to reflect changes in drinking habits. In particular, the shift towards off-premise or private drinking - which has meant that consumption has become less visible – could have disguised any changes in problematic or heavy alcohol consumption. A recent paper by Twigg and Moon explores temporal and spatial changes in binge drinking between 2001-9 using data from the Health Survey for England (**21**). Two definitions of binge drinking were used: 'standard binge drinking', defined as drinking more than twice the daily limits (>4/3 units) on the heaviest drinking day in the last week, and 'episodic binge drinking', defined as drinking more than this level on the heaviest drinking day in the last week and remaining abstinent for the other six days (**21**). The prevalence of binge drinking increased from 2001-9 for both definitions, with standard binge drinking increasing from 27.1% in 2001 to 37.9% in 2009, and episodic binge drinking increasing from 4.5% to 8.5% over the same period, with the greatest increase seen in 2007 (**21**). Multi-level modelling found that, for standard binge drinking only, the gradient in binge drinking by area deprivation quintile evident in earlier years (whereby those living in more deprived areas were more likely to binge drink) had flattened in the years 2007-9 (**21**). Further, in 2007-9, women experienced similar odds of binge drinking to men, whereas in earlier years

women experienced lower odds (**21**). These changes echo updates to survey methodology which took place around this time (see Section 5.5.2.2), and it is acknowledged that this may be artefactual (**21**), however the increasing dominance of the off-trade discussed in the previous section (Section 2.4.1) could also play a role.

This section initiates previously called for inter-disciplinary dialogue (**22**) between the social sciences and epidemiology and public health - with respect to the distinction between 'public' (on-trade) and 'private' (off-trade) drinking. The vast majority of research on alcohol from the social sciences concerns public order rather than public health and is therefore not discussed in this thesis, however that which is relevant for under-reporting is reviewed in this section. How research and policy have (or have not) responded to changes in drinking patterns has implications for how alcohol consumption is measured. In turn this may have affected the extent, nature, and consequences of under-reporting of alcohol consumption. In particular, human geographers are yet to have much impact on alcohol studies' research agendas (**22**), but it has been argued that they have much to offer (**23**). Human geographers have criticised the discipline of alcohol studies for under-theorising the role of space and place – they are merely "a passive backdrop" - when considering alcohol, drinking and drunkenness (**23**). In light of the increase in private drinking, it would be expected that research on alcohol – from human geography, alcohol studies, and the health sciences - would shadow this shift.

This shift in research priorities does not appear to have taken place. The first point of the executive summary to Valentine's 2008 Drinking Places study reads: "the priority given to public drinking – particularly young people's binge drinking – by government policy and the media has detracted attention away from a much broader spectrum of the population's routine drinking practices" (**24**). In contrast to public drinking, domestic drinking is "relatively invisible" (**24**). As Roberts and Eldridge write "the moral panic that surrounds binge drinking erroneously associates excess consumption with youth culture and detracts from the more serious issue of middle-class consumers drinking at equally harmful levels in the privacy of their own homes" (**25**). This research focus on public drinking may be in part attributable to the wealth of outcomes that can be measured in the public sphere, such as police cautions, arrests, costs of policing, and accident and emergency admissions. In contrast, far fewer such outcomes are available specifically related to the private sphere.

It has also been suggested that not only has *research* been over-focused on public drinking, but qualitative work in rural Cumbria and urban Stoke on Trent suggested *resources* too may be over-focused on public disorder as well, as public drinking is often a safe and pleasurable activity (**24**). The 'British disease' of binge drinking in public space has been central in the formulation of urban regeneration strategies (**26**). In human geography the majority of research has focused on problematic alcohol consumption in the public sphere, and the private sphere is

only just beginning to receive attention. Holloway and colleagues write that the "contemporary public and policy debate about alcohol, which centres on these questions of regeneration and fears of drunken disorder, is overly biased towards particular conceptions of problem drinking in public space" (**27**).

When attention has been turned towards heavy domestic drinkers in the past in the media (**28-30**), the response has been to raise questions about individual privacy and the nanny state (**25**). Domestic drinking has been described as "a widespread, socially-sanctioned practice" (**27**), and indeed the trends in alcohol sales composition reflect this (Section 2.4.1). In-depth interviews found that domestic drinking could be a social activity or a way to unwind, but what was common was its perception as a "pleasurable activity that smoothes their passage through everyday life" (**27**). Domestic drinking is therefore not only commonplace and ordinary, but also a valued aspect of home life which people wish to protect.

However, considering public and private drinking as two discrete practices is an over-simplistic conceptualisation of present-day drinking habits. It is important to recognise that a single drinking occasion is not restricted exclusively to either the public or private sphere. For instance, 'pre-loading' is a practice where alcohol is consumed at someone's home before continuing to do so elsewhere – such as a pub, bar, or nightclub - and is associated with young people and drinking with the intention of getting drunk. Hughes and colleagues interviewed young people (18-35 years, n=380) who drink in city nightlife in England while they were in bars and pubs (**31**). Many men and women had pre-loaded that evening (c. 60%), with the mean amount of alcohol consumed in the private sphere before the night out at seven units for men and women (**31**). This represented a greater proportion of women's alcohol consumption than men's (**31**). Although this finding is not generalisable to the wider population, it indicates the complexity of contemporary drinking practices in England.

Whilst the academic community has acknowledged that alcohol consumption in the private sphere should receive more research attention, it seems that the Government is yet to recognise private drinking as an important issue. The Government's 2012 Alcohol Strategy poses 'binge drinking' as an issue of antisocial behaviour, violence, and crime (**4**). These negative consequences of heavy drinking have strong connotations of drinking in the public sphere, particularly among young people. This will have ramifications for future public health policy. However, in reality, there are a great number of people drinking at 'binge' levels as defined by the Department of Health (>8/6 units, see Section 2.3) in the privacy of their homes. Drinking in the private sphere is neglected in the Strategy, perhaps because of its perception as an ordinary and therefore safe part of home life. This failure to acknowledge that problem drinking is occurring in the sector where two-thirds of all the alcohol is sold (**7**) may be due to concerns that 'sensible' and/or middle class drinkers are at risk of being penalised. As a result,

this detracts from the fact that harms from alcohol are not confined to antisocial behaviour and crime in the public sphere. This also results in reduced emphasis on understanding how the strength and volume of drinks affects the alcohol content per drink, and how alcohol units vary in different drinks.

2.4.3 Why does this matter for under-reporting?

Studying these changes in the balance between public and private consumption – and resulting changes in drinking patterns or styles – is highly relevant for studying under-reporting of alcohol consumption. It is probable that the root causes of under-reporting alcohol consumption will differ between the on-trade and the off-trade. For instance, it is likely that under-estimation of drink volumes or strengths will occur in the off-trade: as part of the Change 4 Life campaign in England and Wales, a specific campaign about home drinking in relation to under-reporting named 'don't let drink sneak up on you' was launched in early 2013 (**32**). In contrast, alcohol blackouts (memory loss) may affect those drinking in a mixture of on-trade and off-trade venues (such as pre-loading binge drinkers). So, although we will see that little change over the last decade in the extent of under-reporting is evident (see Chapter 4), the causes of under-reporting may have changed. Understanding the causes of under-reporting is important, as each of the different causes will require different tailored interventions to tackle them.

2.5 Alcohol sales coverage and the missing units

2.5.1 International comparisons

Alcohol sales coverage has been investigated in countries around the world, in studies published between the 1970s and the present. In general, social surveys have been found to estimate sales coverage within a narrower range (40-60%) than family expenditure surveys (20-70%) (**33**). So although self-reported alcohol consumption may not be an accurate measure of drinking, it is more predictable than spending-based measures. This section shows that alcohol sales coverage in the UK is not an anomaly, being in line with international estimates. UK alcohol sales coverage is described in detail in Chapter 4.

Data from 21 US states in the 1985 Behavioural Risk Factor Surveillance System found a strong correlation between state alcohol sales and per capita alcohol consumption of 0.81 (R^2 0.66) (**34**). While alcohol sales coverage is not reported in the paper, the R-squared value describes the amount of variation in per capita consumption that can be explained by per capita sales for that state. If reported consumption and sales were equal, the R-squared would be one. The R-squared value reported of 0.66 means that two-thirds of the variation in consumption is attributable to the variation in sales, implying that consumption not simply explained by sales in the 21 states studied. A Norwegian study conducted in 1988-9 found low sales coverage, of 38.7% (**35**). This study was conducted on the island of Spitzbergen in the Svalbard region, an

area where there is no tax on alcohol resulting in low prices. The authors believe that 'leakage' of alcohol for sale in Spitzbergen to the mainland (where taxes are high) contributed to the low coverage observed (**35**). This highlights that where particularly low coverage is observed, there may be an explanation that goes beyond the limitations of the survey design and under-reporting.

Two Swedish surveys conducted in the late 1980s among similar populations identified two very different coverage rates: one achieved 28% and the other 75% (an investigation into the reasons for this attributed it to differences in questionnaire design between the two surveys used) (**36**). A European comparative study by Knibbe and Bloomfield used coverage estimates based on surveys conducted in 1995 and found sales coverage was at its lowest in Germany (38.6%) and highest in France (55.9%) (**37**). This study found Finland, the Netherlands and Switzerland had intermediate levels of sales coverage. A UK survey was excluded as the sample was not representative. The authors identified that countries whose surveys contained simpler questions on drinking had lower coverage than countries with more detailed questions (**37**). Later, the 2004 Australian National Drug Strategy Household Survey (n=24,109) compared coverage across three question types. Coverage was again highest for the most detailed questions (80.7%), and lowest for the simplest question types (64.4%) (**38**).

A 2002 paper by Leifman using data from the European Comparative Alcohol Study (ECAS) explored alcohol sales coverage for six European countries (**39**). Alcohol sales coverage was 31% in Germany (n=1,000), 36% in France (n=1000), 56% in Finland (n=1,004), 56% in Sweden (n=999), 58% in Italy (n=1,000), and 86% in the UK (n=984) (**39**). For the UK, coverage was 93% for wine, 90% for beer, 79% for spirits and 43% for cider (**39**). This is the highest estimate of sales coverage obtained for a UK sample, but the methodology of the survey may have made coverage spuriously high. The sample size was relatively small and so unlikely to be representative of the population, and also consumption was only recorded among those aged 18-64. A substantial proportion of people under the age of 18 and over the age of 64 drink alcohol and many are lighter drinkers than the 'adult' population used here. Excluding the light drinking young and elderly will increase per capita alcohol consumption, and therefore alcohol sales coverage.

The 2000 National Alcohol Survey in the USA examined coverage of sales volume and value by drink type. By volume, alcohol sales coverage overall was 48.2% (**40**). There was substantial variation by drink type which followed a similar pattern to the UK: coverage was 45.4% for beer, 83.7% for wine, and 37.2% for spirits (**40**). By expenditure, coverage was slightly higher, at 52.3% overall. By drink type this was equivalent to 53.3% for beer, 103.6% for wine, and 48.7% for spirits (**40**). We will see that this corroborates what is observed for the UK alcohol sales volume coverage data in Chapter 4. A more recent study using 2006 data from all 50 US states identified median alcohol sales coverage as 26.4%, varying from 17.3-33.8% (**41**). This used

simple quantity-frequency questions which were not beverage specific and did not take into account drink size. Questionnaire design is explored in more detail in Section 2.6.5.1.

Surveys are now being conducted which can achieve very high alcohol sales coverage. The New Zealand National Alcohol Survey 2000 achieved sales coverage of 94% (**42**). This was a computer-assisted telephone interview (n=5,113, response rate 73%) of people aged 14-65, which used detailed beverage and location-specific questions (**42**). One reason such high coverage may have been observed is similar to why high coverage was observed in the UK ECAS sample (**39**). Again, exclusion of those over 65 from the survey sample, many of whom were likely to be light drinkers, will have artificially inflated per capita consumption, as was seen with Leifman's 2002 paper (**39**).

It is not universally believed that sales coverage of 100% is desirable due to the limitations of survey sampling and methodology (**43**), however increasingly high sales coverage is being obtained. The same method used in the New Zealand National Alcohol Survey 2000 is used by the International Alcohol Control study (**44**) for which data were collected in New Zealand in 2011-12, with England, Scotland, South Korea, and Thailand due to follow suit. When this method was used in a sample of 2,000 adults in Manchester, England, for a report published by the Centre for Public Health at Liverpool John Moores University, alcohol consumption was recorded at 20 units per week (26 units among men, 12 units among women) (**45**). While a much higher estimate than the GLF estimates for the whole of England, it is unclear how this figure related to alcohol sales in Greater Manchester. Nevertheless, perhaps high coverage is a possibility for future surveys using this method.

2.5.2 Can the missing units be attributed to under-reporting?

This thesis argues that the missing units are attributable to under-reporting. A number of objections to this could be raised because there are lots of other factors at play which could explain low alcohol sales coverage, such as drinking by people outside of survey sampling frames, and consumption among visitors or tourists to the UK. Each of these competing factors that could serve as explanations for the missing units is quantified in turn in Table 2.1.

One obvious criticism of attributing the missing units wholly to under-reporting is that alcohol consumption takes place among individuals who are outside the sampling frame. This mainly concerns individuals who do not live in private households – such as people living in military or healthcare institutions - which therefore cannot be identified from the Postcode Address File. Further, alcohol consumption has been found to be heavier among non-responders to surveys such as the GLF (see Section 2.6.2). Also, a proportion of alcohol that is taxed for sale will not actually be consumed: it will be wasted or disposed of (e.g. spillage or beer slops). Finally, the sales figures include alcohol that is consumed by foreign visitors to the UK, and that which is subsequently exported. As a result of these factors, we have several explanations for the discrepancy between self-reported consumption and alcohol sales, aside from the accuracy of

participants' reporting. However, what is perhaps less obvious is that there are also several ways in which alcohol consumption is not captured in the sales data. This includes legal and illegal production and importation, informal production and homebrew, consumption of non-beverage alcohols, and consumption of UK residents while overseas.

Previous work by research teams in England and Scotland has attempted to understand and account for these differences in the data (**46-48**). Table 2.1 updates and extends this account relevant for this thesis. Where possible, an attempt has been made to quantify these factors, which has been particularly aided by a recent UK study by Meier and colleagues (**48**). Although it is not possible to quantify all the factors listed, and many of the estimates are uncertain, it is probable that the total amount of alcohol not captured in sales statistics outweighs that not captured in social surveys. It is estimated that approximately two litres of alcohol per capita is not captured in social surveys for reasons other than under-reporting, but would be taxed for sale (i.e. is included in the sales figures). Any estimate of the extent of under-reporting of alcohol consumption should take this into account when looking at the difference between consumption and sales. However, the sales data appear to under-estimate consumption, too. This has also been noted by researchers in Sheffield and Edinburgh (**47, 48**). It is estimated that between 2.1 and 2.9 litres per capita is not captured in the sales data produced by HM Revenue and Customs. In this case, the synthesis of available data in Table 2.1 shows that calculating sales coverage as reported alcohol consumption as a proportion of alcohol sales, and attributing the missing units wholly to under-reporting of alcohol consumption, is actually a conservative estimate of the extent of under-reporting.

Table 2.1: Quantifying alcohol consumption that is not captured in social surveys, or in HMRC sales statistics

Alcohol sold but not captured in social surveys (for reasons other than under-reporting)		Alcohol consumption not captured in alcohol sales statistics	
Description	**Estimate**	**Description**	**Estimate**
Drinking by people outside sampling frame: under-16s	Average weekly alcohol = 12.9 units in 11-15 year olds in 2010 (**49**). After taking into account prevalence, this is equivalent to 5 million units a week, or 0.6% of alcohol sales. For 2010 this would add 0.12L to per capita consumption. A 2013 UK study by Meier *et. al.* estimated consumption by children to account for 0.7% of UK alcohol sales, or to subtract 0.08L to per capita *sales* (**48**).	Legal imports, illegal imports, informal production and homebrew	A 2013 UK study by Meier *et. al.* estimated this to have an effect of +1.23L on per capita sales estimates (**48**). Illicit home production and tourist import are each thought to contribute to around 30% of unrecorded consumption (**50**). One study estimated the UK's tax free purchases (i.e. while abroad) to be equivalent to 0.23L per adult aged 15+ in 1995 (**51**), equivalent to 23 units per capita per year. Cross-border smuggling (0.3L), personal imports (1.4L), and home production ("a few decilitres") were roughly 2 litres per adult per year in the UK in the 1990s (**52**). This proportion of sales is equivalent to 175 million units a week in England in 2010. HMRC has a strategy to tackle alcohol fraud but information is lacking (**53, 54**). Personal correspondence with the Craft Brewing Association, the National Association of Wine and Beermakers, and homebrew online shops has confirmed there is no estimate of homebrew available for the UK.
Drinking by people outside sampling frame: homeless	A 2013 UK study by Meier *et. al.* estimated this to have an effect of +0.08L on per capita survey estimates (**48**). 50,430 households were in temporary accommodation in March 2012 (**55**). If each household contained two adults this is equivalent to 0.2% of the adult population in 2011. A London-based homelessness charity estimates there are up to 17,000 street drinkers in England drinking on average 45-70 units a day (**56**). This is equivalent to 0.01% of the adult population in 2011. However, not all street drinkers are necessarily homeless/would be outside the sampling frame.	Counterfeit production	None available. This is of increasing concern to the industry; the Wine and Spirits Trade Association launched a fraud prevention unit in May 2011 (**57**).
Drinking by people outside sampling frame: people living in institutions	*This includes those in the armed forces, hospital, residential care etc. Students in halls of residence are included in GLF.* A 2013 UK study by Meier *et. al.* estimated this to have a net effect of -0.041L on per capita survey estimates (military = +0.006L, mental health institutions = -0.003L, care homes = -0.034L, and prisons = -0.010L) (**48**). A 2004 review on measuring alcohol consumption stated that the distribution function of alcohol suggests that very small subgroups could be responsible for a considerable proportion of the missing units, so further research on heavy-drinking subgroups not traditionally sampled is necessary (**58**).	Consumption of non-beverage alcohol	*e.g. antibacterial handwash.* None available

Alcohol sold but not captured in social surveys (for reasons other than under-reporting)		Alcohol consumption not captured in alcohol sales statistics	
Description	**Estimate**	**Description**	**Estimate**
Consumed in UK by foreign visitors	235 million nights spent in UK by foreign visitors in 2011 (**59**). The UK has a 'tourism deficit' of 360 million nights. Meier *et. al.*'s 2013 study uses 2006 data and per capita consumption estimates for key countries and estimates the net impact of tourism to be 0.86L (**48**).	Consumption by UK residents overseas	595 million nights spent abroad in 2011 (**59**). See opposite column for net effect. Using average consumption to estimate consumption while abroad may under-estimate the effect of tourism. A 2011 survey by the world's largest travel website of 6,671 respondents in France, Italy, Germany, Spain and the UK found 65% of British people drink more on holiday than at home, compared with a European average of 41% (**60**). One study estimated the UK's net consumption on journeys abroad to be 0.2l per adult aged 15+, and tax free purchases to be equivalent to 0.23L per adult aged 15+ in 1995 (**51**). This is equivalent to 20 units of alcohol. This was equivalent to 2.7% of alcohol sales for 1995, which would be equivalent to 0.6 units per adult per week today.
Non-responders to surveys	The continuum of resistance theory suggests non-responders are more likely to share characteristics with late responders to surveys, who have been shown to be heavier drinkers (**33, 61, 62**) (also see Section 2.6.2). A 2013 UK study by Meier *et. al.* estimated this to have an effect of +1.24L on per capita survey estimates (non-responding groups estimated were: students = +0.03L, dependent drinkers = +1.01L, proxy interviewees in GLF = +0.20L) (**48**). Non-response to surveys is described as a weak justification of low alcohol sales coverage in Section 4.6.		
Alcohol that is bought but not consumed	*Includes that which is used in cooking, disposed of as reaches expiry, spillage/wastage, stockpiling or storage.* A 2013 UK study by Meier *et. al.* estimated this to have an effect of -0.82L on per capita survey estimates (spillage/wastage = -0.76L, food use = -0.06L) (**48**). Industry estimate for spillage/wastage is <10% (**47**), DEFRA estimates 6%, which is equivalent to 0.64L (**63**). Net effect of storage/stockpiling needs to be considered as previously stockpiled alcohol may be being consumed.		
Consumption of non-beverage alcohol	*e.g. antibacterial handwash.* None available		

Alcohol sold but not captured in social surveys (for reasons other than under-reporting)		Alcohol consumption not captured in alcohol sales statistics	
Description	**Estimate**	**Description**	**Estimate**
Sampling periods not representative	Sampling periods for social surveys often exclude holiday periods and Christmas, when consumption is probably much higher (**61, 64**), however the GLF sampling took place all year round.		
Clustering	There is some evidence that heavy drinkers are clustered in geographical areas making them less likely to be sampled (**33, 62**). This means that heavy drinkers may be under-represented in survey samples.		
Alcohol cleared for sale but not sold	None available		
	Estimated total alcohol included in sales figures but not captured by surveys: *between 1.9 and 2.1 litres per capita*		**Estimated total alcohol not included in sales figures: *between 2.1 and 2.9 litres per capita***

Footnote to table: it is also possible that over-reporting of alcohol consumption occurs. This may take place, for instance, among relatively light drinkers who wish to adhere to social norms, or due to peer pressure (for example among young men). Investigating over-reporting of alcohol consumption was beyond the scope of this thesis. This thesis is interested in understanding reasons for low alcohol sales coverage, which is not explained by over-reported alcohol consumption.

2.6 Under-reporting in social surveys

The previous section has shown that the missing alcohol units are not an artefact of the design of surveys, and that under-reporting of alcohol consumption is substantial. In this section the multiple mechanisms by which under-reporting of alcohol consumption takes place are reviewed. Each mechanism has different causes, and may also relate to: education and information, cognitive ability, intoxication level, and socio-cultural factors. In this section studies which have investigated each mechanism of under-reporting are considered in turn. These are summarised in Figure 2.6 and have collectively been termed 'methodological failures' of substance use surveys (**65**). Under-reporting can be deliberate or accidental, and these two should be distinguished. In the literature to date, higher consumption is generally assumed to be more accurate in social surveys because this brings consumption estimates closer to sales figures. This is debated, as new research by a team that has extensive experience in measurement of alcohol consumption has found that sometimes the method which fits outcomes most accurately is not necessarily the method which achieved the highest estimates of consumption (Gmel, G. personal communication, 2013). However for the purpose of this review we continue with the established 'more is better' assumption.

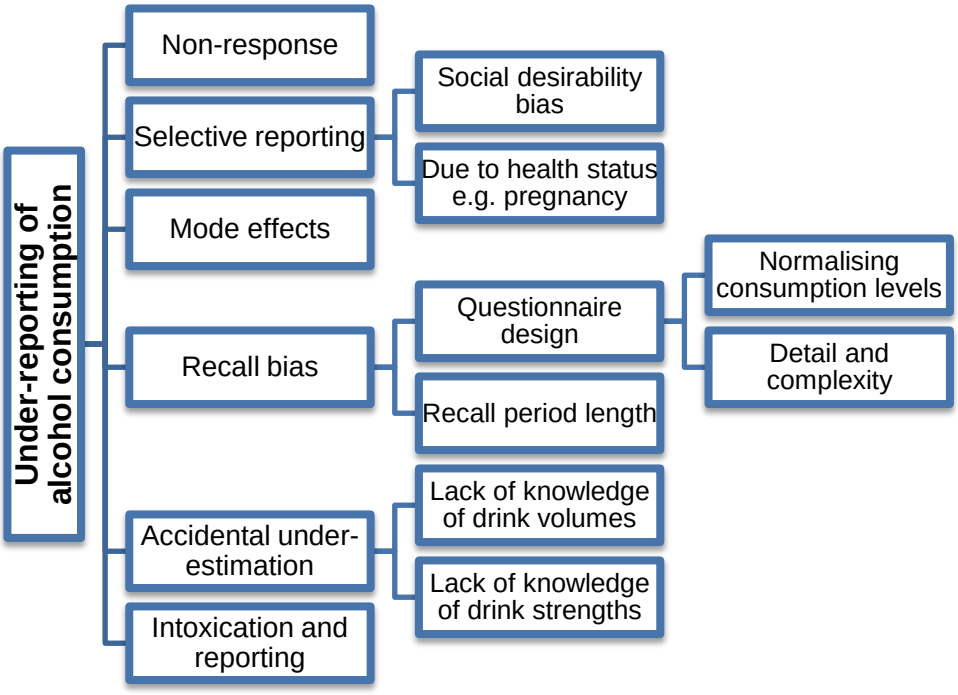


Figure 2.6: Schematic representation of the components of under-reporting included in this systematic review

2.6.1 Search strategy

The literature search for this section was done systematically. Articles selected for inclusion in section one were found through Scopus, Web of Knowledge and Google searches and through discussion with supervisors. Additional references were obtained through hand searches of

reference lists of relevant articles. Publications on methodology from social surveys were also reviewed.

The initial search ran during November 2010. Medline, Web of Knowledge (WoK) and Scopus were searched using the terms “alcohol” OR “drink$” AND “missing” OR “under-report$” OR “under-estimat$”. A total of 678 abstracts were downloaded and screened from Medline (WoK n=28,737, Scopus n= 3,173). In order to manage the number of results, the term “unit” was added to the WoK and Scopus searches, and 471 and 109 abstracts respectively were downloaded for screening. Reference lists of relevant articles were hand searched for additional relevant articles. Any articles that were unavailable were obtained from the British Library in London. The search was re-run in Medline in November 2011 with the addition of “underreport$” and “underestimate$” to the second set of the original search terms to account for different spellings not previously considered. Twenty-two new articles were identified and read from this process. WoK and Scopus were not searched again as the previous search returned very few relevant articles not already identified in Medline. Reference lists of articles were again hand searched and unavailable articles were obtained from the British Library in London. The same search was conducted for a third time in January 2013 and 49 additional articles were identified and assessed. In total, in this section 78 articles have been systematically reviewed.

2.6.2 Non-response

Thirty years ago, Wilson identified “non-response” (this section), “deliberate under-reporting” (Section 2.6.3), and “memory problems” (Section 2.6.5) as the three main problems with surveys asking about alcohol consumption (**66**). If alcohol consumption is different among people who are eligible to take part in social surveys, but who do not respond or who decline, this may also contribute to low alcohol sales coverage. Heavy drinkers are known to be more difficult to contact and less likely to respond to surveys (**61**). Non-response to surveys is a problem for measuring alcohol consumption if non-responders systematically differ from the survey participants - for instance if non-responders’ alcohol consumption is on average substantially higher than survey participants – as this leads to survey estimates being artificially low. Much of the research on non-response has identified differences between participants who were difficult to contact – requiring several attempts or a long period of attempted contact – and those who responded earlier or after fewer attempts. Participants who are difficult to contact are assumed to be more like non-responders than those who are easier to contact. This has been termed the ‘continuum of resistance’ by Lin and Schaeffer (**67**).

If this theory is true, there is some evidence that non-response could be a cause of low alcohol sales coverage. In a 1982 study by Crawford, adults (18+) from the Highlands, Tayside and Kent (in Great Britain) were interviewed about alcohol consumption in their own homes (n=2,349) (**62**). Among men, those who were difficult to contact (requiring 4+ calls) consumed 23.8% more alcohol than others (requiring 1-3 calls) (P=0.02) (**62**). In a 2004 paper, late responders to an internet survey conducted among students in New Zealand (response rate

82%, n=1,564) had a higher prevalence of hazardous drinking (69.3%) than early/intermediate responders 61.1%), and a higher alcohol problems scale score (mean scores 3.32 and 2.78 respectively) (**68**). Whether it is that the late responders were unwilling to share information about their lifestyle because they knew they were heavier drinkers and so deliberately did not respond, or that they simply had busier or more disordered lifestyles and did not remember to respond, is not known.

However, other similar studies have found little or no difference between participants and late or non-responders. A Dutch study from 1988 which followed up non-responders to a survey which had an initial response rate of 31% found that there was little difference between participants (n=1,807) and non-responders (n=295) (**69**). However as the initial response rate was so low, it is not surprising that the non-responders did not differ substantially from the initial responders, as there was such a large proportion of non-responders. A further Dutch study which was published in 2002 found no evidence for non-response bias in the proportion of frequent excessive drinkers, whereas abstainers were under-represented (**70**). A 2003 study in the USA of 1,635 couples at baseline found no significant drinking-related risk factors (in terms of drinking status or frequency of binge drinking) of non-response in the follow-up of a national longitudinal survey (**71**). A Canadian study which compared sample characteristics of a 2004 survey with a response rate of 47% (n=13,909) with a 2002 survey with a response rate of 77% (n=36,984) found that drinking was more prevalent in the survey with the lower response rate (**72**). However, multivariate logistic regression found that the odds of drinking in the past 12 months were 30% higher for late responders to the survey than for early responders (adjusted odds ratio (OR) 1.30, 95% CI 1.09-1.57) (**72**).

A recent study investigating survey non-response using record linkage in Scotland has suggested that the downward trend in alcohol consumption in recent years is partially attributable to falling response rates, with fewer heavy drinkers responding over time (**73**). Response rates in the Scottish Health Survey (SHeS) fell from 81% in 1995 to 61% in 2008 (**73**). Surveys like the SHeS use response probability weighting to make them nationally representative, but these weights are based on limited socio-demographic information. If response is related to alcohol consumption, then this can be incorporated into response probability weights for social surveys. The representativeness of SHeS survey participants in terms of alcohol-related hospitalisations and deaths is currently being investigated by Gray and colleagues using record linkage and population level data (**73**). This will enable representativeness to be established and weights to be developed.

The evidence that non-response bias is an important issue when measuring alcohol consumption is mixed. The majority of studies use late response as a proxy for being similar to a non-responder, however, this ‘continuum of resistance’ theory is uncertain and speculative. The response rate to the initial survey – which will be mediated by the number and type of contact attempts made – will certainly contribute to whether there is a difference between the

participants and non-responders. It could be hypothesised that a robust survey with persuasive contact attempts (leading to a high response rate) would be more likely to have non-responders that differed greatly to the participants, whereas participants in and non-responders to survey where the recruitment was conducted with less persistence (and a lower response rate) would have greater similarities. It is suggested that non-response alone is a weak justification of low alcohol sales coverage in Section 4.6.

2.6.3 Selective reporting

Selective reporting is also known as deliberate under-reporting. This is thought to be relatively rare in comparison to other forms of under-reporting (**61**), and may take place because of a social desirability bias - due to cultural or religious norms, if the participant's family are present – or because of a health condition which precludes drinking.

2.6.3.1 Social desirability bias

A 1982 review of the reliability of self-reported consumption found that agreement between participants' alcohol consumption and collateral reports (from significant others or family members) is generally high (**74**). This suggests that participants' family members generally have an accurate picture of that family member's drinking. Social desirability bias may operate when participants are over-heard and it may lead participants to report drinking only what they feel is acceptable for those around them to hear. In Wilson's 1981 paper on improving the methodology of drinking surveys, deliberate under-reporting was thought to take place in face-to-face interviews if the interview was overheard by a family member (though attempts were made to minimise this), or in particularly heavy drinkers who attempted to adhere to more moderate drinking levels (**66**). Among interviews where the participant was overheard by a family member (39% of approximately 2,000 interviews), reported consumption was slightly (6%) lower (**66**). However, participants who were overheard were also more likely to be married or have children (**66**), so this may not be a causal association, and those who were overheard may simply have been slightly lighter drinkers. Crawford's 1987 review which also reports on their 1982 study of adults (n=2,349) from the Highlands, Tayside and Kent also found consumption to be marginally lower when another person was present during the interview (**62**).

Both these surveys were surveys of drinking habits as opposed to surveys about general health or lifestyle (which national statistics on alcohol usually come from). This may mean that participants attempted to report their alcohol consumption accurately as they knew this was the focus of the survey in which they participated. The evidence that the presence of others influences reporting (although only to a small extent) suggests that social desirability bias may operate, but these findings are not necessarily generalisable to general health or lifestyle surveys. To verify whether social desirability bias does affect reporting, a test-retest methodology would be more useful. This would compare consumption estimates when participants are overheard with when the same participants are alone with the researcher, for

example. Further, participants may selectively report consumption dependent on the mode in which the study is conducted; for example a face-to-face interview, or telephone survey. This literature is reviewed in Section 2.6.4, which considers how study design can influence reporting.

2.6.3.2 Health conditions

Selective reporting due to pre-existing health conditions where drinking is precluded may affect alcohol consumption estimates. However, where this occurs for conditions which are rare, or have a short duration (i.e. acute conditions), this is likely to have little impact on population estimates of consumption. A small study (n=110) conducted in the USA found that people living with human immunodeficiency virus were more likely to report drinking alcohol (and substance use) if they were completing an anonymous questionnaire compared with one which was not anonymous (**75**). A greater proportion of participants that completed an anonymous questionnaire (28.9%) met criteria for alcohol abuse than those who completed a confidential (but not anonymous) questionnaire (11.9%) (**75**).

The validity of self-reports of maternal drinking during pregnancy have also been investigated. A US study published in 1988 by Ernhart and colleagues compared reports of alcohol consumption in pregnant women with a retrospective report regarding pregnancy in the same women five years later (n=238 mother-child pairs) (**76**). A reasonable correlation (r=0.67, P=0.0001) existed between the in-pregnancy and retrospective reports, but retrospectively-reported consumption was higher in 41% of women, and lower in only 18% of women (**76**). A second US study published in 2002 interviewed 354 African-American mothers both antenatally and 13 months postpartum about their alcohol consumption (also cocaine and other drugs) (**77**). A positive correlation (r 0.60, P<0.001) was found between the antenatal and retrospective reports of alcohol use during pregnancy (**77**). However the mean number of grams of absolute alcohol per day was higher in the retrospective report than the antenatal report – 0.88g (SD 2.37) compared with 0.23g (SD 0.54) respectively (**77**). Retrospective reports are thought to be more reliable than in-pregnancy reports – despite the longer recall period which may lead to recall bias (see Section 2.6.5.2) - as participants do not wish to admit to behaviours which are harmful to the foetus. These studies are convincing evidence that selective reporting takes place where drinking is precluded, however the impact of this under-reporting on a population level is likely to be small.

2.6.4 Mode effects

The way in which a survey is conducted can influence the amount of alcohol consumption that is recorded. Several studies have explored the effect of the survey 'mode' – for instance, face-to-face interview, self-completion questionnaire, or telephone survey – on the amount of drinking that is captured by the survey. The presence of the interviewer themselves can introduce bias. Duffy and Waterton randomised participants to complete either a face-to-face

interview (n=133) or answer the same questions on a computer (n=113) in participants' own homes in Edinburgh, Scotland in 1982 (**78**). Alcohol consumption over the previous seven days was 33.4% higher (P=0.016) in the computer interview, at 26.1 units (SD 27.4), compared to 19.6 units in the direct interview (SD 21.0) (**78**). This particular mode effect is known as an 'interviewer effect', and is thought to be due to both the characteristics of the interviewer, and the way they ask the questions (**62**). A discussion of how questions are phrased can influence reporting is in Section 2.6.5.1.

Kraus and Augustin compared telephone and self-completion questionnaires in a random sample in Germany 1994-1996, hypothesising that the greater privacy of the self-completion questionnaire would lead to more accurate reporting (**79**). Beverage-specific quantity-frequency measures (see Section 2.6.5.1.2) were used for both methods, the response rate to the self-completion questionnaire was 65% (n=6,193), and 6,427 telephone interviews were completed (**79**). The telephone interview found a lower prevalence of hazardous drinkers than the self-completion questionnaire in all age groups and genders (**79**). In England, Tipping and colleagues investigated mode effects in their comparison of the nationally-representative Health Survey for England (HSE) 2006 core direct interview and the London boost self-completion questionnaire (**80**). Household non-response rates were similar for the core (42%, n=709) and boost (39%, n=2,439) samples (**80**). However, as a greater proportion of the core sample (85%, n=1,569) gave a productive interview than returned a productive questionnaire in the boost sample (65%, n=5,004), overall response rates were greater for the core sample (49%) than the boost (40%) (**80**). Responses were similar for core and boost samples regarding whether a participant had consumed alcohol in the previous seven days of 12 months (**80**). The mean number of units drunk in the previous seven days was significantly (P<0.001) higher in the self-completion boost questionnaire sample for men (8.6 units) than the core direct interview sample (6.5 units), and women (5.9 vs. 4.6 units, respectively) (**80**).

Valentine *et. al.*'s 2008 Drinking Places study compared telephone survey estimates of consumption with later estimates from qualitative interviews (20 adults each in two case study locations). It was found that, among heavy drinkers, a greater proportion of adults aged 25 years and over under-estimated their consumption than those aged 18-24, based on comparisons of a telephone survey and qualitative interview descriptions of drinking (**24**). Further, it was found that for both men and women, only around half of those who reported drinking heavily in the survey actually described their drinking in this way in the interview (**24**). The interviews also revealed these 'older' drinkers also had a casual attitude towards the alcohol content of different drinks and the drinking guidelines (**24**). This shows that under-reporting has emerged - almost by accident - as an important consideration for qualitative researchers interested in domestic drinking practices.

More recently, the HSE 2011 collected information on drinking in two modes: the direct interview and a self-completion seven-day drinking diary (**1**). All survey participants interviewed

aged 18 and over were invited to complete the drinking diary, therefore there are two measures of drinking available for a large proportion of the sample, but these do refer to different weeks (**1**). The same proportion reported drinking in the past week in the interview and the diary (70% men and 54% women) (**1**). The mean number of drinking days in the last week was similar in the interview (3.4 days for men and 2.9 days for women) and diary (3.2 days and 2.8 days) (**1**). However, where quantity is considered, the diary captured more drinking: 46% men and 35% women reported drinking more than the daily limits (>4/3 units) in the diary compared with 39% and 38% respectively in the survey interview (**1**). Mean weekly alcohol consumption was equivalent to 17.4 units for men and 9.5 units for women (based on average consumption over the last 12 months), and 20.3 units and 12.5 units respectively in the diary (**1**). While this does indicate that survey mode does have an effect on reported alcohol consumption, the fact that the survey interview was retrospective and the drinking diary prospective is likely to also have contributed to this difference (see Section 2.6.5.2). There is good evidence from recent and nationally-representative surveys that mode effects do operate, and that changes to survey design can lead to changes in reporting accuracy.

2.6.5 Recall bias

Recall bias is where the information obtained in surveys is inaccurate because participants cannot remember relevant events or health behaviours, such as drinking alcohol. Memory can be prompted by the design of surveys, in particular, by increasing the specificity of the questions asked. Further, as remembering events that took place in the distant past is more difficult than remembering those in the more recent past, prospective and recent measurement are preferable to longer-term retrospective.

2.6.5.1 Question design

2.6.5.1.1 Normalising consumption levels

Recall bias is sensitive to the questions participants are asked, and also the way in which these are asked. This is distinct from selective reporting because it arises due to questionnaire design and not from a deliberate attempt to limit the consumption that is reported. Where particular amounts are specified in survey questions - for instance frequency of drinking more than 8/6 units (binge drinking) - if participants know how this relates to drinking guidelines they may answer in a way which places themselves below the threshold (**61**). It has been found that participants use scaling information to normalise consumption levels (**81**) so asking about very large quantity levels and keeping questions as open-ended as possible could improve accuracy further. Alternatively, participants can be asked about the maximum drunk on any one day in the previous week as they are in the HSE (**61**).

There is some evidence that question wording is also important. A Finnish study conducted in 1983 among 86 patients experiencing withdrawal symptoms from alcohol or other drugs used two questionnaires on their alcohol consumption in the previous six months; one oriented

towards light consumption, and the other towards heavy consumption (**82**). Mean daily alcohol intake was 137g in the light questionnaire and 302g in the heavy questionnaire, with a Spearman's correlation coefficient of 0.58 (P-value not reported) (**82**). In this small sample of alcohol-dependent patients, it seems that the questionnaire oriented towards heavier drinking normalised heavier consumption level, leading to greater reported consumption. However due to the fact that the P-value is not reported, the significance of this effect is uncertain. Further, a 1994 telephone survey from Canada compared closed-ended and open-ended questions in reports of heavy drinking (defined as >5 drinks on one occasion) in the past year (n=649) (**83**). Agreement between two question types was fair (kappa 0.43) with 61% of responses consistent (**83**). The closed-ended questions found significantly more reports of heavy drinking, with 50% reporting drinking five or more drinks at least 12 times in the last year, compared to 28% with the open-ended questions (**83**). The open-ended question required participants to name this frequency themselves which may have resulted in some under-reporting if participants are wary of stigma. Although the idea that consumption levels can be normalised through question wording is intuitive, the evidence that normalising consumption levels through question wording influences recall bias and under-reporting is inconclusive.

2.6.5.1.2 Question detail and complexity

A number of studies have investigated how the types of questions participants are asked influences reported consumption. Under-reporting is assumed to be prevalent when questions used achieve relatively low consumption estimates. Where reported consumption is higher, under-reporting is thought to be less of a problem. Quantity-frequency (QF) questions, which ask about how much alcohol is consumed, and how often, are common in social surveys. Graduated-frequency (GF) questions ask the frequency consumption of, for example, more than 12 drinks, and working downwards to 3-4 and 1-2 drinks (**84**). These often give greater consumption volumes than QF questions (**84**). Although this is thought to be more accurate, a participant whose usual consumption is above the mid-point of the quantity level has their consumption recorded as this mid-point, and is under-reporting (**84**). Such participants would benefit from being asked the maximum number of drinks on an occasion (**84**).

Rehm's 1998 review compared questionnaire designs, finding that drinking diaries recorded the highest consumption, followed by GF questions, QF questions, then weekly recall (**43**). Questions can be beverage-specific, or be about all types of alcohol combined. Beverage-specific questions or questions about specific occasions lead to higher consumption estimates (**43**), so are considered to be more accurate. Another review, published in 1999 by Feunekes, reviewed 33 methodological papers published after 1984 and compared five different question types (QF, extended QF, retrospective diary, prospective diary, and 24-hour recall) (**85**). The mean level of alcohol intake was found to differ by about 20% between these methods (**85**). Beverage-specificity tended to increase consumption by around 20% (**85**). Where a prospective drinking diary (PD) is used to record alcohol consumption, quantity estimates are often higher than those obtained by standard survey questionnaire estimates such as QF (**1**). Table 2.2

summarises the findings of two review articles and other relevant studies identified in the systematic review. The majority of the studies conducted have used a test-retest methodology; where the same participants are asked twice about their alcohol consumption, using two different measures or instruments. Where intra-individual comparisons are made the two measures are not always asking about the same time period. Therefore it is not the individual difference between the two (or more) measures, but rather the difference between the two measures on an aggregate level that is of interest. Studies have been conducted worldwide and over a long period of time. There is no clear pattern in the difference between QF, GF and RR across the studies reviewed. However, the studies reviewed generally find beverage-specificity to be beneficial, and that prospective diaries lead to the greatest consumption estimates. It is also clear that detailed questions about ‘actual’ rather than ‘usual’ consumption increase the amount of alcohol that is captured by social surveys.

Table 2.2: Studies which have compared different measures of alcohol consumption

Study ID	Year	Country	Sample size	Population	Comparison(s)	Findings	Notes
Poikolainen & Karkkainen 1983 (86)	Not reported	Finland	49	Men aged 35-45	QF and PD (both BS)	QF was 60% of PD	Difference between QF and PD did not vary with age or alcohol-related factors. Small sample size.
Rehm 1998 (43)	1998	Worldwide	Review of studies comparing different measures of drinking	General population	GF, GF(BS), PD(BS), QF, QF(BS), WDR	PD>GF>QF>WDR For QF, BS>not For QF, taking into account drinking pattern/context leads to higher estimates	Review
Feunekes *et. al.* 1999 (85)	1999	Worldwide	Review of 30 studies published after 1984. 15,028 participants (12 studies) in the quantitative synthesis, and a further 36,658 (18) in a narrative synthesis.	General population	24H, F, FFQ(BS), PD, PD(BS), QF, QF(BS), extended QF, extended QF(BS), Q(BS) (situation specific), RD, RD(BS)	Studies with BS = +1 drink p.w.. QF & PD mean alcohol intake = 6.2 drinks p.w., RD = 5.1 drinks p.w.. 8-14 day reference period = 7.7 drinks p.w.. 3-7 days, 15-30 days, one month and 'usual' = c.6 drinks p.w.. Qualitative examination supported the BS findings, but only weakly supported the differences between methods observed in the quantitative synthesis.	Review
Rehm *et. al.* 1999 (87)	1990-4	Canada	3,961	General population	QF, GF, and WDR	Proportion of abstainers: 75% in WDR, 23% in GF, 21% in QF. Proportion of low-risk drinkers: 17% in WDR, 31% in GF, 39% in QF. Proportion of hazardous drinkers: 2% in WDR, 4% in GF, 3% in QF. Proportion of harmful drinkers: 1% in WDR, 4% in GF, 2% in QF.	
Goddard 2001 (61)	1989	England & Wales	3,116	General population	QF and 7-day RR (both BS)	Alcohol consumption p.w. very similar for both measures among men at 15.0 units using QF and 14.1 using weekly recall, and women at 4.1 units for QF and 4.2 units for weekly recall	
Koppes *et. al.* 2002 (88)	2000	Netherlands	368	General population	QF and FFQ (both BS)	Mean consumption was higher using the dietary history questionnaire among both men (14.2 units p.w.) and women (9.9 units p.w.), than using QF questions (9.0 vs. 5.4 respectively).	Small sample size

Abbreviations:
24H = 24-hour recall, (BS) = beverage-specific, F= frequency, FFQ = quantity-frequency within food frequency questionnaire, GF = graduated-frequency, PD = prospective diary, Q = quantity, QF = quantity frequency, RR = recent recall, RD = retrospective diary, WDR = weekly drinking recall
p.w. = per week

Study ID	Year	Country	Sample size	Population	Comparison(s)	Findings	Notes
						Dietary history and QF were highly correlated in both men (Spearman's r = 0.81) and women (0.91)	
Townshend & Duka 2002 (89)	Not reported	England	55	University students	QF and PD (both BS)	Strong correlation (r=0.975, P<0.01) between QF and PD, although alcohol consumption was 'under-estimated' by 12% on the QF. Heavier drinkers tended to under-estimate their drinking behaviours, and light drinkers tended to overestimate (see Section 2.6.7).	Small sample size
Stockwell *et. al.* 2004 (90)	2001	Australia	21,674, aged 14+	General population	24H (BS), GF, and QF	Mean difference of 1.1 drinks p.w. (95% CI 0.9-1.2) between GF and QF (not shown for recent recall). The proportion of risky and high risk drinkers was 10.6% using GF and 8.1% using QF (not shown for recent recall). Consumption in litres of pure alcohol per person per year was 5.27 using 24H, 5.25 with GF, and 4.54 with QF.	The similarity between recent recall and GF in this study can be attributed to the large sample size, removing problems of 24H not conveying typical consumption. Low response rate: 51%.
Heeb & Gmel 2005 (91)	1999	Switzerland	767	General population	GF (BS), QF, and PD (BS)	Mean on PD (7 days) (13.9g) differed significantly from the means on QF (9.2g) and GF (9.8g), both P<0.01 Kendall's Tau rank-order correlations between measures were all significant (P <0.01), and of modest magnitude. Agreement was higher between QF and GF (s = 0.49) than between QF and PD (s = 0.45), than between GF and WDD (s = 0.41).	Moderate sample size
Stahre *et. al.* 2006 (92)	2003	USA	253,365 from Behavioural Risk Factor Surveillance System	General population	Daily QF, and recalculated consumption additionally including self-reports of binge drinking.	Consumption increased the relative prevalence of heavy drinking (as >2 drinks a day for men, >1 for women) among all adults by 19-42% (depending on the method used to calculate a 'binge'). Among binge drinkers, the overall prevalence of heavy drinking increased by 53% points, resulting in half of women binge drinkers and half of binge drinkers aged over	Large sample size, but putative

Abbreviations:
24H = 24-hour recall, (BS) = beverage-specific, F= frequency, FFQ = quantity-frequency within food frequency questionnaire, GF = graduated-frequency, PD = prospective diary, Q = quantity, QF = quantity frequency, RR = recent recall, RD = retrospective diary, WDR = weekly drinking recall
p.w. = per week

Study ID	Year	Country	Sample size	Population	Comparison(s)	Findings	Notes
						55 meeting the criteria for heavy drinking.	
Stockwell *et. al.* 2008 (38)	2004	Australia	24,109, aged 12+	General population	GF, QF, and 24H	24H gave the highest estimate, 7.53 litres pure alcohol per year (95% CI 7.19-7.86), 80.7% of alcohol sales. The GF estimate was 6.45 litres (95% CI 6.31-6.59); 69.2% of sales, and QF was 6.03 litres (95% CI 5.88-6.18); 64.4% sales.	
Boniface & Fuller 2012 (1)	2011	England	4,969	General population	QF, RR of heaviest day in the last week, and PD (7 day), (all BS).	Drinking frequency was similar between QF and PD. Mean alcohol consumption among drinkers on the heaviest day in the RR was 7.7 units for men and 5.1 units for women, compared with 8.4 units and 5.9 units respectively in the PD. Mean alcohol consumption p.w. was 17.4 units for men and 9.5 units for women in the QF, and 20.3 units and 12.5 units respectively in the PD.	This could also be due to mode effects: see Section 2.6.4.

Abbreviations:
24H = 24-hour recall, (BS) = beverage-specific, F= frequency, FFQ = quantity-frequency within food frequency questionnaire, GF = graduated-frequency, PD = prospective diary, Q = quantity, QF = quantity frequency, RR = recent recall, RD = retrospective diary, WDR = weekly drinking recall
p.w. = per week

2.6.5.2 Recall period length

It is intuitive that focusing recall on a recent time period would lead to greater reported consumption, with reporting accuracy decreasing as the recall period becomes more distant. Recall bias has been investigated in self-reported alcohol consumption by comparing recent recall and a longer time period in several studies. A review by Crawford from 1987 estimates 9-15% of occasions and 8-17% of consumption were forgotten about where seven-day recall is used (assuming previous day recall is 100% accurate), and that this increases as the length of recall increases (**62**). Where prospective and retrospective measures of drinking are compared, it is usually found that the prospective measure captures more alcohol consumption. This is seen in Section 2.6.5.1.2 where prospective diaries are compared with retrospective diaries, recall, or questionnaires. Individual studies which have explored the effect of time on recall are discussed chronologically in this section.

A US study published in 1985 used QF questions and compared 14 and 28 day recall periods using three methods for assessing reliability (alternate forms, test-retest and a combined method) (**93**). Each of the estimates of reliability calculated was high, and no significant differences between the 14 and 28 day recall periods were identified (**93**). This suggests there may be little difference between a two and a four week recall period, however in the wider scheme of recall this is quite a narrow range selected for comparison. A longer time period was investigated in a study published in 1997 of men in New Mexico (n=57) who were asked about the previous 3 months' consumption, then asked about the same period again 2-19 months later (**94**). Correlations between percentage of drinking days (0.72) and alcohol consumption over the 90 days (0.66) were high, but decreased when abstainers were excluded (to 0.57 and 0.44 respectively) (**94**). The reconstructed estimates reported drinking on more days (0.34, SD 0.39) than the initial estimates (0.27, SD 0.34), and also greater weekly consumption (20.37 'SEC' units, SD 32.92) than initial estimates (12.60 'SEC' units, SD 20.01, $P<0.05$) (**94**). In this study, more distant recall led to an increase in consumption estimates. As the initial recall period was reasonably long it could be expected that recall may be poor, however the reason why the reconstructed report 2-19 months later captures more drinking is uncertain. It could be that there is less of a social desirability bias talking about more distant events, or these could be spurious results: this is a small study and the period over which the reconstructed reports were collected was broad.

In 1999-2000, 80 drinkers were recruited to a US study with a daily drinking diary which continued for over a year, then retrospectively asked about alcohol consumption on 11th September 2001 four to five days following the terrorist attacks (**95**). Based on comparisons between the 11th September in the diary with the retrospective report of the same date, 40% of the sample under-reported, and 12% over-reported (**95**). The small sample size and the unusual

circumstance mean the results need to be interpreted with caution, but this study suggests that even in a short time period, recall bias may operate. Another US study from 2001 of adults (n=574) recruited as medical students between 1948 and 1964 explored the reliability of recall after 15 and 21 years of follow up (**96**). Recall after 15 years over-estimated concurrently reported intake by a mean of 0.47 (95% CI 0.10-0.85) drinks per week, and after 23 years consumption was under-estimated by a mean of 0.79 (95% CI -1.27 - -0.30) drinks per week (**96**). This is a small effect and a long time period. Characteristics independently associated with under-estimation of recall were being aged 71 or older in 2001, self-reported memory difficulties, and self-reported difficulties in physical functioning (**96**). The initial measure of drinking used in this study was self-reported 'typical' alcohol intake, which itself could be expected to be poorly-recalled. This could explain why recall did not deteriorate with time in this study. Reported consumption was compared in 33 men across a retrospective timeline follow back (TLFB) method and an interactive voice response (IVR) dial-in telephone system in another US study, which was published in 2002 (**97**). On average, for measures of drinking quantity and frequency, TLFB gave a lower consumption estimate than IVR (**97**). The TLFB was periodic and retrospective, whereas the IVR was completed in closer proximity to the drinking event.

The majority of studies which have investigated the effect of recall period length on recall bias were conducted in the USA and are therefore not necessarily generalisable to the UK. As the evidence for recall period length affecting recall bias is mixed, the relationship between recall period length and under-reporting of alcohol consumption is unclear. This is partly due to the heterogeneity between studies, different measures and time periods that have been used making it difficult to make a comparison.

2.6.6 Under-estimation

2.6.6.1 Knowledge of units in England

Under-estimation of alcohol consumption may be due to inadequate understanding of the number of units or standard drinks in different drinks, or lack of awareness of sensible drinking guidelines. This is distinct from recall bias as it is not captured in social surveys because the amount of alcohol in drinks recalled is under-estimated, rather than consumption that is 'forgotten about' being omitted. Off-trade consumption may be particularly easy to under-estimate, as drinks are not served in standard volumes as they are in the on-trade in the UK. This is particularly applicable for wines and spirits. However as the strength of wine (ABV) varies in both the on and off-trades, and some off-trade drinks are served in standard volumes (e.g. beer bottles and cans), this is a complex issue. As two-thirds of all alcohol sales in the UK are in the off-trade (see Section 2.4.1), there is the potential for under-estimation in this area to contribute substantially to the missing units.

Awareness of drinking guidelines and the number of units (or standard drinks) in alcoholic beverages is poor. Market research conducted in 2009/10 for Drinkaware found that 82% women and 81% men (aged 25-44) have heard of units, but the proportion able to correctly identify drinks equal to one unit and the drinking guidelines is much lower (**98**). The most recent academic research on this is the HSE 2007, which found that 92% men and 89% women aged 16 and over have heard of units (**99**). There is a social gradient, with respondents of lower socio-economic position more likely to have not heard of units than those of higher socio-economic position (**100**). The proportion of adults able to correctly identify the sensible drinking guidelines was low – 14% men and 9% women correctly identified the daily limit for men (four units), and 11% men and 6% women correctly identified the daily limit for women (three units) (**99**). The proportion of men and women able to correctly identify the number of units in a 125ml glass of wine, a pint of normal strength beer, and a pub measure of spirits was higher than the proportion able to identify drinking guidelines, and higher still among respondents who drank that beverage on their heaviest drinking day in the last week (**99**).

2.6.6.2 Pouring a 'standard drink' or a 'usual glass'

Several studies have asked participants to pour drinks and compared these poured volumes to the 'standard' drink. Studies which have looked at how people pour drinks have been reviewed systematically (Table 2.3). Studies reviewed have used varied methodologies to achieve diverse aims, therefore a quantitative synthesis is not appropriate. Although many of the studies are relatively small, they have been conducted worldwide, with participants with varied demographic characteristics.

Table 2.3: Systematic review of studies asking participants to pour either their usual glass or one standard drink

Study ID	Year	Country	Number of participants	Age	Gender	Glass used	Liquid used	Target pour	Pouring task all alcohol	Red Wine	White Wine	Spirits
Wilson 1981 (66)	1978	England	Not reported	Not reported	Not reported	Not reported	Water	Usual glass	n/a	n/a	n/a	Mean 36ml
Stockwell 1991 (101)	1989	Australia	24	>18	Not reported	A range of sizes	Coloured water	One standard drink. Comparing standard drink labelling with ABV labelling	Beer: standard drink labelling led to smaller divergence from standard drink than ABV labelling (P=0.025).	No difference	No difference	n/a
Carruthers & Binns 1992 (102)	1987	Australia	356	18-45	200 female	Participant's own	Water	Usual glass	n/a	10-50% extra	10-50% extra	10-50% extra
Lemmens 1994 (103)	Not reported	Netherlands	863	15-70	531 men	Participant's own	Water	Usual glass	Consumption increases 7.3% (11.9% in women, 5.8% in men)	8% larger Men>women Consumption increases 4.3%	8% larger Men>women Consumption increases 4.3%	29% larger Women>men Consumption increases 20%

Study ID	Year	Country	Number of participants	Age	Gender	Glass used	Liquid used	Target pour	Pouring task all alcohol	Red Wine	White Wine	Spirits
Banwell 1999 (104)	Not reported	Australia	86	Not reported	Women	Participants' own Self-measured using measuring jug	Alcohol	Usual glass	n/a	'Larger'	'Larger'	'Larger'
Gual 1999 (105)	Not reported	Spain	1600	Not reported	Not reported	Choice from 16 glasses	Alcohol	Usual glass	Bartenders pour larger than these participants	10.897g (SD 3.869)	10.897g (SD 3.869)	19.951g (SD 8.467)
Kaskutas 2000 (106)	1996-7	USA	211	Not reported	Pregnant ethnic minority women	Pointed to a level on marked vessels	n/a	Usual glass	Conversion ratios either in whole sample, or proportion pouring more than a standard drink	Median conversion ratio 1.50 (among 50%) or 1.3 in full sample	Median conversion ratio 1.50 (among 50%) or 1.3 in full sample	Median conversion ratio 4.00 (among 75%) or 2.0 in full sample
White 2003 (107)	2003	USA	106	College students	Both	3/4 glass sizes used	Water	One standard drink	Magnitude of discrepancy increased with cup size	n/a	n/a	1.5 oz for shots, 1.75-2.5 oz for mixed drinks (1.25 oz standard)

Study ID	Year	Country	Number of participants	Age	Gender	Glass used	Liquid used	Target pour	Pouring task all alcohol	Red Wine	White Wine	Spirits
Gill & Donaghy 2004 (108)	Not reported	Scotland	238	Adults	120 men	Not reported	Alcohol	Usual glass	n/a	97.6% poured more than one unit, mean 159.6ml (SD 37.0) or 1.92 units (95% CI 1.86-1.97) Women pour more than men	n/a	97.5% poured more than one unit, mean 57.1ml (SD 24.0), or 2.3 units (95% CI 2.16-2.41) Men pour more than women
Kerr 2005 (109)	2000	USA	310	Adults	Both	Participants' own Self-measured using measuring jug and strainer	Water	Usual glass	Mean ethanol 0.67oz (SE 0.02) (0.6oz is standard) Men drink more beer so has greater effect on women's consumption	Mean ethanol 0.66oz (SE 0.02)	Mean ethanol 0.66oz (SE 0.02)	Mean ethanol 0.89oz (SE 0.04)
White 2005 (110)	2003	USA	133	College students (18-22)	Both	Not reported	Water	One standard drink	n/a	Mean pour 7oz (95% CI 6.60-7.40), standard is 6oz	Mean pour 7oz (95% CI 6.60-7.40), standard is 6oz	Mean pour 4.19 oz for mixed drinks (95% CI 3.70-4.68) Mean pour 2.03oz for shots (95%

Study ID	Year	Country	Number of participants	Age	Gender	Glass used	Liquid used	Target pour	Pouring task all alcohol	Red Wine	White Wine	Spirits
												CI 1.91-2.14), standard is 1.25oz
Gill 2007 (111)	Not reported	Scotland	19	18-25	Female	Not reported	Alcohol	Usual glass	n/a	Mean 1.98 units (95% CI 1.7-2.2)	Mean 1.98 units (95% CI 1.7-2.2)	Mean 2.24 units (95% CI 1.8-2.7)
Kerr 2008 (112)	2007	USA	480 beverages	Not reported	Not reported	Drinks poured by bartenders sold on premise	Alcohol	Bar serving	n/a	Mean pour 6.18oz (95% CI 5.95-6.41) of 13.99% ABV, standard is 5oz of 12% ABV	Mean pour 6.18oz (95% CI 5.95-6.41) of 13.99% ABV, standard is 5oz of 12% ABV	Mean pour 5.28oz (95% CI 5.06-5.50) of 19.47%ABV, standard is 1.25oz of 40%
Nayak 2008 (113)	Not reported	India	Not reported	Not reported	Not reported	Comparing the size of a 'peg' of spirits	Unclear	Unclear	n/a	n/a	n/a	40-60ml depending on single/double Varies from 21.6-70.0% ABV
Wilkinson 2011 (114)	2005	Australia	844	65-74	Both	Participant's own	Coloured water	Usual glass	Men 1.33 standard drinks (SE 0.03) Women 1.15	Men 1.28 standard drinks Women 1.18 standard	Men 1.28 standard drinks Women 1.18 standard	Men 1.39 standard drinks Women 1.30 standard

Study ID	Year	Country	Number of participants	Age	Gender	Glass used	Liquid used	Target pour	Pouring task all alcohol	Red Wine	White Wine	Spirits
									standard drinks (SE 0.02)	drinks	drinks	drinks
De Visser & Birch 2012 (115)	Not reported	England	Two samples: school sample=309 and university sample=125	16-18 and 18-25	136 and 54 men respectively	5 types, clear shatterproof plastic	Coloured water	Usual glass, then unit	n/a	Usual drink: 1.76 units in large glass (95% CI 1.66-1.85), 1.24 units in small (95% CI 1.18-1.29) Unit: 1.17 units in large glass (95% CI 1.07-1.25), 1.13 units in small (95% CI 1.06-1.20)	n/a	Usual drink: 1.77 units (95% CI 1.61-1.19 Unit: 1.17 units (95% CI 1.11-1.26)

The studies reviewed provide evidence that participants often pour more than one alcohol unit or standard drink when asked to pour either their usual glass (**66, 102-105, 108, 109, 111, 113-116**) or one standard drink (**107, 110, 115**) particularly when pouring wine and spirits. Only one study identified addressed how perceived volumes or amounts of alcohol poured by the participant compares with actual amounts, and this was conducted in 65-74 year-olds only (**114**). This study found that participants on average under-estimated their drinks: men by 23% and women by 16% (**114**). Comparing actual and perceived amounts of alcohol poured (e.g. units) would aid understanding of how under-estimation of alcohol consumption occurs.

Little is known about the accuracy of participants' estimation of standard drinks or units, however there is a body of research that explores the accuracy of volume estimation. A 2012 study conducted by psychologists from England recruited 159 (80 male) drinking participants aged 18-37 to investigate how consumption speed can be affected by glass shape and volume (**117**). Participants were asked to judge the half-way point of both a straight and curved 12 fl oz (340ml) glass. For both glasses the half-way point indicated was below the true half-way point, and this was to a greater degree for the curved glass than for the straight-sided glass (**117**)..This accuracy around volume estimation has also been shown to translate into drinking speed of alcoholic drinks. Participants consumed a 12oz alcoholic drink (lager) 60% more slowly from the straight glass than from a curved glass, which was drunk from at a similar rate to participants consuming a 12oz carbonated soft drink (**117**).

There are also studies from academic consumer and marketing research which explore the effect of glass shape on perceived volume of glasses and how this influences volumes of drinks (alcoholic and non-alcoholic) poured. A 1999 study found that participants generally (in this study and others reviewed within it) perceive taller and more elongated glasses to have a larger volume than they actually do, and drink more from tall glasses than shorter ones (means 6.91 vs. 6.20 ml; $P<0.0001$) in a laboratory setting (**118**). As many previous studies have used containers provided by the researcher, the accuracy of participants' estimates may be lower than if participants were using their own glasses as people "may have their own consumption experiences to guide their volume estimate" (**118, p316**). As elongated glasses are perceived to have a greater volume, it follows that a smaller volume would actually be poured into them in order to reach an intended poured volume (**119**). A US study published in 2003 found children (n=97) pour more fruit juice than they perceive into short wide glasses, and less than they perceive into tall slender glasses (**119**). The actual volume poured into short wide glasses was greater than into tall slender glasses (9.66 vs. 5.54 oz, $P<0.05$) (**119**). The same test in 89 adults (69 male) showed the same in juice pouring (6.88 oz in short glass vs. 5.75 oz in tall glass, $P<0.05$) (**119**). In 45 bartenders pouring spirits the same pattern was observed in bars (2.06 oz in tall slender vs. 1.62 oz in short wide, $P<0.01$), suggesting that although more

experienced (>5years) bartenders poured less than less experienced bartenders (<5yrs), pouring experience attenuated but did not eliminate the effect of elongation on perceived volume.

These studies using non-alcoholic drinks in the home setting have been replicated to explore if the effect is the same where alcoholic drinks are concerned. A 2005 study in the BMJ by the same authors as the previous US study recruited US students (n=198) to pour a shot (44.3ml) of coloured liquids from spirit bottles into both tall slender glasses and short wide ones (**120**). Mean volume poured was 59.1ml in short wide glasses compared to 45.5 ml in tall slender glasses (P<0.01) (**120**). This was also observed in their sample of 98 bartenders, where the mean pour was 54.6ml in the tall glass and 46.4ml in the short glass (P<0.01) (**120**). Asking bartenders to pay attention attenuated effect of glass shape significantly (P<0.01), with the mean difference between short/wide and tall/slender 11.5ml in low attention group, and 4.8 ml in high attention group (**120**).

The studies reviewed in this section suggest that under-estimation may potentially contribute substantially to a substantial proportion of the missing units. Unfortunately the extent of this contribution is not known, and very little is known about participants perceptions of the amount of alcohol in alcoholic drinks they would pour for themselves at home. A participant's 'usual glass' is commonly greater than one unit, but would often be recorded as one unit or standard drink in many social surveys (depending on questionnaire design). This has been found in studies conducted worldwide including in the UK. Laboratory-type settings have proven that mis-estimation is common, however relatively little is known about home pouring practices and how estimation accuracy relates to these. The degree of under-estimation will be influenced by factors such as glass shape, which have been shown to be associated with drinking speed and volume perception. Further research on estimation accuracy of home drinking is necessary to identify the extent to which under-estimation contributes to under-reporting of alcohol consumption.

2.6.7 Intoxication level

Together with the deliberate and accidental forms of under-reporting, it is likely that the level of intoxication experienced by a participant will influence the accuracy of their reporting. This may occur due to a combination of poorer recall while intoxicated – including alcohol-related amnesia ('blackouts') – and more erratic pouring, resulting in drinks poured being larger and more likely to be under-estimated. An inverse relationship between alcohol consumption and recall accuracy has long been hypothesised (**74, 85**). It has been shown that a gamma function can be used to align reported alcohol consumption with sales, which takes account of the fact that under-reporting is greater among heavier drinkers, and that this fits the distribution of

outcomes well (**48, 121-123**). Several innovative studies have been conducted that are able to compare self-reported consumption with objective or observational measures of drinking. These are able to measure the extent of under-reporting of self-reported alcohol consumption.

2.6.7.1 Objective measures

Scientific objective measurements such as blood alcohol concentration (BAC) and transdermal alcohol concentration (TAC) have also been used to monitor the accuracy of reported consumption. TAC uses skin secretions (usually measured at the ankle) of the products of alcohol metabolism and is therefore less invasive and allows for continuous measurement, while yielding similar results to BAC (**124-126**). No studies were identified which used TAC to investigate under-reporting, however several studies have used BAC compared with a self-report.

A study published in 1994 investigated the blood alcohol concentration (BAC) of night-time drivers in Australia (n=5,765) (**127**). It was found that light drinkers tended to over-estimate their BAC and heavier drinkers to under-estimate their BAC (**127**). This corroborates what has been hypothesised about under-reporting increasing with consumption level or intoxication. Similar results were found in a US study with a different methodology published in 2000 (n=209) (also reported in (**128**)), which recruited participants with unintentional injuries and compared the estimated BAC (eBAC) based on self-reported alcohol consumption was compared with the actual BAC from blood serum (**129**). For women (n=30) mean BAC was 149.53 mg/dl and mean eBAC was 114.67 mg/dl, for men (n=104) mean BAC was 146.35 mg/dl; and mean eBAC was 55.38 mg/dl (**129**). It is not surprising that participants in this study under-reported their consumption, however, as all participants presented with injuries at a trauma centre and they may be embarrassed that alcohol played a part in their injury. However, studies comparing BAC with eBAC do not always identify under-reporting of self-reported consumption. In 2004 US college students (n=152) who had been drinking alcohol were recruited and asked questions about their alcohol consumption on the current occasion (**130**). Average eBACs were calculated as 0.12% (SD 0.07), whereas average measured BACs were equivalent to 0.09% (SD 0.046) (**130**). This difference was significant ($P<0.001$), yet the two measures were highly correlated (R^2 0.22, $P<0.001$) (**130**). This suggests participants may have over-reported their consumption whilst intoxicated, and perhaps this was due to a reversed social desirability bias: a desire to be seen as liminal by the researchers or friends, among this student population.

Other scientific measurements of recall bias are also possible. One study from 2001 compared 24-hour recall with a biomarker of alcohol consumption; 24-hour urinary excretion of 5-hydroxytryptophol (5-HTOL):5-hydroxyindole-3-acetic acid (5-HIAA) (5-HTOL:5-HIAA ratio) in a subset of respondents in the European Prospective Investigation into Cancer and Nutrition

(EPIC) Potsdam study in Germany (n=107) (**131**). Pearson's correlation coefficient was 0.85 for recent recall and the biomarker, and even higher (0.92) where five respondents who reported no alcohol consumption but had a 5-HTOL:5-HIAA ratio above the cut-off were excluded (**131**). This high correlation may be attributable to the short recall period (see Section 2.6.5.2), and with a longer period the correlation may decline.

A US study conducted in 2010 which asked 225 college students to 'guesstimate' their BAC found an inaccurate estimation of the BAC to be significantly associated with negative consequences of the night ($P<0.001$), such as inappropriate behaviour and hangovers (**132**). Similarly, a 2009 study from North West England recorded breath alcohol concentrations in participants (n=219) in the night-time economy between 8pm-2am and found a higher BAC to be associated with a later planned time for returning home (**133**). While these two studies are not directly linked to under-reporting, they indicate that high BACs are associated with the kind of behaviours that would also be associated with blackouts, where consumption may be forgotten.

The evidence that under-reporting can be detected using an objective measure – such as BAC – is mixed. As with the studies of under-estimation (Section 2.6.6), studies comparing objective measures with self-report are heterogeneous. Most of the studies conducted are quite small and were carried out in specific populations – such as trauma centre patients or students – making the external validity of the findings limited.

2.6.7.2 Observational measures

Where observational analysis is used to validate self-reported chronological records (such as a drink diary), agreement tends to be high (**74**), although one study from the 1970s found the magnitude of the discrepancy between questionnaire estimates and self-monitored intake is correlated with alcohol consumption (Pearson's r = 0.908) when investigating US college students' drinking (**134**). It is also acknowledged that observational analysis of drinking by researchers might actually influence participants' behaviour (**74**). Few studies have used observational methods to corroborate self-reports of alcohol consumption and those which have used quite different methods.

In the early 1980s alcohol consumption was recorded in men aged 25-54 (n=58) in simulated restaurant surroundings, without their knowledge, in Finland (**135**). Recorded consumption was compared to a self-report in an interview the following day: mean actual alcohol consumption was 11.4 drinks (range 7.0-16.0), mean recalled consumption was 10.5 drinks (range 6.0-15.5) (**135**). The degree of under-estimation increased with consumption: 12% among heavier consumers (12-16 drinks) and 4% among lighter drinkers (7-11 drinks) (**135**). The majority

(71%, n=41) of participants under-estimated their consumption - although this tended to be by a small amount (38% under-estimated by just one drink) – and very few participants over-estimated (7%, n=4) (**135**). This small study shows that recall bias can operate even where the recall period is very short. More recently, a 2011 Australian study trained fieldworkers to observe alcohol consumption in a purposive sample of 158 drinking occasions in 62 18-25 year-olds (**136**). The participants were interviewed about their consumption one or two days later. A multi-level model found overall reported consumption was 91% of observed consumption (95% CI 86-96%) (**136**). The relationship between observed and reported consumption is non-linear; reporting accuracy decreased as observed consumption increased (**136**). Under-estimation was significant where participants drank 9-12 drinks (mean difference between observed and reported = 0.7 drinks, P=0.04) and more than 12 drinks (mean difference 2.0, P<0.01) (**136**).

Both studies were quite small in size so these results need to be treated with caution, and one was conducted around 30 years ago. Both did however identify under-reporting of alcohol consumption in their respective countries (Finland and Australia). Despite their differences in method, these two studies support the hypothesis that reporting accuracy decreases as alcohol consumption or intoxication increase. These findings are not necessarily generalisable to the UK but given the absence of studied with conflicting findings it could be hypothesised that under-reporting does vary with consumption level and that this can be identified using novel observational methods.

2.7 Discussion

2.7.1 Summary of findings

This literature review has identified changing drinking habits in England, signified by the changing nature of the composition of alcohol sales. Changes in drinking patterns will be associated with shifts in the causes of under-reporting, so the relative contribution of each of the following findings to under-reporting may change in space and time. The literature on the potential mechanisms by which under-reporting of alcohol consumption takes places has been systematically reviewed and critically appraised.

With regard to non-response, the evidence that non-responders drink more than survey participants is uncertain. There is some evidence that participants who are difficult to contact drink more than those who are easier to contact, however the continuum of resistance theory (that late responders are more similar to non-responders) is somewhat speculative. Little is known about the characteristics of non-responders who do not respond to repeated attempts as a fact of their aversion to taking part in research studies. It could be hypothesised that non-responders may be experiencing illness, or lead chaotic lifestyles and be heavier drinkers, but

this is unknown. Further research on the characteristics of late responders or those who are difficult to contact would be welcome for alcohol as well as a range of health behaviours.

Similarly difficult to investigate to non-response is the idea of selective reporting, or deliberate under-reporting. There is evidence that participants under-report their consumption more if they have a health condition which precludes drinking such as pregnancy or HIV infection. Whether social desirability bias leads to selective reporting is less certain, however there is some suggestion of a small effect leading to increased under-reporting. There are only a small number of studies of social desirability bias so whether the effect of a health condition is similar to that of the presence of a spouse or child is not known.

The evidence that mode effects influence survey estimates of alcohol consumption is much more convincing. Self-completion questionnaires or diaries yield higher estimates of consumption than face-to-face or telephone interviews. Caution should be taken when comparing different questionnaire types delivered in different modes, however, as there may be other factors which influence this difference between the two methods. For example, where a diary is compared with a face-to-face interview, as in (**124**), the additional effect of the prospective nature of the diary should be considered.

There is an extensive literature on how questionnaire design can mitigate recall bias in social surveys measuring alcohol consumption. Careful and consistent phrasing of questions appears to be important for normalising particular consumption levels. This would particularly apply in face-to-face surveys where an interviewer is present. Studies which have used test-retest methods to explore the effect of questionnaire design have quite consistently found that more detailed questions, beverage specificity, and a short recall period (or prospective nature) all help to achieve higher alcohol consumption estimates. As a result, the 'gold standard' measure of drinking is a self-completion prospective drinking diary with beverage specific questions and takes account of drink size. Studies which have specifically investigated length of recall period have had mixed findings, and may be partly due to the heterogeneity between studies in terms of design and recall periods studied.

The fact that survey participants may under-estimate their alcohol consumption due to lack of knowledge of drink strengths (ABV) or volumes is often cited in the literature as one reason for the 'missing units', however remarkably little research has addressed this topic. There is convincing evidence that participants pour more than one standard drink or unit when asked to pour their usual glass or a standard drink. However, very little is known about participants' perceptions of how much alcohol is in their usual glass: only one study was identified and this was conducted among 65-74 year olds in Australia. As many modern social surveys about

alcohol consumption (such as the HSE) take drink size into account (rather than recording each drink reported as one unit or standard drink), participants' perception of their drinks is important. This is a potentially substantial area of under-reporting, but current knowledge is not able to verify its contribution to under-reporting.

It is intuitive that there would be an inverse relationship between levels of intoxication and reporting accuracy. The use of biological and observational measures to verify self-report is an exciting and growing area of research. The use of objective biological measures to verify self-report is mixed, but supports this hypothesis where studies of students - who may be overly-keen to report heavy drinking - are excluded. Only two studies have verified self-reports using observational methods and these have been successful in identifying under-reporting being greater among the heavier-drinking participants. More studies investigating the shape of the relationship between intoxication and reporting accuracy would be welcome, but ethical issues must be considered.

2.7.2 Conclusions

This literature review has identified several areas of under-reporting which may contribute to the 'missing units'. Many of these concern the failure of social surveys to account for the complexity of participants' lives, and arise from the fact that it is of little benefit to the participants to ensure the information they provide is accurate. With the shift towards private or off-premise drinking in England in recent years, the potential for under-estimation to contribute to the missing units may have grown. Research on the extent of under-estimation and its potential impact on survey data is surprisingly scarce, although data would be reasonably cheap and simple to collect. These kind of experimental studies where participants have been asked to pour drinks are relatively rare in comparison to the wealth of research on questionnaire design using test-retest procedures. Indeed, there has been relatively little methodological innovation in measuring alcohol consumption beyond changes to questionnaire design, and novel approaches such as photo-elicitation, documentary photographic or video diaries, and greater exploitation of biological measures of drinking such as BAC and TAC are encouraged.

From the systematic literature review, it is difficult to identify the relative contribution of each component of under-reporting to the total amount of under-reporting taking place in social surveys. It does appear, however, that some components of under-reporting are more definite than others. The mode in which a survey is conducted, and the design of the questionnaire, appear to be particularly important. A self-completion questionnaire or diary with detailed questions about actual consumption (as opposed to typical), using beverage specific questions that take into account drink size, and ideally a prospective design, could be expected to achieve

the highest estimates of alcohol consumption. Very little research has addressed how under-reporting of alcohol consumption might vary in different groups, by gender, age, region, socio-economic factors, or by alcohol-related factors.

Chapter 3 Unanswered questions and aims of the thesis

The gap in the literature reviewed in the previous chapter is identified. The importance of researching under-reporting is demonstrated through illustrating public health consequences with reference to the J-shaped curve and to the social patterning paradox between alcohol consumption and alcohol-related harm. The main aim of this thesis is to explain under-reporting of alcohol consumption in England. This will be achieved through four studies, the first two of which will use statistical analysis of existing national surveys to estimate the impact of under-reporting and risk factors for it. A qualitative study will also attempt to identify risk factors for under-reporting. A quantitative study will explore whether people under-estimate the amount of alcohol in their usual glass of drinks. Each of these studies is a unique contribution to the literature on under-reporting of alcohol consumption.

3.1 The gap in the literature

The literature review has identified that drinking in the private sphere is relatively under-studied, despite the fact that around two-thirds of alcohol sales are now in the off-trade. In Chapter 1 the gap between self-reported alcohol consumption and sales – the missing units – was introduced, and this will be fully quantified in this thesis. The literature review (Chapter 2) identified many different types of under-reporting, each of which may contribute to low alcohol sales coverage. The contribution of each component of the missing units is uncertain, although there is stronger evidence for some (such as mode effects) than others (such as under-estimation). The validity of assuming the missing units are attributable to under-reporting was justified.

Despite this extensive literature review, little is known about the distribution of under-reporting in the population. There is a large body of literature which describes the problem of under-reporting but little which attempts to actually explain it. While different aspects of under-reporting have frequently been investigated in isolation, these are generally inadequately linked to alcohol sales coverage. The implications and distribution of under-reporting have received very little research attention, either using analysis of large surveys or collecting data for the specific purpose.

3.2 Public health consequences

It was shown in Table 2.1 that under-reporting of alcohol consumption is substantial. It is useful to now consider why it is an important area of research. Improved measurement of alcohol consumption will have public health consequences. These can be demonstrated using the 'J-shaped' relationship that is observed between alcohol consumption and cardiovascular disease mortality (after (**137, 138**)) that is well-known and observed in developed countries worldwide. Although biological mechanisms to support this relationship have been suggested (**139, 140**), the causality of this relationship is contested (**141-144**). The examples presented in Figure 3.1 and Figure 3.2 could equally have used the linear relationship between alcohol consumption and many other diseases, such as alcoholic liver disease and cancers of the breast, mouth and stomach.

Consider this J-shaped relationship between self-reported alcohol consumption and mortality. If under-reporters could be identified, for a given level of reported alcohol consumption (e.g. 'x' in Figure 3.1) alcohol-related mortality will be higher among under-reporters than in the general population. If accurate reporters could be identified, they would experience a lower level of mortality than the general population. If demographic, social, or alcohol-related 'risk factors' for under-reporting can be identified in this thesis then individuals belonging to these groups can be

identified as having a higher risk of harm than their reported consumption reflects. Specific public health interventions to target under-reporters could be developed.

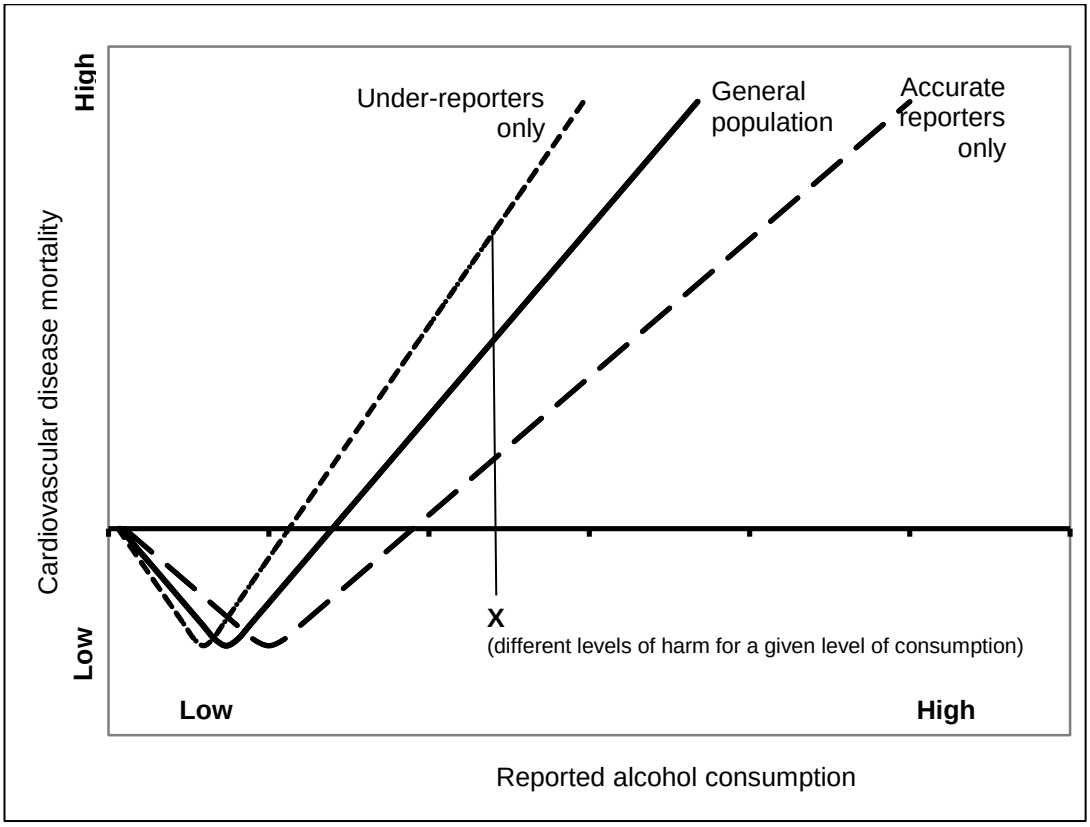


Figure 3.1: Implications of under-reporting for public health demonstrated by the J-shaped relationship between alcohol consumption and mortality.

*Note: See also Figure 1 in Feunekes et al.'s 1999 review for a conceptual diagram of true vs. reported consumption (**85**)*

A second issue that under-reporting raises which can be illustrated using the J-shaped curve is that identifying under-reporting could create perverse incentives for alcohol policy in the England. If we believe under-reporting to be extensive, and the majority of data on the relationship between consumption and harm is based on self-reported consumption data, it is possible that the magnitude of the harmful effect of alcohol on health is over-estimated. Suppose the current observed relationship between reported alcohol consumption and mortality is 'A' and official drinking guidelines are 'Y' (Figure 3.2). If it were possible to account for under-reporting, alcohol consumption would increase without any corresponding effect on mortality: we would now be operating on curve 'B'. Should the drinking guidelines be raised to 'Z'? This is discussed in detail in Section 9.3, where a case is also made for more careful and balanced consideration of this issue.

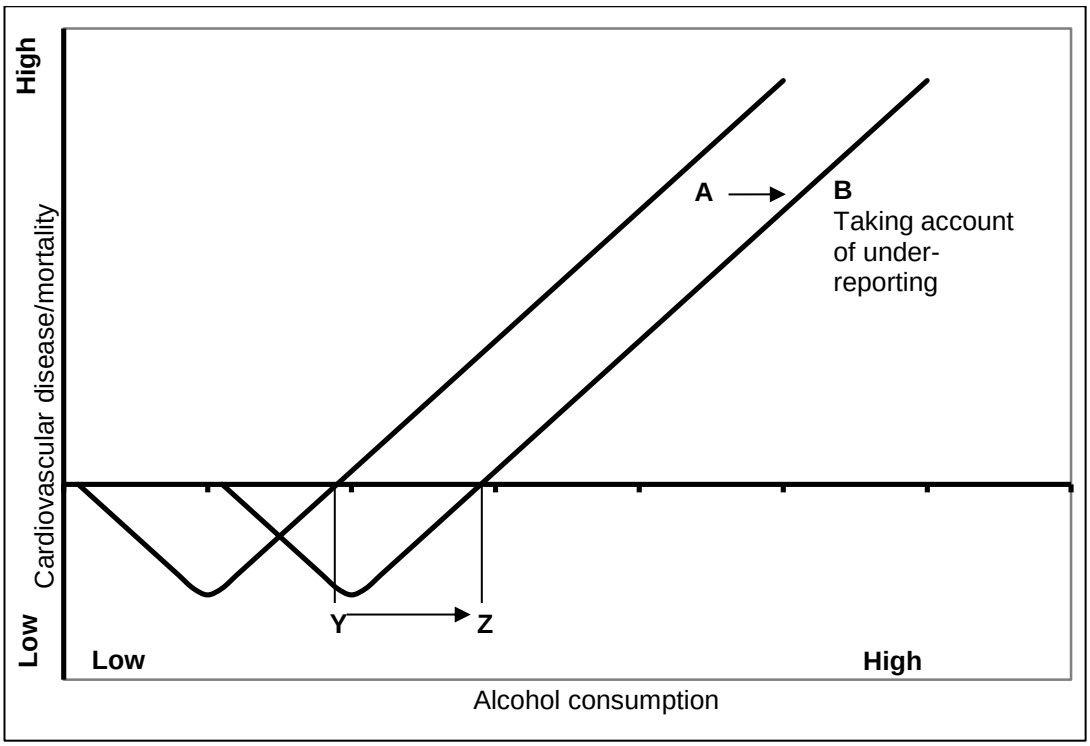


Figure 3.2: How accounting for under-reporting could lead to perverse incentives for alcohol policy

These two examples have demonstrated that under-reporting has implications for health promotion and public health policy and practice. Further, research on under-reporting could help to explain a paradox that is observed in the social gradient of alcohol consumption and alcohol harm. People of higher socio-economic status (SES) tend to drink more frequently and greater quantities: people living in higher income households are more likely to drink on five or more days of the week (**145**), and people living in higher income household and in the least deprived areas are more likely to drink above the threshold for harm (**145**). Conversely, people of lower SES have been found to be more likely to experience alcohol-related harm in studies conducted in the UK (**146-148**) and in other European countries (**149-152**).

This can be demonstrated on an aggregate level in England by comparing alcohol harm at a London borough level to an area-based measure of deprivation. In Figure 3.3, the months of life lost to alcohol in London boroughs is compared with the median Index of Multiple Deprivation 2010 (IMD) rank for that borough. There is a strong association between deprivation and months of life lost due to alcohol. The trend is similar for women, and is also observed if wards in the North West are investigated. However, this pattern is not seen for the North East, and this is possibly because the region as a whole is relatively deprived. Other regions in England have not been investigated.

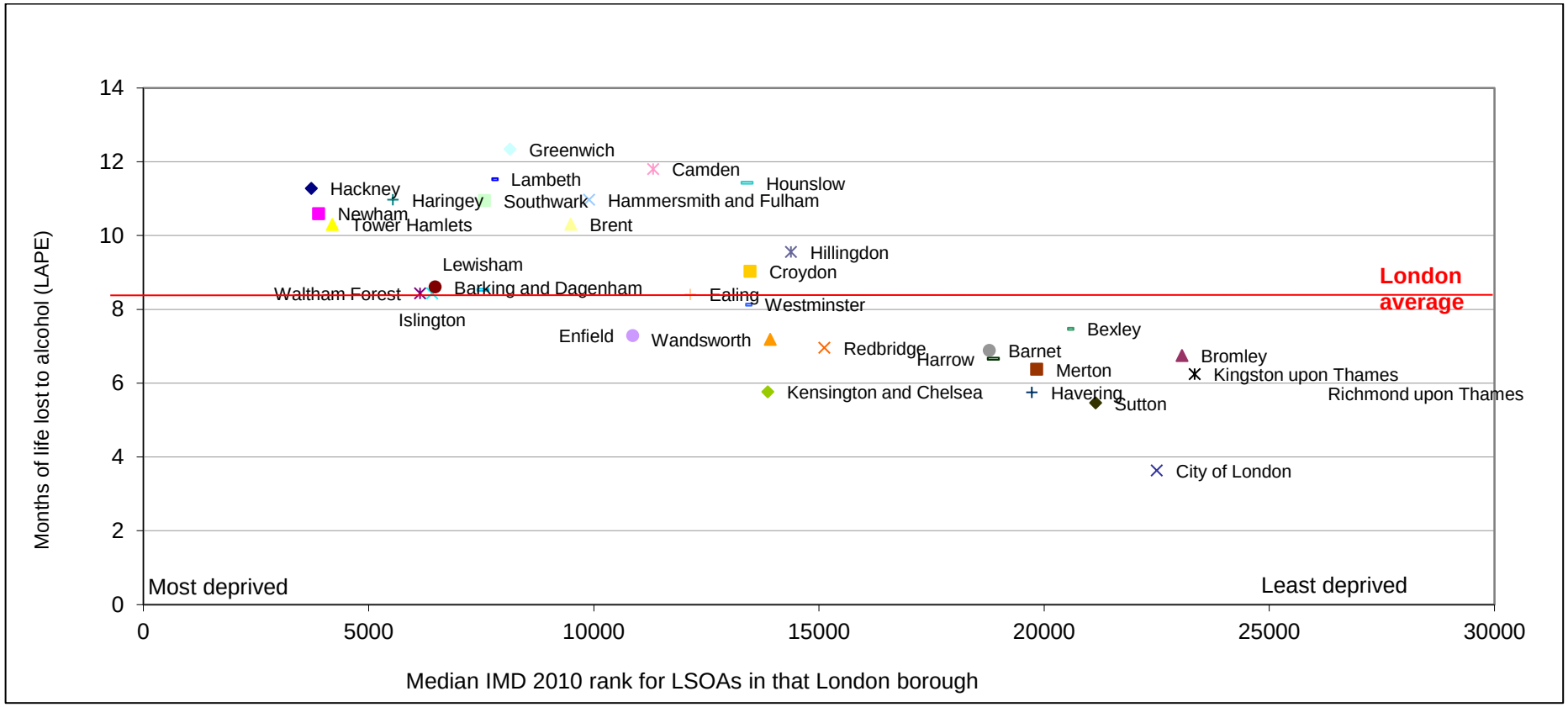


Figure 3.3: Months of life lost due to alcohol by mean IMD rank of borough: males aged less than 75 years, 2006-8, London

If this thesis finds that low SES groups under-report to a greater extent, this could be one explanation for the alcohol consumption and harm social patterning paradox. This has been previously suggested in a study which identified the social gradient in alcohol-related mortality (**153**). Other explanations include residual confounding due to other factors associated with drinking and mortality (e.g. diet quality), and that social patterning of drinking style or pattern may play a role, although the evidence for this so far is mixed (**148, 154-167**). It is probable that each of these factors is each involved in the social patterning paradox, but their relative contributions are not known. Indeed, very little research addresses the social patterning paradox directly. A team at Liverpool John Moores University led by Bellis is currently investigating this paradox in the UK as part of an Alcohol Research UK flagship grant programme.

3.3 Aims and objectives

3.3.1 Overall aim of the thesis

Identify and explain the missing units in England.

3.3.2 Specific aims

i. Quantify the extent of under-reporting.

ii. Consider the implications of under-reporting for estimates of alcohol consumption.

iii. Identify socio-demographic groups, drink types, and drinking habits/styles that are most strongly associated with under-reporting using mixed methods.

iv. Explore the potential for under-estimation of alcoholic drinks to contribute to under-reporting.

v. Make public health and policy recommendations.

3.3.3 Specific objectives (corresponding to aims)

i. Estimate alcohol sales coverage using the most recent data available for England.
ii. Revise alcohol consumption to align with alcohol sales and explore the effect on the prevalence of drinking above daily and weekly guidelines in different population groups.
iii. Use a combination of qualitative interviews and analysis of existing survey data to identify socio-demographic and/or alcohol-related ‘risk factors’ for under-reporting of alcohol consumption.

iv. Conduct a face-to-face survey investigating estimation accuracy of a self-defined usual glass of wines and spirits

v. Use the findings (from i, ii and iii) to produce two sets of recommendations. Public health recommendations will identify people more likely to under-report their consumption (and therefore at greater risk of harm than their reported consumption reflects). Policy recommendations will highlight any requirements for changes to survey methodology.

3.4 Research questions and hypotheses

This is a mixed-method thesis which uses a combination of analysis of existing data and primary data which were collected specifically for this thesis. After a prefacing chapter, the main empirical chapters of this thesis are split into two parts. The prefacing chapter quantifies the extent of under-reporting of alcohol consumption using the most recent sales data available. Part A is secondary analysis of national health and lifestyle survey data from the Health Survey for England and the General Lifestyle Survey. The two chapters which comprise Part A address objectives 'ii' and 'iii' in turn. Part B comprises two studies which are primary data specifically collected for this thesis. The two chapters which comprise Part B address objectives 'iii' and 'iv'.

3.4.1 Preface

3.4.1.1 Research question

What is the extent of under-reporting of alcohol consumption, and how has this varied over time and by drink type?

3.4.1.2 Hypothesis

Under-reporting will have increased as the proportion of off-trade alcohol sales increased since 2000. Under-reporting will be greater for drinks which are not generally sold in volumes designed for serving as 'a drink' such as wines and spirits, and lower for drinks that are sold in individual bottles or cans, namely beer.

3.4.2 Part A

3.4.2.1 Study one

Research question: how is alcohol consumption affected if we account for under-reporting?

3.4.2.1.1 Hypothesis

Estimates of alcohol consumption will increase substantially if under-reporting is taken into account, and there is potential for some groups to be more affected than others.

3.4.2.2 Study two

Research question: Can socio-demographic and alcohol-related 'risk factors' for under-reporting be identified from a nationally-representative survey with extensive measures of drinking patterns?

3.4.2.2.1 Hypothesis

After adjustment for demographic and social factors, the level of alcohol consumption, types of alcohol consumed and drinking venue will be associated with differential reporting of alcohol consumption in a retrospective interview compared with a prospective diary.

3.4.3 Part B

3.4.3.1 Study three

Research question: Which socio-demographic and alcohol-related 'risk factors' for under-reporting in surveys can be identified from qualitative interviews?

3.4.3.1.1 Hypothesis

As this is a qualitative study, a hypothesis was not formally tested. The interviews set out to explore the research question and to identify socio-demographic and/or alcohol related factors that may be linked to under-reporting of alcohol consumption.

3.4.3.2 Study four

Research question: Do drinking adults know how many units of alcohol are in their 'usual glass' of alcoholic drinks?

3.4.3.2.1 Hypothesis

Participants will tend to under-estimate the amount of alcohol in their usual glass and the extent of this may vary by drink type and socio-demographic factors: for instance older participants who may not be aware of units will be more likely to under-estimate than younger participants who are more aware of units.

Chapter 4 Preface to Parts A and B: the missing units

This chapter sets the scene for the research that is presented in Parts A and B. The missing units are calculated as equivalent to 44% of alcohol sales for Great Britain in 2010, equivalent to almost a bottle of wine per week for every adult aged 16 and over. Comparisons of survey and sales to explore trends in alcohol sales coverage over time show that there has been little change in coverage since the early 1990s, despite improvements to questionnaire design in recent years. The survey data also show that alcohol sales coverage varies considerably by drink type, with coverage highest for wine, and lowest for spirits; with less than one third of spirits sales accounted for by self-reported consumption.

4.1 Introduction

Why does England experience the high levels of alcohol-related harm discussed in Chapter 1 when we report we are a nation of sensible drinkers? The concept of the missing units as drinking which is not captured by social surveys, meaning that surveys grossly under-estimate actual alcohol consumption, was introduced in Chapter 1. In the literature review (Chapter 2) it was shown that the amount of alcohol that is 'missing' can be attributed to under-reporting (Table 2.1), of which many different forms take place in social surveys. Although these various types of under-reporting each have different aetiologies, and contribute to differing extents, only the overall combined effect on alcohol consumption estimates is currently known. It was also shown in the literature review that alcohol sales coverage is low in studies which have been conducted worldwide (Section 2.5.1). In this chapter, alcohol sales coverage is used to quantify the extent of under-reporting of alcohol consumption in England. Published studies have paid little attention to the variability in alcohol sales coverage. In this chapter, time trends are investigated, and the extent of the missing units is explored by the main (alcoholic) drink types: beer, wine, and spirits, to see if under-reporting is likely to vary by drink type. The findings from this chapter are used to inform analyses conducted and interpretation of results in Chapters 5-8.

4.2 Research question

What is the extent of under-reporting of alcohol consumption, and how has this varied over time and by drink type?

4.3 Objective

Estimate alcohol sales coverage using the most recent data available for England.

4.4 Hypothesis

Under-reporting will have increased as the proportion of off-trade alcohol sales increased since 2000. Under-reporting will be greater for drinks which are not sold in volumes designed for serving as 'a drink' such as wines and spirits, and lower for drinks that are sold in individual bottles or cans, namely beer.

4.5 Measuring alcohol consumption

Estimates of alcohol consumption in the UK are available in several different measurements from a variety of research and industry sources (see Appendix F for a full list). There are measures of sales volume and value available from HM Revenue and Customs (HMRC) and

the British Beer and Pub Association (BBPA). There is a high degree of agreement between the BBPA and HMRC data (see Appendix G). According to the BBPA data for 1974-2009 (Figure 2.1), alcohol sales (in litres per capita 15+) have fluctuated over the time period but have remained above 10 litres per capita since 2000. These data are available at a UK-level and country or region-specific data are not freely available (some commercial data are collected). While sales-type data are considered to be a reasonably accurate representation of alcohol consumption at a population level, they are quite limiting from a public health perspective as they do not reveal any information about consumption at an individual level or drinking patterns. However, alcohol sales per capita are published annually, and are available by drink type.

As was mentioned in Chapter 1, it is essential to distinguish between alcohol sales per capita and alcohol consumption per capita, because unlike sales, consumption is measured using self-reported data. Self-reported alcohol consumption was measured as average weekly units by the nationally-representative General Lifestyle Survey (GLF) in Great Britain until the survey ended in 2011. The GLF weekly alcohol consumption data are based on beverage-specific quantity-frequency questions about drinking over the previous 12 months. This is an attempt to counter the fact that drinking is commonly not the same from week-to-week, and often follows a seasonal pattern as well. The GLF methodology is described in detail in Section 5.5.1.

However, this method is liable to recall bias due to the long period of recollection (12 months), and as it asks about 'usual' drinking it is also open to participants making (favourable) generalisations about their alcohol consumption. Specific data about actual consumption – such as seven-day recall or a drinking diary – are preferable to data about 'usual' consumption, and often lead to higher alcohol consumption estimates (for a detailed discussion of survey methodology and questionnaire design, please see Section 2.6.5). In the Health Survey for England (HSE), information on the heaviest drinking day in the last week is collected using beverage-specific questions with drink size, and this is converted into alcohol units (see Section 2.3) so that consumption can be compared to daily guidelines. For the HSE 2011, the GLF-style questions on drinking to calculate average weekly drinking, and a seven-day prospective drinking diary were included in addition to the heaviest day questions. The HSE methodology is described in detail in Section 5.5.2 and Section 6.5.

4.6 Alcohol sales coverage in the UK

It was stated in Chapter 1 that when alcohol sales data (such as those from HMRC) are compared with self-reported alcohol consumption (from social surveys) it is consistently found that reported consumption is less than total sales. The difference between the survey estimate of consumption and the sales estimate is the 'missing units'. The GLF 2010 recorded self-reported alcohol consumption as 11.5 alcohol units per week per adult in Britain aged 16+ (**10**).

This figure is an average across the whole adult population, regardless of drinking status. UK alcohol sales measured by HMRC in the financial year 2010/11 (the most recent year for which data are available), equivalent to 20.4 units a week for every adult (**11**). Alcohol consumption as a proportion of total sales – or 'sales coverage' - is 56%, with 44% of alcohol sales not accounted for. The equivalent of 8.9 units a week per adult is 'missing', see Figure 4.1 below, equivalent to a 750ml bottle of average strength (12% ABV) wine. It was shown in Table 2.1 that the missing units can be wholly attributed to under-reporting. Therefore under-reporting of alcohol consumption is extensive and has considerable implications for public health, as described in Chapter 3.

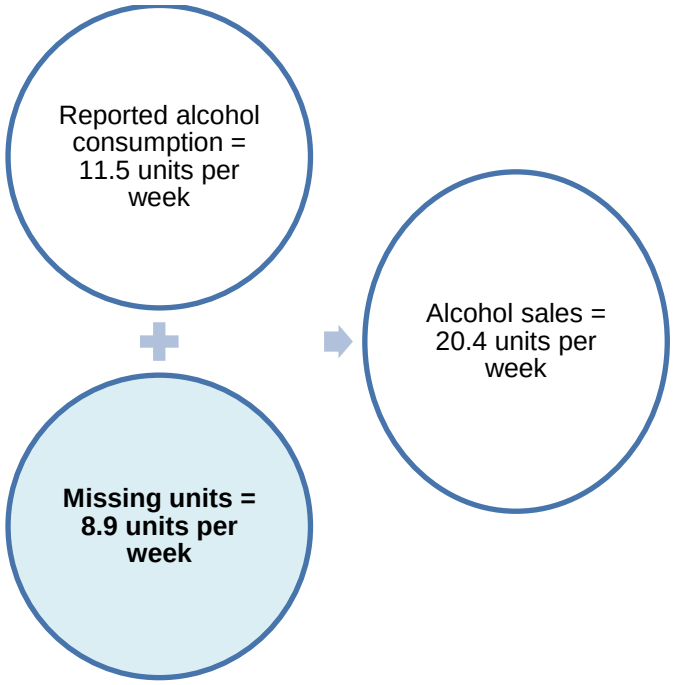


Figure 4.1: Schematic of the missing units

The GLF data are weighted to account for non-response. The household response rate to the GLF 2010 was 72% (**168**). If unweighted data are used, mean reported average weekly alcohol consumption is equivalent to 11.4 units (**10**) (55.9% of alcohol sales). Hypothetically, if the discrepancy between reported consumption and alcohol sales was entirely due to non-response, the 28% of non-responders would have to have consumed 44.1% of all the alcohol sold that year. This is equivalent to non-responders drinking on average 32 units of alcohol every week (Appendix H). Non-response is a classic explanation for low alcohol sales coverage but this shows that non-response is actually a weak justification for low alcohol sales coverage alone. Other explanations for low alcohol sales coverage must be considered.

4.7 Time trends

Not only is this problem extensive, but investigations conducted for this thesis show it is persistent too. Over time using these GLF (Great Britain) and HMRC (UK) measurements of drinking, alcohol sales coverage has been fairly stable (Figure 4.2). During this period there have been substantial changes in alcohol sales volume and value, the composition of alcohol sales and types of drink sold (see Section 0). Overall, alcohol sales coverage does not appear to have improved nor worsened with these changes, having remained between 50% and 60% over the two decades for which data are available. Other studies conducted in the UK using different data sources have found similar estimates for sales coverage of 40-60% (**66, 74, 169**). Although alcohol sales coverage overall does not appear to have varied, the relative contributions of the different causes of the missing units identified in Chapter 2 may still have varied greatly. The extent of this is not known, but given the variation in alcohol sales composition identified between 2000 and 2010, some changes would be expected. It is important to note that the improvement to alcohol sales coverage in 2006 was the result of a change in survey methodology, where the strength of wine was updated from 9% ABV to 12% ABV. This led to an increase of 33% points in the amount of wine that was reported consumed 'overnight'. If this change had not taken place, it is possible that sales coverage would have remained below 50% since 2005.

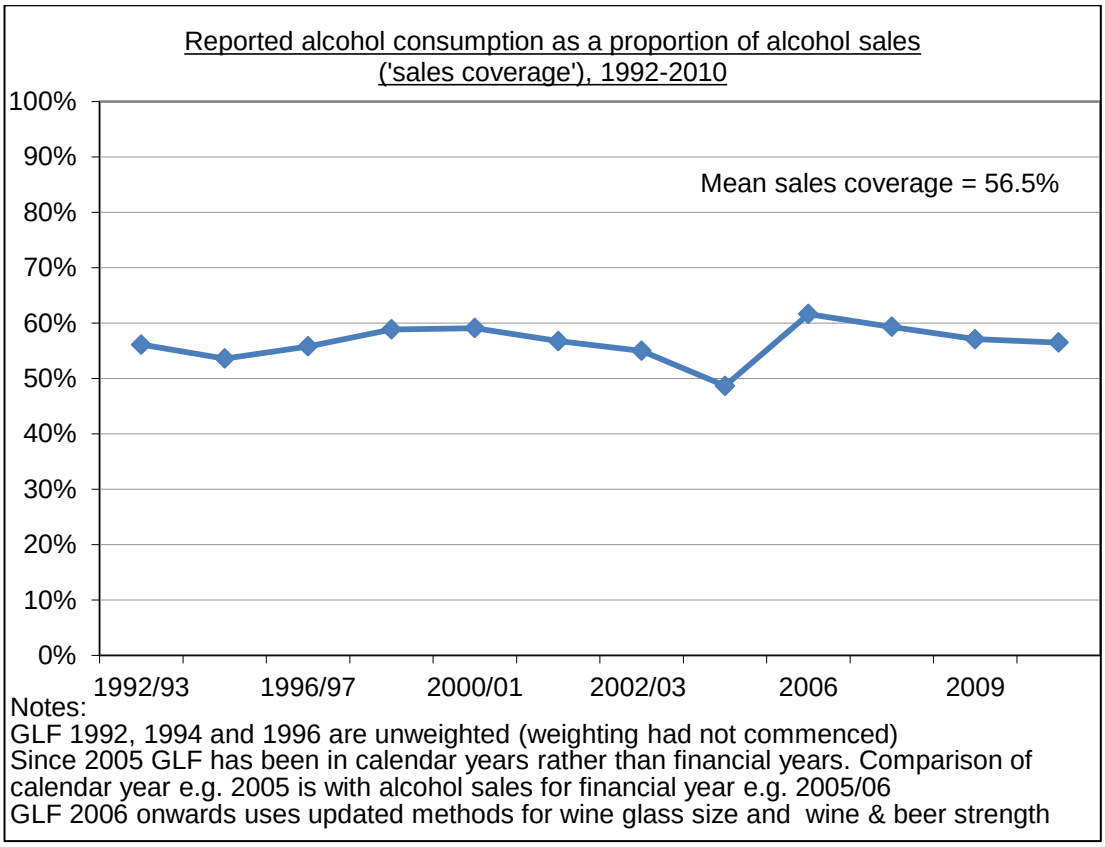


Figure 4.2: Time trends in alcohol sales coverage calculated through comparison of self-reported consumption (GLF) and alcohol sales (HMRC)

4.8 Sales coverage by drink type

Both the HMRC sales data and the GLF self-reported consumption data are available by drink type. This means that coverage can be calculated separately for wine, beer and spirits. It was not possible to calculate coverage for sherry and alcopops as HMRC does not provide sales data for these drink types individually (the total for wine included 'made wine', fortified wines such as sherry and port, and 'coolers' up until 2001/2 only (**170**)). The GLF 2010 and the HMRC data for the financial year 2010/11 are used to calculate coverage by drink type in Table 4.1. For wine, coverage is high (66%). Coverage for beer and cider is moderate (56%). Coverage for spirits is low (33%). This variation in sales coverage by drink type is considerable and has not been explored previously.

Table 4.1: Sales coverage by drink type in 2010

	Reported alcohol consumption per adult 16+ (GLF 2010)		Alcohol sales per adult 16+ (HMRC 2010/11)		Sales coverage
	n	Weekly units	Litres /year	Units /week	
All drinks	13,238	11.47	10.59	20.37	**56.3%**
Beer (normal)	13,268	4.77			
Beer (strong)	13,269	0.37			
Beer (all)		5.14	3.84	7.38	
Cider		*	0.95	1.83	
Beer + cider		5.14	4.79	9.21	**55.8%**
Wine	13,264	4.50	3.53	6.79	**66.3%**
Spirits	13,254	1.45	2.27	4.37	**33.2%**
Sherry	13,267	0.14	†		
Alcopops	13,270	0.25	†		

** included in beer*
†not recorded

4.9 Conclusion

This chapter adds to what was found in Section 2.5.1 about changes in alcohol sales that alcohol sales coverage is - and has historically been - low using recent data for the UK. However, despite substantial changes in the composition of alcohol sales over the time period for which alcohol sales coverage was calculated, there seems to have been little change in the extent of under-reporting. However, if the recent changes to survey methodology had not taken place, alcohol sales coverage would probably have decreased in recent years. If further improvements to survey methodology are not sought, then survey estimates of alcohol consumption will be of decreasing validity as time goes on.

Coverage varies by drink type, and is lowest for spirits. The exact reasons for this are not known. This could be due to survey participants' reluctance to report drinking strong alcohol, or because it is difficult to know how much is consumed when drinking at home: drinks are not served in fixed measures and are usually larger than one unit (see Chapter 8). It could also be indicative of the reporting accuracy of spirit drinkers, or reflect the possibility that spirit drinkers may not be adequately represented in the survey sampling frame. The high coverage observed for wine could be due to the social acceptability of drinking wine – as part of a civilised occasion involving food - meaning it is more likely to be reported, or it could be indicative of the reporting accuracy of wine drinkers themselves.

Although several explanations for low coverage have been described in Table 2.1, it is unlikely that these explanations exceed the sum of the alcohol that is not captured in the HMRC sales data. As a result, the estimate of the missing units is likely to be conservative, and the missing units can be attributed to under-reporting of alcohol consumption. For 2010 in England, 43.5% of alcohol sold was not reported consumed, and the missing units amount to around a bottle of wine a week for every adult in the country. This thesis attributes the missing units to under-reporting of alcohol consumption, where under-reporting is considered in a broad sense to include recall bias, accidental under-estimation, and selective reporting (see Chapter 2). Now that under-reporting of alcohol consumption has been understood and quantified, research can be conducted to examine the implications of under-reporting and to identify risk factors for under-reporting.

Chapter 5 PART A. Study one: revising estimates of alcohol consumption to account for under-reporting

Although a small number of recent studies have revised alcohol consumption to align consumption and sales data in order to improve understanding of the relationship between consumption and harm, none have done this in order to explain the effect on the proportions drinking above guidelines. This chapter presents revised estimates of the proportion of drinkers who may be drinking above weekly guidelines, and may be drinking more than the recommended daily limits or twice the daily limits on their heaviest drinking day in the last week. Overall in the revised scenarios, approximately 40% men and 30% women drank above the weekly guidelines, and 75% men and 80% women drank more than the daily limits on their heaviest drinking day in the last week. The revised scenarios represent a substantial increase in estimates of alcohol consumption and affect the proportion drinking above the drinking guidelines differentially.

5.1 Background to the study

In Chapter 2 it was shown that the missing units can be attributed to under-reporting, and therefore that under-reporting of alcohol consumption is substantial, equivalent to over 40% of alcohol sales (Chapter 4). While it is clear that attempting to account for under-reporting would affect alcohol consumption estimates considerably, the precise nature of this effect is not known. The work presented in this chapter is the first study which has explored the effect of under-reporting on alcohol consumption above Department of Health drinking guidelines. However previous studies have been conducted which revise survey estimates of alcohol consumption in order to align reported consumption with sales data.

Three studies have been published by a team in Canada which revise consumption to improve alcohol sales coverage using data from the USA, the first of which is largely methodological (**122**). The team modelled the distribution of alcohol consumption and compared the results from three distributions the authors selected on the criteria that they were unimodal, had a density with only one maximum, and could be used with right-skewed empirical data: gamma, log-normal and Weibull (**122**). The Weibull distribution was found to fit the data best, followed by the gamma distribution (**122**). The authors state that there is 'no straightforward way' of shifting the data in a Weibull distribution and so they chose to use the gamma distribution for their three papers. The gamma distribution was used by this team to revise alcohol-attributable fractions (AAFs, which describe the extent to which a disease is caused by alcohol) for liver cirrhosis in the USA (**122**), population-attributable fractions (PAFs, which are similar to AAFs but are not necessarily for alcohol) for breast cancer, diabetes, and pancreatitis in countries worldwide (**121**), and potential years of life lost due to alcohol in the USA (**123**). These studies were published while the research in this thesis was on-going.

A 2013 study by the alcohol team at the University of Sheffield used the method developed by the researchers in Canada to investigate the impact on gender- and age-specific AAFs for oral and pharyngeal cancers in Great Britain (**48**). This study was published online shortly after a version of the work in this chapter was accepted for publication. This study quantified sources of error in both the General Lifestyle Survey (GLF) survey data and the HM Revenue and Customs (HMRC) sales data and some of these estimates were used in Section 2.5.2. The advantage of using the gamma function in this way is that this allows for different levels of under-reporting based on alcohol consumption level. Previous studies reviewed in Section 2.6.7 have shown that the extent of under-reporting varies by consumption level, therefore this is a valuable approach. This chapter does not use the gamma distribution (the reasons for this are described in Section 5.8.2), but instead takes account of under-reporting varying by consumption level in a different way.

This chapter sets the scene for the following empirical chapters, reinforcing why research on under-reporting is important. The results presented are effectively a 'worst case scenario' of what alcohol consumption could actually be, and how different groups could be affected differently. In the absence of any clear data on the population distribution of under-reporting, three putative scenarios are presented and the results of each discussed in turn.

5.2 Research question

How is alcohol consumption affected if we account for under-reporting?

5.3 Objectives

Revise alcohol consumption to align with alcohol sales and explore the effect on the prevalence of drinking above daily and weekly guidelines in different population groups.

5.4 Hypothesis

Estimates of alcohol consumption will increase substantially if under-reporting is taken into account, and there is potential for some groups to be more affected than others.

5.5 Data

In this chapter, data from two nationally-representative surveys are used: the Health Survey for England (HSE) 2008, and the GLF 2008. The year 2008 was chosen because the most recent sales data available from HMRC for comparison were for the financial year 2008/09 until March 2012, when data were published for 2009/10 and 2010/11. There is approximately a 15 month time lag between the end of data collection for a given year of the HSE, and the data being deposited in the UK Data Archive and made available for use. A similar time lag exists for the GLF. The analyses could have been conducted for the survey years 2009 or 2010, but the sample size of both these survey years was far smaller for the HSE, with 4,645 (**171**) and 8,420 (**172**) adults interviewed respectively.

5.5.1 The General Lifestyle Survey

The GLF – formerly known as the General Household Survey – covered Great Britain, beginning in 1971 and conducted continuously as a cross-sectional survey until the survey ended in 2011 (**173**). There were breaks in the survey in 1997/8 and 1999/2000 when the survey was reviewed and re-developed, respectively (**174**). In 2005, the GLF adopted a longitudinal design, in which participants were interviewed for four consecutive years, with around one quarter of participants replaced each year (**174**). The 75% overlap between years

was intended to avoid high attrition rates (**175**). This brought the GLF in line with the EU Survey of Income and Living Conditions so that international comparisons could be drawn (**175**), and to enable statistically significant changes over time to be more detectable than in the previous repeated cross-sectional design (**175**). In June 2011 after a user consultation it was announced that the GLF would not continue in its current form in light of funding cuts in the NHS Information Centre, and the survey closed in January 2012 (**173**).

5.5.1.1 Sampling

The GLF was a nationally-representative survey of private households in Great Britain (**175**). From 2008 students who living in halls of residence were also included as residents of the household sampled even if they were not *in situ* at the time of the interview (**175**). A probability, stratified two-stage sampling design was used, with the small user postcode address file (PAF) used as the sampling frame (**175**).

The primary sampling units (PSUs) were postcode sectors, and the secondary sampling units were addresses within those sectors (**175**). In 2000, a new stratification procedure was introduced to improve representativeness of the sample. Postcode sectors were allocated to 30 major strata to cover regions of Great Britain, and then further stratified based on Census data on car ownership, occupational group, and proportion of pensioners. This led to a sampling frame of several hundred major strata, from which one PSU was selected each year (**175**). Selected PSUs were randomly allocated to a month of the year and formed the data collection requirement for one interviewer (**175**).

The longitudinal format of the GLF since 2005 meant that participants remained in the sample for four years or waves (**175**). One quarter of the sample was replaced each year in a 'replication', each of which was designed to be nationally-representative (**175**). Each year, one replication (the oldest) was dropped and a new one added, such that any two consecutive years had three of the same replications (**175**). Participants interviewed in replications in their first, second, or third wave were asked if they agreed to be interviewed the following year (**175**). If multiple-occupancy addresses in the PAF were identified by the interviewers visiting the addresses, up to three households were interviewed (**175**). If there were more than three households at the PAF, a sample was taken using a random selection table (**175**). The GLF aimed to interview every adult aged 16 and over at sampled addresses (**175**).

5.5.1.2 Data collection

Sampled addresses were sent an advance letter explaining the survey and stating that a trained interviewer would be coming to visit. Since 1994, the interview conducted was a face-to-face computer-assisted personal interview (CAPI) on a laptop computer (**175**). The household

questionnaire contained questions about household composition and relationships, housing, car ownership, consumer durables, migration, ethnicity, education, employment, income and pensions, leisure, health and health services, alcohol consumption, and cigarette smoking (**176**).

Questions about alcohol consumption were first included in 1978 (**176**), and were included every two years from then until 1998 (**174**). After the 2000 review of the GLF, questions on drinking were included in 2000-2, 2005, 2006 and 2008 (**174**). Before 1988 these questions were asked only among those aged 16 and over, but since then 16 and 17 year olds were asked to complete a self-completion questionnaire (**174**). Average weekly alcohol consumption was measured periodically since 1986, in order to examine consumption in relation to the Department of Health's weekly drinking guidelines (see Section 2.3) (**174**). Respondents were asked about quantity and frequency of consumption of normal strength beer, strong beer (>6% ABV), wine, spirits, fortified wines, and alcopops, in the last 12 months (**174**). A frequency multiplier was used to estimate the average weekly consumption over the course of the year (see Table 5.1).

Table 5.1: Calculation of average weekly alcohol consumption from quantity-frequency in the last 12 months in the GLF (174)

Drinking frequency	Multiplying factor
Almost every day	7.0
5 or 6 days a week	5.5
3 or 4 days a week	3.5
Once or twice a week	1.5
Once or twice a month	0.375 (1.5/4)
Once every couple of months	0.115 (6/52)
Once or twice a year	0.029 (1.5/52)

With the introduction of daily recommended limits in 1995, questions about the maximum daily amount in the last week were also introduced in 1998 (**174**). These were similar to the heaviest drinking day in the last week in the HSE (see Section 5.5.2.2). The methods used to convert a glass of wine into units were updated in 2006. A 'glass' increased from 125ml to 170ml and the alcohol by volume (ABV) of wine was increased from 9% to 12%, resulting in a glass of wine which was previously one unit becoming equivalent to two units (**174**). The strength of beer was revised also (**174**). Questionnaire options for the size of a glass of wine were introduced in 2008 (**174**).

On occasions where it was not possible to contact a household member to take part in the survey, a proxy interview was conducted with a close household member (**175**). In the proxy interviews, some questions on topics such as smoking, drinking, education, health, and family information were excluded (**175**). Since 2000, proxy interviews were converted to full Computer Assisted Telephone Interviews by interviewers at a central unit (**175**). The proxy participant was re-contacted by telephone to obtain answers to questions not included in the proxy CAPI (**175**).

5.5.1.3 Weighting

The GLF was weighted using a two-step approach in order to compensate for non-response and attrition (once the longitudinal component was introduced in 2005), and to match the sample distribution to the population distribution (**177**).

Non-response and attrition were weighted for by giving each participant a weight so that they represented any non-responders similar to themselves (**177**). The 2001 Census was linked to the sampled addresses for social surveys including the GLF which allowed Census information to be used to model the types of household that were under-represented in the survey (**177**). Household variables used were region, number of rooms, household size, number of adults, accommodation type, adults not employed, number of pensioners, and sex of the household reference person (**177**). Attrition was weighted for by investigating the characteristics of non-responders at previous waves of the survey when they did respond (**177**). Logistic regression was used to identify demographic and socio-economic predictors of attrition which were then used to weight the participants to the most recent survey wave (**177**). The population distribution was matched using mid-year population estimates for private households for sex, age category, and region (**177**). This population-based weighting provided an adjustment to the non-response weight (**177**).

5.5.1.4 The 2008 survey

In 2008, 684 minor strata from the previous year were rolled forward in the longitudinal design (**175**). 192 pseudo wave four strata were replaced, and an additional 36 added, leading to a total of 912 minor strata for 2008 from each of which one PSU was selected (**175**). In total, 12,358 addresses were selected as the survey sample (**175**). Of this, 741 addresses were either ineligible (e.g. demolished or used solely for business purposes) or not traced, and 11,617 were eligible (**175**). There were 11,700 households at the 11,617 eligible addresses (some addresses in the PAF contain more than one household) (**175**).

The proportion of households in which at least some household members were contacted by the interviewer – known as the contact rate - was 95% (**175**). Of households selected for interview, 18% did not wish to take part (**175**). If only complete interviews for the whole

household are considered, the response rate was 61% (7,164 interviews) (**175**). Since the survey began in 1971, the GLF also calculated a 'middle' response rate in order to measure response over time. This took households where full interviews took place, and also households where only partial interviews took place but information is not missing altogether for any of the family members (**175**). For 2008, this middle response rate was 73% (**175**). This response rate was highest in South East England (77%) and lowest in London (63%), and was similar to recent years of the GLF (**175**). In total, 8,729 households were interviewed, containing 16,407 adults aged 16 and over (52% women) (**175**).

Significant predictors of attrition (loss of respondents from previous waves) in the GLF 2008 based on responses in the GLF 2007 were survey wave (1-4), accommodation type, area classification of regional neighbourhoods, age and ethnicity of household reference person, qualifications and longstanding illness (**175**). These characteristics were used to calculate the non-response weights for the GLF 2008. Households that were buying with a mortgage, with only one person, with four or more adults, and with no access to a car or light van were slightly under-represented in the survey sample (**175**). Households which were owned outright, with a married couple and no children, or with two adults were slightly over-represented in the survey sample (**175**). This was adjusted in the weighting to make the sample representative of private households in Great Britain.

Participants interviewed in replications that were in wave one, two, or three in 2008 were asked to be re-interviewed the following year (**175**). The majority (84%) agreed to be interviewed, and 3% declined. Of the remainder, the majority were proxy interviews (**175**).

5.5.1.5 Outcome measures

Adults aged 18 and over answered questions about alcohol consumption in the face-to-face CAPI conducted by a trained interviewer. Young adults aged 16 and 17 answered questions about alcohol in a self-completion booklet (see Section 5.5.1.2). Information was collected on average weekly alcohol consumption based on consumption of different drink types in the previous 12 months, frequency of drinking in the last week, and maximum daily amount drunk in the last week (**174**). In this chapter average weekly alcohol consumption in units is used, with reference to the Department of Health's weekly drinking guidelines from 1987 (see Section 2.3).

5.5.1.6 Key risk factors

Detailed socio-demographic information was collected in the survey interview. Key socio-demographic factors known to be risk or protective factors for alcohol consumption were selected for the analyses in this chapter. These were sex, age, region, and equivalised

household income quintile (although Index of Multiple Deprivation (IMD) was used in the HSE 2008 analyses, IMD was not available for the GLF dataset).

5.5.2 The Health Survey for England

The HSE is a series of annual cross-sectional surveys which began in 1991, representative of the adult population aged 16 and over living in private households in England (**178**). The HSE has been commissioned by the NHS Information Centre for health and social care since April 2005, and before then it was commissioned by the Department of Health (**179**). Since 1994 the HSE has been designed and conducted by the Joint Health Surveys Unit of the National Centre for Social Research and the UCL Research Department of Epidemiology and Public Health (**179**).

5.5.2.1 Sampling

The HSE sampling strategy is not dissimilar to the GLF. The core sample was designed to be nationally representative of adults living in private households in England. Adults who live in institutions – such as University students, prisoners, the military, and people in residential care – are therefore excluded (**179**). The survey used a multi-stage stratified probability sampling design (**179**). The sampling frame for the survey was the small user PAF which covers over 99% of addresses in England (**179**). From the PAF, a random sample of PSUs based on postcode sectors was selected. Where a postcode sector contains fewer than 500 PAF addresses, these sectors were combined with an adjacent sector to form a PSU to avoid clustering of sampled addresses (**179**). To ensure the sampling is representative, it was stratified by the proportion of households in the 2001 Census with a head of household in a non-manual occupation, by local authority. PSUs were selected by sampling from this list at fixed intervals from a random starting point (**179**).

Selected PSUs were allocated a month of the year for data to be collected so that the data collection took place year-round. Within each of the selected PSUs, a random sample of addresses was selected from the PAF (**179**). At each address, all adults aged 16 and over were selected for the interview (up to a maximum of 10 adults), and up to two children.

5.5.2.2 Data collection

As in the GLF, each sampled address was sent an advance letter explaining the survey before an interviewer sought permission to interview (**179**). Data collection involved a face-to-face CAPI conducted by a specially trained interviewer (**179**). At eligible and co-operating households, information was collected at both household and individual level. The household questionnaire was conducted with the 'household reference person' and collected information on household size, composition and relationships, accommodation tenure and number of

bedrooms, economic status/occupation of household reference person, household income, smoking in the household, type of dwelling and area, and car ownership (**179**). The individual questionnaire conducted with all adults contained questions on general health and illness, fruit and vegetable consumption, physical activity, smoking, drinking in the past week, economic status/occupation and educational attainment, ethnicity, height and weight, and consent to linkage to NHS Central Register and Hospital Episodes Statistics (**179**).

In addition to the CAPI, there was a self-completion booklet for adults aged 18 and over about general health recently and on that day, and a similar booklet for young adults aged 16 and 17 which additionally contained questions about smoking and drinking alcohol (**179**). This is similar to the GLF booklet used for smoking and drinking in young adults, although the HSE booklet is more detailed. The interviewers had the option of using the booklet for 16 and 17 year olds with 18-24 year olds if they felt it would be difficult for the participant to answer the questions in the interview with family members present (**179**).

The HSE has collected information on adult alcohol consumption as part of the core survey interview since the survey began in 1991. The drinking questionnaire was revised between 1998 and 2003 to reflect the shift in Department of Health drinking recommendations from weekly drinking guidelines to daily recommended limits (**180**), with questions on weekly consumption being replaced by those on daily consumption; specifically, the heaviest drinking day in the last week. Number of drinking days in the week prior to the CAPI was also collected. Similar to the changes in the GLF, further revisions to the questionnaire took place in 2006 to account for the increase in the alcoholic strength (ABV) of wine and beer. In 2007 the questionnaire was amended to take wine glass size into consideration also, with options of 125ml, 175ml and 250ml replacing the assumption that glasses of wine were 125ml (**180**).

5.5.2.3 Weighting

The sample was weighted in order to match the general population. There were several stages of weighting in order to calculate the interview weight used in the analyses in this chapter. Firstly, dwelling selection weights were calculated to account for the small proportion (1%) of addresses in the PAF that contain more than one dwelling (**179**). Next, household selection weights were calculated for the small proportion of addresses in the PAF that contain more than one household (**179**). These two weights ensured that addresses containing more than one dwelling and/or household were not under-represented in the sample. Calibration weights were calculated to match the distribution of participants interviewed to mid-year population estimates for 2007 on sex, age and region (**179**). This adjusted for household non-response varying by these factors. Finally, a non-response weight was calculated for individual adults in co-operating

households who did not respond using a logistic regression model. The four weights together were combined to form an interview weight (**179**).

5.5.2.4 The 2008 survey

The 2008 survey was the 18th survey, and as with previous surveys asked participants a set of core questions, with modules of additional questions on topics which change from year-to-year. The focus of the additional modules of the 2008 survey was physical activity and fitness, with some of the associated additional modules completed among a sub-sample only (**179**). Questions on drinking in the past week form part of the core survey and therefore were included every year (**179**).

For the core sample, 16,056 addresses were selected at random in 1,176 PSUs/postcode sectors. 11.3% of selected addresses did not contain private households when visited by interviewers and were therefore excluded (**179**). Of all the households sampled, 64% (9,191) participated in at least some parts of the HSE 2008 (**179**). All the eligible adults and children in the household participated in 53% of sampled households (**179**). Among the estimated total number of adults in sampled households (estimated because the number of adults in households which did not co-operate is not known), the proportion interviewed was 58% (**179**). Response to the interview was higher among women than men (61% and 55% respectively) (**179**). Household response also varied by region - with 78% households in the North East responding compared with 54% in London - and by type of dwelling, with 68% detached households compared with 54% flats on the fourth floor or above responding (**179**). Households in which at least one adult was interviewed are known as co-operating households (**179**). Among co-operating households where at least one person was interviewed, the overall response rate was higher (88%), and the same pattern was observed for gender; with 92% women compared with 83% men in co-operating households responding to the interview (**179**). The response rate was higher in the final quarter of the year (68%, compared with 63% on average for the first three quarters), during which period a £5 gift voucher was included with the initial advance letter (**179**). In total, 15,102 adults were interviewed (**179**).

Compared with the Office for National Statistics mid-year population estimates, men were under-represented relative to women (45% men in the HSE compared with 49% in the mid-year population estimates) (**179**). By age group there were some slight differences between the survey and population estimates. Men under 35 were under-represented in the survey, and men over 55 were over-represented (**179**). Women aged under 25 were under-represented, and women over 65 were over-represented (**179**). As a result, survey interview weights were created to account for household selection and household and individual (within household) non-response (**179**).

5.5.2.5 Outcome measures

Adults aged 18 and over answered questions about alcohol consumption in the face-to-face CAPI conducted by a trained interviewer (**180**). As in the GLF 2008, young adults aged 16 and 17 answered questions about alcohol in a self-completion booklet (detailed in Section 5.5.2.2) (**180**). Information was collected on drinking frequency in the last year, as well as detailed information on alcohol consumption in the past week. This included number of drinking days in the last week, and - among those who drank in the last week – quantity of different types of alcohol drunk on the heaviest drinking day (**180**). In this chapter the total number of units consumed on the heaviest drinking day in the last week is used, with reference to the Department of Health drinking guidelines (see Section 2.3).

5.5.2.6 Key risk factors

As part of the main survey interview detailed socio-demographic information was collected. Key socio-demographic factors known to be risk or protective factors for alcohol consumption were selected for the analyses in this chapter. These were sex, age, region, equivalised household income quintile, and IMD 2007 quintile.

5.6 Methods

5.6.1 Revising alcohol consumption

As it has been shown that the missing units can be attributed wholly to under-reporting (Section 2.5.2), this chapter considers the implications of under-reporting to this extent for drinking above Department of Health drinking guidelines for England. Three drinking guidelines were used:

i. Drinking more than the weekly guidelines of 21 units for men and 14 units for women (the official drinking guideline from 1987-1995 (**17**)), also known as 'hazardous drinking'.
ii. Drinking more than the upper threshold of the recommended daily limit of no more than four units for men or three units for women on the heaviest drinking day in the last week (**17**).
iii. Drinking more than twice the recommended daily limits in one session: more than eight units for men or more than six units for women. This was the Department of Health in England's definition of binge drinking (**18**).

The GLF was used to explore weekly (hazardous) drinking, and the HSE was used to explore drinking above the upper threshold of the recommended daily limits, or twice the daily limits, on the heaviest drinking day in the last week. It would have been possible to use the GLF for the heaviest drinking day analyses, but the HSE was selected instead due to its more detailed

socio-demographic information (such as IMD). As both the HSE and GLF were nationally-representative, this does not have any impact on the results.

The HSE analyses concern drinking that took place in the last week only. Participants who do not drink alcohol - or who do drink alcohol but did not drink in the past week - are assumed not to have under-reported their consumption. Similarly, the GLF analyses concern drinking in an 'average' week (based on consumption in the previous 12 months), and where participants do not drink alcohol, they too are assumed not to have under-reported their consumption. Previous studies have identified that self-reported non-drinkers in longitudinal studies have reported drinking alcohol at previous survey waves (**181, 182**) and that abstainer categories are problematic (**145**), however assessing misclassification of self-reported non-drinkers who actually do drink alcohol was beyond the scope of this chapter, and indeed this thesis.

Reported alcohol consumption in the GLF was 12.2 units per week per adult aged 16 and over (**174**). Alcohol sales for the financial year 2008/9 were equivalent to 20.5 units per week per adult aged 16 and over (**170**), meaning that sales coverage for 2008 was 60%. The difference between reported consumption and sales can be attributed to under-reporting (see Section 2.5.2). Alcohol consumption in the GLF 2008 and HSE 2008 was revised to account for under-reporting to this extent, such that the total per capita alcohol consumption aligned with total per capita sales. This was done in three putative scenarios. Scenario one assumes an equal *proportion*[1] of under-reporting among all drinkers based on comparison of GLF with HMRC sales data (see Section 4.6). Scenario two assumes that heavy drinkers under-report proportionally more than light drinkers, based on the GLF/HMRC comparison and findings that recall accuracy is lower among heavier drinkers (see Section 2.6.7) (**135, 136**). On the advice of a senior statistician, Professor Allan Hackshaw at the UCL Cancer Institute, consumption tertiles were selected and attributed different levels of under-reporting. For scenario three, alcohol consumption as a proportion of alcohol sales was calculated by drink type using the GLF/HMRC comparison by drink type, as coverage varies greatly by drink type (see Section 4.8). A multiplier was created based on a participant's drink type on their heaviest drinking day in the last week. In the HSE this means that heaviest day consumption is revised with respect to heaviest day drink type, but in the GLF heaviest day drink type is used as an indicator of a participant's 'preferred' drink type. Where a participant drank a combination of drink types on their heaviest drinking day in the last week their consumption was revised using the global multiplier, which is the same as scenario 1. The three under-reporting scenarios created are summarised in Table 5.2. The scenarios were generated using the relevant multiplier so that alcohol consumption was revised with the aim of matching alcohol sales. Average weekly alcohol intake or heaviest drinking day in the last week was revised accordingly.

[1] Such that 3.00 reported units become 4.98 units, 6.00 reported units become 9.96, 9.00 reported units become 14.94 units, for example.

Table 5.2: Description of three under-reporting scenarios

	Scenario	Under-reporting level(s) assigned	Multiplying factor	GLF	HSE
1	Proportionate under-reporting	40% globally	x1.66	N=12,490	N=9,608
2	Under-reporting varying by consumption level	Alcohol consumption split into tertiles: T1 (lightest) = 20% T2 (middle) = 40% T3 (heaviest) = 60%	T1: x1.25 T2: x1.67 T3: x2.5	Average weekly drinking: T1 = consumed 0.1-1.5 units T2 = 1.5-12.0 units T3 12.0-289.0 units	Heaviest drinking day in the last week: T1 = consumed 0.1-3.0 units T2 = 3.0-6.0 units T3 = 6.0-82.0 units
3	Under-reporting varying by drink type	Globally (mixed drinks) = 40% Beer/cider only = 49% Wine only = 22% Spirits only = 60%	Globally = x1.66 Beer/cider = x1.97 Wine = x1.27 Spirits = x2.47	Proportion of participants in each group (n=9,256*): Global = 19% Beer/cider = 31% Wine = 37% Spirits = 13%	Proportion of participants in each group (n=9,608): Global = 21% Beer/cider = 31% Wine = 36% Spirits = 12%

**Plus a further 3,234 drinking adults who either did not drink in the last week or did not report their heaviest drinking day in the last week whose weekly consumption was revised using the global multiplier. Final proportions were equivalent to 40% global method, 23% beer, 27% wine, 9% spirits.*

Footnote to table: under-reporting levels were assigned based on comparisons between reported consumption and sales for 2008, in a similar way to Table 4.1.

5.6.2 Statistical analyses

The three under-reporting scenarios described in Table 5.2 were created in each of the two datasets. For each scenario and in the original survey - and stratified by gender due to the different guidelines for men and women - binary variables were created to designate whether a participant was above each of the three drinking guidelines; weekly, daily, and twice the daily limits. Each of the gender-specific variables was subsequently combined into one binary variable for both men and women. Participants who had not drunk alcohol were excluded from further analyses. Mean average weekly alcohol consumption and mean heaviest drinking day in the last week were calculated for the original surveys and each of the three revised scenarios.

Multivariate logistic regression was used to estimate the odds of drinking more than each of the three guidelines (weekly, daily, and twice the daily) in the original surveys and each of the three revised scenarios, controlling for sex, age, region, equivalised household income quintile, and IMD 2007 quintile (HSE only). As with the descriptive statistics, income and deprivation were investigated in quintiles. However, in the multivariate analysis, age was included as a

continuous variable in order to retain power while adjusting for age as a confounder when considering the other socio-economic factors. The reference categories used for the categorical variables were the North East for region, lowest income quintile, and least deprived quintile. These covariates were selected *a priori* because they are known risk or protective factors for alcohol consumption. All odds ratios presented are controlling for each of the other factors in the table and are also adjusted for complex survey design, as appropriate. All statistical analyses were completed in Stata version 12 (StataCorp, College Station, TX).

5.7 Results

5.7.1 Descriptive statistics

5.7.1.1 Mean consumption

5.7.1.1.1 Mean weekly alcohol intake in original survey and revised scenarios

Average weekly alcohol consumption was available for 12,490 adults (54% women) in England in the GLF 2008, from a total of 14,041 adults aged 16+ in England in the sample. Due to the multipliers used, each of the three revisions affects alcohol consumption estimates substantially for both men and women. Mean weekly alcohol consumption was particularly high in scenario two. If total mean weekly alcohol consumption is compared with sales, alcohol sales were exceeded by around 50% in scenario two. The tertiles used in scenario two led to an over-estimate of alcohol consumption, so the results from this scenario in particular must be treated with caution. Generally, the trends observed in the original survey were replicated in each of the revised scenarios. Higher weekly consumption was observed in middle aged adults compared with younger adults and older adults. Higher weekly consumption was also observed in the Northern regions of England compared with the Midlands and the South. A gradient was observed for income; with participants in higher-income households having higher weekly consumption than those in lower-income households. Mean weekly alcohol intake in the original survey and each of the three revised scenarios is shown in Table 5.3.

Table 5.3: Mean weekly alcohol consumption (units) among drinking adults in the GLF 2008 and three revised scenarios accounting for under-reporting, by sex, age, region and income.

	Men					Women				
	Original GLF 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base ('000s)	Original GLF 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base ('000s)
Total	16.9	28.0	40.5	29.4	16,800	8.6	14.3	19.9	13.3	19,300
Age (10 year bands)										
16-24	16.7	27.7	39.9	29.8	2,048	10.7	17.7	25.0	16.8	2,256
25-34	15.8	26.2	37.5	27.4	2,510	8.5	14.2	19.3	13.1	2,894
35-44	17.3	28.7	41.4	30.1	3,298	10.3	17.1	23.8	15.5	3,799
45-54	19.2	31.9	46.6	33.9	2,852	9.6	16.0	22.2	14.8	3,253
55-64	18.5	30.7	44.7	32.1	2,712	8.9	14.8	20.6	13.8	2,827
65-74	16.3	27.1	39.2	27.8	1,904	6.6	10.9	15.1	10.4	2,116
75+	10.9	18.1	25.8	18.5	1,444	3.8	6.3	8.4	6.2	2,131
Region*										
North East	18.4	30.5	44.3	32.6	769	10.7	17.7	25.1	16.7	927
North West	17.4	28.9	41.9	30.9	2,291	10.1	16.8	23.4	16.4	2,615
Yorkshire & Humber	20.2	33.6	49.0	36.0	1,782	10.2	17.0	23.8	15.8	2,017
East Midlands	15.6	25.9	37.4	27.1	1,545	8.7	14.4	19.8	13.6	1,663
West Midlands	15.2	25.2	36.2	27.2	1,812	7.0	11.6	15.7	10.7	2,115
East of England	16.1	26.7	38.4	27.6	2,033	6.9	11.5	15.4	10.5	2,163
London	15.4	25.5	37.3	26.1	2,052	8.0	13.3	18.7	12.1	2,634
South East	16.8	28.0	40.3	29.0	2,764	8.5	14.2	19.4	12.8	3,101
South West	17.6	29.2	42.1	30.1	1,703	8.8	14.6	20.6	13.4	2,023
Income quintile										
1 (lowest)	14.0	23.3	33.7	25.4	2,173	6.0	10.0	13.9	10.0	3,268
2	12.9	21.5	30.8	23.3	2,590	6.3	10.4	14.1	10.2	3,276
3	16.4	27.3	39.4	29.0	3,200	8.1	13.4	18.5	12.8	3,810
4	18.0	29.9	43.2	31.2	3,681	9.5	15.7	21.7	14.4	3,781
5 (highest)	20.8	34.5	50.2	35.1	3,900	12.2	20.3	28.5	18.2	3,647

** Government office region. Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type*

5.7.1.1.2 Mean heaviest drinking day in the last week in original survey and revised scenarios

Heaviest drinking day in the last week was available for 9,608 adults (50% women) in the HSE 2008. This is 99.3% of respondents who reported drinking alcohol in the last week, from a total of 15,102 adults aged 16+ in the sample. Again, alcohol consumption was affected substantially in each of the three revised scenarios. For the reasons explained previously (Section 5.7.1.1.1), particular caution needs to be taken interpreting scenario two as this scenario over-estimated alcohol consumption. As was observed for weekly consumption, similar patterns were observed in the original survey and the revised scenarios. However the nature of these patterns was slightly different. Mean alcohol consumption on the heaviest drinking day was greatest among those aged under 35, and was lowest in the oldest adults. The most alcohol was drunk on the heaviest drinking day among those living in the North of England. The relationship between heaviest day and income appears to be J-shaped; the poorest quintile consumed more alcohol than the second and third quintile, while the fourth and fifth quintile consumed more alcohol than the third. Among men, the richest two quintiles drank the most, while among women the poorest quintile drank slightly more. By deprivation, a gradient emerged whereby those in the most deprived area quintile drank the most on the heaviest drinking day, and the least deprived area quintile drank the least. Mean heaviest drinking day in the last week by sex, age, region, income and deprivation is shown in Table 5.4.

Table 5.4: Mean alcohol consumption on heaviest drinking day in the last week (units) among adults who drank in the last week in the HSE 2008 and three revised scenarios accounting for under-reporting, by sex, age, region, income and deprivation.

	Men					Women				
	HSE 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base	HSE 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base
Total	8.1	13.4	18.4	14.5	9,152	5.3	8.8	11.1	8.6	9,423
Age (10 year bands)										
16-24	11.8	19.6	28.3	21.8	1,137	8.1	13.4	18.7	14.4	1,091
25-34	10.0	16.7	23.6	17.9	1,213	6.5	10.7	14.3	10.6	1,216
35-44	8.8	14.6	20.4	15.9	1,416	5.6	9.4	12.1	9.1	1,433
45-54	8.0	13.2	18.2	14.3	1,211	5.1	8.5	10.5	8.0	1,233
55-64	6.1	10.1	13.1	10.8	1,087	4.4	7.3	8.6	6.8	1,124
65-74	5.2	8.6	10.7	9.1	726	2.8	4.7	4.7	4.4	800
75+	3.2	5.2	5.6	5.5	540	2.3	3.9	3.7	3.7	785
Region*										
North East	11.2	18.5	26.6	20.6	481	6.3	10.5	14.0	11.2	474
North West	9.2	15.3	21.5	16.6	1,212	6.1	10.1	13.2	10.0	1,309
Yorkshire & Humber	8.3	13.8	19.2	15.2	896	5.7	9.5	12.4	9.5	990
East Midlands	7.7	12.8	17.6	13.8	795	5.1	8.5	10.8	8.3	814
West Midlands	7.8	13.0	17.8	14.3	954	5.0	8.3	10.4	8.1	997
East of England	7.5	12.4	16.8	13.2	1,044	5.0	8.4	10.5	8.2	1,027
London	7.8	12.9	17.7	14.0	1,341	4.8	8.0	9.9	7.9	1,318
South East Coast	6.8	11.3	15.2	11.8	755	4.8	7.9	9.6	7.3	775
South Central	7.3	12.1	16.4	13.0	757	4.9	8.2	10.1	7.8	754
South West	7.7	12.8	17.4	13.8	917	5.0	8.2	10.3	7.7	967
Equivalised household income quintile										
1 (lowest)	8.5	14.1	19.6	15.9	1,240	5.8	9.6	12.7	10.2	1,465
2	7.0	11.6	15.6	12.9	1,436	5.5	9.2	11.9	9.5	1,589
3	7.6	12.6	17.2	13.8	1,469	5.2	8.7	10.9	8.4	1,499
4	8.9	14.8	20.6	15.8	1,597	5.3	8.7	11.0	8.4	1,530
5 (highest)	8.8	14.6	20.3	15.2	1,669	5.4	9.0	11.3	8.3	1,474
IMD quintile										
1 (least deprived)	7.6	12.6	17.1	13.1	1,930	4.7	7.8	9.6	7.2	2,007
2	7.7	12.8	17.6	13.7	1,772	5.3	8.8	11.2	8.3	1,795
3	8.0	13.3	18.3	14.3	1,802	5.1	8.4	10.5	8.2	1,870
4	8.6	14.2	19.8	15.8	1,824	5.6	9.2	11.9	9.3	1,877
5 (most deprived)	8.7	14.5	20.1	16.3	1,824	6.1	10.2	13.5	10.8	1,874

** Strategic Health Authority region. Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type*

5.7.1.2 Drinking with reference to Department of Health drinking guidelines

5.7.1.2.1 Drinking more than the weekly limits (>21/14 units)

The estimated proportions of adults drinking more than the weekly guidelines in an average week (based on their consumption in the previous 12 months) in the original GLF and the three revised scenarios are shown in Table 5.5. In the original GLF, approximately 30% men and 20% women drank above these guidelines. In the revised scenarios, these estimates increased by more than 10% points, to over 40% of men and 30% of women.

5.7.1.2.1.1 Age

Among men, the percentage increase in each age group in the revised scenarios was between 10-20% points, such that over half of 45-54 year olds drank above the weekly limits in all three scenarios. Among women, the increase in the proportion drinking above the weekly guidelines was around 10% points (identical in scenarios one and two), except for among the youngest and oldest age groups, who experienced a smaller increase of less than 10% points.

5.7.1.2.1.2 Region

The estimated prevalence drinking above the weekly limits increased in men by between 10-20% points in the revised scenarios in most regions. In the North East, North West, Yorkshire & Humber and the East Midlands, the estimated prevalence of drinking above the weekly guidelines among men was close to 50% in all three revised scenarios. Among women, the estimated prevalence of drinking more than the weekly guidelines increased by between 10-20% points in most regions in scenarios one and two. In the North East, North West, and Yorkshire & The Humber over one-third of women drank above the weekly limits in all three scenarios.

5.7.1.2.1.3 Income

Among men, there was little pattern in the increase in the estimated prevalence of drinking above the weekly limits, with the revised scenarios leading to a 10-20% point increase in most groups. In the highest income quintile, the estimated prevalence of drinking more than the weekly limits among men was between 55 and 60% in the three revised scenarios. In women, the lowest two income quintiles experienced a smaller increase of less than 10% points, and most of the higher income quintiles experienced an increase of between 10-20% points. In the highest quintile, the estimated prevalence of drinking more than the weekly limits in women was around 45% in all three scenarios.

Table 5.5: Proportion of drinkers who drank above the weekly guidelines (>21/14 units) in an average week in the GLF 2008 and three revised scenarios accounting for under-reporting, by age, region and income.

	Men					Women				
	GLF 2008 % >21/14	Scenario 1 % >21/14	Scenario 2 % >21/14	Scenario 3 % >21/14	weighted base ('000s)	GLF 2008 % >21/14	Scenario 1 % >21/14	Scenario 2 % >21/14	Scenario 3 % >21/14	weighted base ('000s)
Total	28	43	44	43	16,800	21	32	32	30	19,300
Age (10 year bands)										
16-24	27	40	41	42	2,048	25	35	35	33	2,256
25-34	25	42	43	42	2,510	20	35	35	31	2,894
35-44	30	45	46	44	3,298	24	37	37	33	3,799
45-54	33	49	50	49	2,852	25	37	37	36	3,253
55-64	31	46	48	46	2,712	22	32	32	29	2,827
65-74	27	42	42	40	1,904	16	25	25	25	2,116
75+	19	31	32	29	1,444	9	15	15	16	2,131
Region*										
North East	30	45	47	47	769	25	39	39	36	927
North West	31	44	46	46	2,291	25	39	39	36	2,615
Yorkshire & Humber	32	47	48	49	1,782	25	35	35	34	2,017
East Midlands	27	46	47	46	1,545	19	32	32	29	1,663
West Midlands	25	42	42	42	1,812	17	27	27	26	2,115
East of England	25	42	42	39	2,033	17	28	28	26	2,163
London	26	39	40	38	2,052	19	28	28	26	2,634
South East	29	42	45	41	2,764	20	32	32	29	3,101
South West	33	44	45	44	1,703	23	31	31	30	2,023
Gross household income quintile										
1 (lowest)	22	33	33	33	2,173	14	21	21	20	3,268
2	21	32	33	32	2,590	14	22	22	22	3,276
3	27	42	43	42	3,200	19	31	31	28	3,810
4	31	46	48	45	3,681	25	37	37	36	3,781
5 (highest)	37	56	57	55	3,900	31	47	47	42	3,647

** Government office region. Colours denote percentage change from the original HSE: yellow/light grey = <10% increase, orange/mid-grey = 10-20% increase, red/dark grey = >20% increase.*
Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type

5.7.1.2.2 Drinking more than the daily limits (>4/3 units)

The estimated prevalence of drinking more than the daily limits on the heaviest drinking day in the last week in the original HSE 2008 and three revised scenarios is shown in Table 5.6. In the original HSE, 58% men who drank in the last week drank more than the daily limits on their heaviest drinking day. In the revised scenarios, this increased approximately 20% points such that the estimated prevalence was around three-quarters. In the original HSE 55% women drank more than the daily limits on their heaviest drinking day in the last week. In the revised scenarios, the estimated prevalence increased between 10 and 26% points.

5.7.1.2.2.1 Age

Among men, the oldest two age groups experienced the greatest percentage increase in drinking above the daily limits, at over 20% points. Younger age groups generally experienced an increase of around 10-20% points. Among men under age 55, the estimated prevalence of drinking above the daily limits was around 80% in each of the three revised scenarios. Among women, scenario one had the greatest effect, with all groups aged over 35 experiencing an increase in the estimated prevalence of drinking above the daily limits of 20% points or more. The estimated prevalence of drinking more than the daily limits was over 70% among women aged less than 55 in all three revised scenarios.

5.7.1.2.2.2 Region

Among men, the change in the estimated prevalence of drinking above the daily limits was greatest in scenario three, increasing by over 20% points in six regions. The region where the estimated prevalence of drinking above the daily limits was highest was the North East, at over 80% in all three scenarios. Among women, scenario one had the greatest effect – with the estimated prevalence of drinking more than the daily limits increasing by at least 20% in each region - and scenario two the smallest effect. In scenario one, the estimated prevalence of drinking more than the daily limits among women exceeded 80% in five of the ten regions in England.

5.7.1.2.2.3 Income

The estimated prevalence of drinking more than the daily limits among men increased by 10-20% points in most income quintiles in all three scenarios. Among women, scenario one had the greatest effect again, with the estimated prevalence of drinking more than the daily limits increasing in all income groups by at least 20% points. Scenarios one and two for women represent increasing polarisation in the estimated prevalence of drinking more than the daily limits on the heaviest drinking day in the last week.

5.7.1.2.2.4 Deprivation

Among men, the change in the estimated prevalence of drinking above the daily limits displays no clear pattern by IMD in the three revised scenarios. In all three revised scenarios, the estimated prevalence of drinking above the daily limits was around 75% in each IMD quintile. Among women, the estimated prevalence of drinking more than the daily limits increased by more than 20% points in each IMD quintile in scenario one, but less so in scenarios two and three. For both genders, the weak association between IMD and drinking above the daily limits remained.

Table 5.6: Proportion of drinkers who drank above the daily guidelines (>4/3 units) on the heaviest drinking day in the last week in the HSE 2008 and three revised scenarios accounting for under-reporting, by sex, age, region, income and deprivation.

	Men					Women				
	HSE 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base	GLF 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base
Total	58	76	73	77	5,149	55	80	65	71	4,379
Age (10 year bands)										
16-24	70	83	80	87	649	71	85	79	85	540
25-34	66	80	78	81	880	64	83	72	76	687
35-44	65	81	78	82	1,030	61	84	71	76	904
45-54	61	79	77	80	915	60	85	70	77	818
55-64	51	73	71	73	825	51	81	61	70	717
65-74	43	67	65	69	498	29	68	43	53	380
75+	21	45	42	49	352	17	57	28	38	333
Region*										
North East	71	85	83	86	301	64	86	72	81	242
North West	65	81	79	83	687	62	84	70	77	629
Yorkshire & Humber	64	80	77	81	534	58	78	66	72	479
East Midlands	58	75	74	78	446	53	82	64	72	385
West Midlands	58	77	75	80	565	51	78	62	69	489
East of England	54	73	71	75	596	55	80	65	72	469
London	54	72	69	77	598	51	77	63	68	472
South East Coast	50	68	67	67	447	52	82	64	70	375
South Central	52	72	69	73	421	52	78	61	68	349
South West	53	73	71	73	555	51	79	60	67	489
Equivalised household income quintile										
1 (lowest)	53	72	69	74	519	56	80	63	73	475
2	52	71	69	74	671	55	80	64	72	630
3	54	73	71	75	777	54	78	63	69	672
4	65	79	76	80	1,028	58	81	68	73	840
5 (highest)	64	82	80	82	1,213	58	85	71	76	948
IMD quintile										
1 (least deprived)	55	75	73	74	1,200	52	79	62	68	1,096
2	58	74	71	75	1,114	56	83	66	72	952
3	58	76	74	78	1,059	52	79	63	70	909
4	59	76	74	80	979	56	81	66	74	765
5 (most deprived)	60	78	76	80	796	60	80	67	75	656

** Strategic Health Authority region. Colours denote percentage change from the original HSE: yellow/light grey = <10% increase, orange/mid-grey = 10-20% increase, red/dark grey = >20% increase.*
Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type

5.7.1.2.3 Drinking more than twice the recommended daily limits (>8/6 units)

The proportion of men and women drinking more than twice the daily limits on their heaviest drinking day in the last week in the original HSE and three revised scenarios is shown in Table 5.7. In the original HSE, 32% men and 26% women who drank in the last week drank more than twice the daily limits on their heaviest drinking day. In the three revised scenarios, the estimated prevalence in both genders was over 50% (with the exception of women in scenario three). The revised prevalence of drinking more than double the daily limits is similar to the original prevalence of drinking more than the daily limits themselves (see Table 5.6). For drinking more than double the daily limits, it is a coincidence that scenarios one and two are identical (the syntax has been checked).

5.7.1.2.3.1 Age

The estimated prevalence of drinking more than twice the daily limits increased by over 20% points among men aged 45-74 years in scenarios one and two, and among 55-74 year olds in scenario three. In all three scenarios, at the estimated prevalence of drinking more than twice the daily limits among men was at least 60%. Among women, the estimated prevalence of drinking more than twice the daily limits increased by over 20% points in 16-74 year olds in scenarios one and two, but less so in scenario three. In all three scenarios, the estimated prevalence of drinking more than twice the daily limits among women aged 16-44 was at least 50%.

5.7.1.2.3.2 Region

The estimated prevalence of drinking more than twice the daily limits increased by at least 20% points in roughly half of regions in England in all three revised scenarios. The estimated prevalence of drinking more than twice the daily limits was approximately 60% among men in the North East, North West and Yorkshire & the Humber in all three scenarios. Among women, the estimated prevalence of drinking more than twice the daily limits increased by at least 20% points in every region in scenarios one and two, but only four regions were affected to this extent in scenario three. In the North East and North West, the estimated prevalence of drinking more than twice the daily limits among women was over 60% in scenarios one and two.

5.7.1.2.3.3 Income

Among men in the highest two quintiles, the estimated prevalence of drinking more than twice the daily limits increased by more than 20% points in scenarios one and two. In the three revised scenarios, the estimated prevalence of drinking more than twice the daily limits was close to 50% among men in the lowest three income quintiles, and close to 60% among men in the highest two quintiles. In scenarios one and two, the estimated prevalence of drinking more than twice the daily limits among women increased by at least 20% points in all income

quintiles. In the top two quintiles this increase was over 30% points. In scenarios one and two, the estimated prevalence of drinking more than twice the daily limits among women was over 50% in all income groups.

5.7.1.2.3.4 Deprivation

For IMD an opposing trend was observed to that for income in men. The estimated prevalence of drinking more than twice the daily limits among men in the two most deprived quintiles increased by approximately 20% points in all three scenarios. This slightly exaggerated the graded association between drinking more than twice the daily limits and deprivation, particularly in scenario three. Among women, the estimated prevalence of drinking more than twice the daily limits increased by more than 20% points in all income quintiles in scenarios one and two. In scenario three, only the two most deprived quintiles are affected to this extent. Therefore as was seen for men, scenario three exaggerated the graded association between drinking more than twice the daily limits and deprivation.

Table 5.7: Proportion of drinkers who drank more than twice the daily limits (>8/6 units) on their heaviest drinking day in the last week in the HSE 2008 and three revised scenarios accounting for under-reporting, by age, region, income and deprivation.

	Men					Women				
	HSE 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base	HSE 2008	Scenario 1	Scenario 2	Scenario 3	Weighted base
Total	35	54	54	54	5,149	27	54	54	46	4,379
Age (10 year bands)										
16-24	52	67	67	70	649	50	70	70	70	540
25-34	46	64	64	64	880	37	63	63	56	687
35-44	41	60	60	61	1,030	31	61	61	49	904
45-54	37	58	58	55	915	24	60	60	50	818
55-64	24	48	48	46	825	19	51	51	40	717
65-74	15	39	39	38	498	5	29	29	20	380
75+	4	19	19	17	352	3	17	17	11	333
Region*										
North East	49	69	69	68	301	36	63	63	59	242
North West	41	62	62	62	687	31	62	62	54	629
Yorkshire & Humber	40	60	60	60	534	31	58	58	50	479
East Midlands	35	54	54	53	446	28	53	53	46	385
West Midlands	34	55	55	55	565	26	50	50	44	489
East of England	33	51	51	50	596	24	54	54	45	469
London	32	51	51	51	598	22	50	50	41	472
South East Coast	28	46	46	44	447	20	51	51	39	375
South Central	30	48	48	48	421	24	52	52	45	349
South West	29	50	50	49	555	25	51	51	39	489
Equivalised household income quintile										
1 (lowest)	33	51	51	52	519	33	56	56	50	475
2	29	48	48	49	671	29	55	55	48	630
3	31	50	50	51	777	25	53	53	46	672
4	40	61	61	60	1,028	27	57	57	47	840
5 (highest)	40	60	60	58	1,213	27	58	58	47	948
IMD quintile										
1 (least deprived)	32	50	50	49	1,200	23	52	52	40	1,096
2	35	54	54	52	1,114	27	56	56	45	952
3	34	55	55	54	1,059	25	51	51	43	909
4	36	55	55	57	979	29	56	56	50	765
5 (most deprived)	37	58	58	59	796	33	59	59	55	656

** Strategic Health Authority region. Colours denote percentage change from the original HSE: yellow/light grey = <10% increase, orange/mid-grey = 10-20% increase, red/dark grey = >20% increase. Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type*

5.7.2 Multivariate analyses

Multivariate logistic regression was used to calculate the odds of drinking more than the thresholds specified - for weekly limits, daily limits and twice the daily limits - in the original surveys and the three revised scenarios. All odds ratios are mutually adjusted (for the other factors presented in the table) and take account of complex survey design, as appropriate. Changes to the significant risk factors for drinking above these limits were investigated.

5.7.2.1 Drinking more than the weekly guidelines (>21/14 units)

5.7.2.1.1 Age and sex

The odds of drinking more than the weekly guidelines in the original GLF and the three revised scenarios are shown in Table 5.8. In the original GLF, women had significantly lower odds than men of drinking more than the weekly guidelines (OR 0.69, P<0.001). In the three revised scenarios, this remains significant with between a 36% and 42% lower odds among women (P<0.001 in each case). In the original GLF, for a one year increase in age, there was no significant association between age and drinking more than the weekly guidelines. This became highly significant in all three revised scenarios (not evident from the OR 1.00 due to 1 year units used, but P<0.006 in each case).

5.7.2.1.2 Region

In the original GLF, those in the North West, Yorkshire & the Humber, and the South West had equal odds of drinking more than the weekly guidelines to those in the North East. Those in the East Midlands, West Midlands, the South East and London experienced 27-35% lower odds of drinking more than the weekly guidelines than participants in the North East (P<0.027), and those in the East of England had 41% lower odds of drinking above the weekly guidelines than participants in the North East (P<0.001). In the three revised scenarios, those in the South West were of borderline significance in experiencing lower odds than the North East, at between 22% and 24% lower odds of drinking more than the weekly guidelines than those in the North East (P<0.057).

5.7.2.1.3 Income

In the original GLF, those in the highest three income quintiles had significantly higher odds of drinking more than the weekly guidelines than those in the poorest (P<0.006 in each case), and a graded association was evident, with those in the highest quintile 143% greater odds, in the fourth quintile 74% greater odds, and in the third quintile 34% greater odds of drinking above the weekly guidelines. Those in the highest three income quintiles retained significantly higher odds of drinking more than the weekly guidelines than those in the poorest quintile in all three

revised scenarios (P<0.001 in each case). The same relationship between drinking above the weekly guidelines and income was observed in scenarios two and three.

Table 5.8: Odds of average weekly alcohol intake >21/14 units in GLF 2008 and three revised scenarios

	GLF 2008					Scenario 1					Scenario 2					Scenario 3				
	OR	95% CI			P		OR	95% CI			P		OR	95% CI			P		OR	95% CI			P	
Sex (female)	0.69	0.63	-	0.75	0.000	***	0.64	0.59	-	0.69	0.000	***	0.61	0.56	-	0.65	0.000	***	0.58	0.54	-	0.63	0.000	***
Age (1 yr incr.)	1.00	0.99	-	1.00	0.062	ns	1.00	0.99	-	1.00	0.006	**	1.00	0.99	-	1.00	0.004	**	1.00	0.99	-	1.00	0.006	**
Region†																								
North East	1.00						1.00						1.00						1.00					
North West	1.00	0.75	-	1.33	0.980	ns	0.96	0.74	-	1.24	0.747	ns	0.96	0.75	-	1.23	0.743	ns	0.97	0.76	-	1.24	0.819	ns
Yorkshire & Humber	0.95	0.70	-	1.28	0.725	ns	0.92	0.71	-	1.18	0.512	ns	0.91	0.71	-	1.16	0.458	ns	0.92	0.72	-	1.17	0.492	ns
East Midlands	0.71	0.53	-	0.96	0.025	*	0.77	0.59	-	0.99	0.042	*	0.77	0.60	-	0.99	0.042	*	0.76	0.59	-	0.97	0.028	*
West Midlands	0.69	0.51	-	0.94	0.020	*	0.72	0.55	-	0.95	0.019	*	0.71	0.54	-	0.92	0.010	**	0.71	0.55	-	0.91	0.008	**
East of England	0.59	0.44	-	0.80	0.001	**	0.62	0.48	-	0.80	0.000	***	0.61	0.47	-	0.78	0.000	***	0.58	0.45	-	0.75	0.000	***
London	0.65	0.48	-	0.89	0.008	*	0.60	0.45	-	0.79	0.000	***	0.59	0.45	-	0.78	0.000	***	0.56	0.43	-	0.73	0.000	***
South East	0.73	0.55	-	0.96	0.027	*	0.69	0.54	-	0.88	0.003	**	0.71	0.56	-	0.90	0.004	**	0.65	0.51	-	0.82	0.000	***
South West	0.97	0.71	-	1.31	0.819	ns	0.77	0.59	-	1.01	0.056		0.76	0.59	-	0.99	0.042	*	0.78	0.61	-	1.01	0.057	
Income quintile																								
1 (lowest)	1.00						1.00						1.00						1.00					
2	0.96	0.79	-	1.18	0.731	ns	1.04	0.87	-	1.25	0.652	ns	1.05	0.88	-	1.26	0.584	ns	1.04	0.87	-	1.25	0.668	ns
3	1.34	1.09	-	1.65	0.006	**	1.56	1.30	-	1.87	0.000	***	1.57	1.31	-	1.88	0.000	***	1.47	1.23	-	1.76	0.000	***
4	1.74	1.43	-	2.10	0.000	***	1.97	1.65	-	2.34	0.000	***	2.00	1.68	-	2.39	0.000	***	1.86	1.56	-	2.21	0.000	***
5 (highest)	2.43	1.99	-	2.97	0.000	***	2.98	2.48	-	3.59	0.000	***	3.03	2.52	-	3.65	0.000	***	2.72	2.27	-	3.25	0.000	***

*Odds ratios from logistic regression accounting for complex survey design and using the survey weight, mutually adjusted. N=12,490 drinking adults. OR = odds ratio, CI = confidence interval, P=p-value, *=p<0.05, **=p<0.01, ***=p<0.001, † Government office region*

Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type

5.7.2.2 Drinking more than the recommended limits (>4/3 units)

5.7.2.2.1 Age and sex

The odds of drinking more than the recommended daily limits on the heaviest drinking day in the last week in the original HSE and the three revised scenarios are shown in Table 5.9. In the original HSE, women who drank alcohol in the last week had significantly lower odds than men of drinking more than the daily limits on their heaviest drinking day (OR 0.90, P=0.020). In scenario one, women had significantly *higher* odds than men of drinking more than the daily limits (OR 1.38, P<0.001), however in scenarios two and three the results were similar to the original HSE (ORs 0.67-0.75, P<0.001 in each case). In the original HSE, for a one year increase in age, there was a 3% reduction in the odds of drinking more than the daily limits on the heaviest drinking day in the last week (P<0.001). In each of the three revised scenarios, the relationship between age and drinking more than the daily limits was similar (ORs 0.97-0.98, P<0.001 in each case).

5.7.2.2.2 Region

In the original HSE, most regions in England had significantly lower odds of drinking above the daily limits on their heaviest drinking day in the last week than the North East, with the exceptions of the North West and Yorkshire & the Humber. Those in the regions with lower odds experienced between 32% and 49% lower odds of drinking above the daily limits than those in the North East (P<0.008 in each case). In the three revised scenarios, the ORs become slightly - although not significantly – lower than the original HSE, and those in Yorkshire & the Humber had significantly lower odds of drinking above the daily limits than those in the North East.

5.7.2.2.3 Income

For income, in the original HSE there was a graded association between income quintile and odds of drinking more than the daily limits on the heaviest drinking day in the last week. Those in the highest two quintiles had significantly higher odds of drinking above this level than those in the poorest quintile, with 35% and 38% greater odds respectively (P<0.003 in both cases). In scenarios one and two, the top two quintiles remained at significantly greater odds of drinking above the daily limits, and the OR for the highest quintile was slightly although not significantly elevated. In scenario three, the odds of drinking above the daily limits were similar to those in the original HSE, although the second highest quintile was no longer significant.

5.7.2.2.4 Area deprivation

In the original HSE and all three revised scenarios, those in the most deprived quintile had the highest odds of drinking more than the recommended limits on the heaviest drinking day in the

last week. However this was not significantly different from the other quintiles with the exception of scenario three (OR 1.27, P=0.031).

Table 5.9: Odds of drinking above daily limits on the heaviest drinking day in the last week in HSE 2008 and three revised scenarios

	HSE 2008						Scenario 1						Scenario 2						Scenario 3					
	OR	95% CI			P		OR	95% CI			P		OR	95% CI			P		OR	95% CI			P	
Sex (female)	0.90	0.82	-	0.98	0.020	*	1.38	1.24	-	1.52	0.000	***	0.67	0.61	-	0.74	0.000	***	0.75	0.68	-	0.83	0.000	***
Age (1 yr incr.)	0.97	0.97	-	0.97	0.000	***	0.98	0.97	-	0.98	0.000	***	0.97	0.97	-	0.98	0.000	***	0.97	0.97	-	0.98	0.000	***
Region†																								
North East	1.00						1.00						1.00						1.00					
North West	0.92	0.70	-	1.21	0.559		0.87	0.63	-	1.20	0.395		0.86	0.64	-	1.15	0.305		0.88	0.65	-	1.18	0.389	
Yorkshire & Humber	0.82	0.62	-	1.10	0.185		0.68	0.49	-	0.95	0.024	*	0.73	0.54	-	0.99	0.042	*	0.72	0.52	-	0.99	0.045	*
East Midlands	0.68	0.51	-	0.90	0.008	**	0.71	0.49	-	1.03	0.074		0.71	0.51	-	0.99	0.042	*	0.69	0.50	-	0.97	0.034	*
West Midlands	0.64	0.48	-	0.86	0.003	**	0.62	0.44	-	0.88	0.007	**	0.66	0.49	-	0.91	0.010	**	0.66	0.48	-	0.92	0.015	*
East of England	0.56	0.42	-	0.75	0.000	***	0.54	0.39	-	0.75	0.000	***	0.55	0.41	-	0.75	0.000	***	0.55	0.40	-	0.76	0.000	***
London	0.51	0.38	-	0.69	0.000	***	0.46	0.32	-	0.66	0.000	***	0.50	0.36	-	0.69	0.000	***	0.48	0.35	-	0.67	0.000	***
South East Coast	0.51	0.38	-	0.71	0.000	***	0.50	0.35	-	0.71	0.000	***	0.53	0.38	-	0.75	0.000	***	0.44	0.31	-	0.62	0.000	***
South Central	0.51	0.38	-	0.69	0.000	***	0.50	0.34	-	0.72	0.000	***	0.50	0.35	-	0.70	0.000	***	0.51	0.36	-	0.72	0.000	***
South West	0.57	0.43	-	0.76	0.000	***	0.54	0.39	-	0.76	0.000	***	0.55	0.41	-	0.75	0.000	***	0.49	0.36	-	0.67	0.000	***
Income quintile																								
1 (lowest)	1.00						1.00						1.00						1.00					
2	1.05	0.87	-	1.26	0.638		1.06	0.86	-	1.31	0.576		1.09	0.89	-	1.33	0.398		1.04	0.85	-	1.28	0.689	
3	1.09	0.89	-	1.32	0.414		1.07	0.87	-	1.31	0.515		1.12	0.92	-	1.37	0.261		1.00	0.82	-	1.23	0.977	
4	1.35	1.11	-	1.65	0.003	**	1.31	1.06	-	1.62	0.013	*	1.34	1.09	-	1.64	0.005	**	1.19	0.96	-	1.47	0.105	
5 (highest)	1.38	1.14	-	1.68	0.001	**	1.70	1.37	-	2.10	0.000	***	1.64	1.34	-	2.01	0.000	***	1.46	1.18	-	1.79	0.000	***
IMD quintile																								
1 (least deprived)	1.00						1.00						1.00						1.00					
2	1.12	0.95	-	1.31	0.173		1.08	0.90	-	1.29	0.399		1.09	0.92	-	1.29	0.311		1.15	0.97	-	1.36	0.114	
3	0.93	0.79	-	1.10	0.378		0.96	0.79	-	1.16	0.652		0.96	0.81	-	1.14	0.637		1.04	0.87	-	1.25	0.679	
4	1.03	0.86	-	1.24	0.741		1.02	0.83	-	1.26	0.836		1.02	0.84	-	1.25	0.810		1.21	0.98	-	1.48	0.079	
5 (most deprived)	1.14	0.95	-	1.37	0.173		1.17	0.93	-	1.46	0.174		1.21	0.98	-	1.48	0.074		1.27	1.02	-	1.57	0.031	*

*Odds ratios from logistic regression accounting for complex survey design and using the interview weight, mutually adjusted. N=9,608 drinking adults. OR = odds ratio, CI = confidence interval, *=p<0.05, **=p<0.01 ***=p<0.001, † Strategic Health Authority region.*

Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type

5.7.2.3 Drinking more than twice the recommended daily limits (>8/6 units)

5.7.2.3.1 Age and sex

The odds of drinking more than twice the daily limits on the heaviest drinking day in the last week in the original HSE and the three revised scenarios are shown in Table 5.10. Scenarios one and two are identical to one another and this is the result of coincidence. In the original HSE, women had significantly lower odds than men of drinking more than twice the daily limits on their heaviest drinking day in the last week (OR 0.66, P<0.001). In scenarios one and two, women equal odds to men of drinking more than twice the daily limits (OR 1.02, P=0.598 in both cases). Scenario three was similar to the original HSE, with women having significantly lower odds of drinking more than twice the daily limits than men (OR 0.72, P<0.001). As was observed for drinking more than the weekly guidelines and the daily limits, with a one year increase in age the odds of drinking more than twice the daily limits decreased slightly in both the original HSE (OR 0.96, P<0.001) and the three revised scenarios (OR 0.97, P<0.001 in each case).

5.7.2.3.2 Region

In the original HSE, those in all regions except the North West and Yorkshire & the Humber had significantly lower odds of drinking more than twice the daily limits on their heaviest drinking day than those in the North East, with between 30% and 55% lower odds (P<0.017 in each case). In the three revised scenarios, the pattern was similar to the original HSE.

5.7.2.3.3 Income

For income, in the original HSE none of the income quintiles were significantly different to the lowest quintile for drinking more than twice the daily limits. In scenarios one and two, the highest two income quintiles had significantly higher odds of drinking more than twice the daily limits than the lowest quintile, with between 29% and 33% higher odds (P<0.012 in each case). The ORs were slightly - although not significantly - higher in scenarios one and two than in scenario three.

5.7.2.3.4 Area deprivation

In the original HSE there was no association between drinking more than twice the daily limits and deprivation. This was maintained in scenarios one and two. In scenario three, the two most deprived quintiles had significantly higher odds of drinking more than twice the daily limits than the least deprived quintile (ORs 1.21 and 1.36, P=0.034 and 0.002).

Table 5.10: Odds of drinking more than twice the daily limits on the heaviest drinking day in the last week in HSE 2008 and three revised scenarios

	HSE 2008					Scenario 1					Scenario 2					Scenario 3				
	OR	95% CI			P		OR	95% CI			P		OR	95% CI			P		OR	95% CI			P	
Sex (female)	0.66	0.60	-	0.72	0.000	***	1.02	0.94	-	1.12	0.598		1.02	0.94	-	1.12	0.598		0.72	0.66	-	0.79	0.000	***
Age (1 yr incr.)	0.96	0.96	-	0.96	0.000	***	0.97	0.97	-	0.97	0.000	***	0.97	0.97	-	0.97	0.000	***	0.97	0.96	-	0.97	0.000	***
Region†																								
North East	1.00						1.00						1.00						1.00					
North West	0.86	0.66	-	1.13	0.270		0.93	0.71	-	1.21	0.597		0.93	0.71	-	1.21	0.597		0.93	0.73	-	1.18	0.541	
Yorkshire & Humber	0.82	0.62	-	1.10	0.183		0.80	0.61	-	1.06	0.119		0.80	0.61	-	1.06	0.119		0.79	0.62	-	1.01	0.065	
East Midlands	0.70	0.52	-	0.94	0.017	*	0.67	0.51	-	0.89	0.005	**	0.67	0.51	-	0.89	0.005	**	0.68	0.53	-	0.88	0.003	***
West Midlands	0.62	0.46	-	0.84	0.002	***	0.63	0.47	-	0.84	0.002	***	0.63	0.47	-	0.84	0.002	***	0.66	0.51	-	0.85	0.001	***
East of England	0.54	0.40	-	0.71	0.000	***	0.55	0.42	-	0.73	0.000	***	0.55	0.42	-	0.73	0.000	***	0.56	0.44	-	0.71	0.000	***
London	0.50	0.36	-	0.68	0.000	***	0.51	0.38	-	0.68	0.000	***	0.51	0.38	-	0.68	0.000	***	0.51	0.40	-	0.66	0.000	***
South East Coast	0.45	0.33	-	0.62	0.000	***	0.50	0.37	-	0.68	0.000	***	0.50	0.37	-	0.68	0.000	***	0.47	0.35	-	0.62	0.000	***
South Central	0.50	0.37	-	0.68	0.000	***	0.51	0.38	-	0.69	0.000	***	0.51	0.38	-	0.69	0.000	***	0.55	0.42	-	0.72	0.000	***
South West	0.57	0.42	-	0.76	0.000	***	0.58	0.44	-	0.77	0.000	***	0.58	0.44	-	0.77	0.000	***	0.55	0.43	-	0.70	0.000	***
Income quintile																								
1 (lowest)	1.00						1.00						1.00						1.00					
2	0.91	0.73	-	1.14	0.431		1.01	0.84	-	1.21	0.942		1.01	0.84	-	1.21	0.942		1.02	0.83	-	1.24	0.863	
3	0.90	0.72	-	1.12	0.342		1.03	0.85	-	1.25	0.784		1.03	0.85	-	1.25	0.784		1.02	0.82	-	1.26	0.872	
4	1.07	0.87	-	1.33	0.516		1.29	1.06	-	1.56	0.012	**	1.29	1.06	-	1.56	0.012	**	1.18	0.96	-	1.46	0.122	
5 (highest)	1.14	0.92	-	1.40	0.228		1.33	1.10	-	1.61	0.003	***	1.33	1.10	-	1.61	0.003	***	1.17	0.95	-	1.43	0.131	
IMD quintile																								
1 (least deprived)	1.00						1.00						1.00						1.00					
2	1.14	0.96	-	1.37	0.140		1.16	0.99	-	1.35	0.072		1.16	0.99	-	1.35	0.072		1.16	0.99	-	1.35	0.067	
3	0.94	0.78	-	1.13	0.509		0.95	0.81	-	1.13	0.586		0.95	0.81	-	1.13	0.586		1.01	0.85	-	1.20	0.884	
4	1.07	0.88	-	1.31	0.479		1.05	0.88	-	1.25	0.601		1.05	0.88	-	1.25	0.601		1.21	1.01	-	1.45	0.034	*
5 (most deprived)	1.15	0.92	-	1.43	0.217		1.20	1.00	-	1.44	0.056		1.20	1.00	-	1.44	0.056		1.36	1.12	-	1.65	0.002	***

*Odds ratios from logistic regression accounting for complex survey design and using the interview weight, mutually adjusted. N=9,608 drinking adults. OR = odds ratio, CI = confidence interval, *=p<0.05, **=p<0.01, ***=p<0.001, † Strategic Health Authority region*

Footnote to table: scenario 1 = proportionate under-reporting, scenario 2 = consumption level, scenario 3 = drink type

5.8 Discussion

Each of the three putative scenarios makes a substantial change to alcohol consumption, and the proportion of drinkers drinking more than the limits described. For instance, the prevalence of drinking more than twice the daily limits in the three revised scenarios is similar to the original HSE prevalence of drinking more than the daily limits themselves. When mean consumption is investigated, alignment with alcohol sales was only achieved in scenarios one and three. However, scenario two over-estimated alcohol consumption, therefore the results from scenario two should be treated with particular caution. However, there was only a small amount of variation in the increase in the prevalence of drinking more than the weekly guidelines in the three revised scenarios. The prevalence of drinking more than the daily limits increased in particular among women and in among those living in the south of England, population groups among which alcohol consumption is typically thought to be less problematic. The prevalence of drinking more than twice the daily limits increases the most among women, those living in the north of England, those in higher income groups, and in more deprived regions.

Similar patterns persisted in the multivariate analyses. There was little change to the risk factors for drinking more than the weekly guidelines in the analyses of the GLF and the three revised scenarios. More changes were evident among the risk factors for drinking above the daily limits in the HSE 2008 in the three revised scenarios (such as the reversal of the effect of gender in scenario one), but these were not always consistent across all three scenarios. For drinking more than twice the daily limits, the greatest changes were seen in the revised scenarios. Women went from being significantly less likely to drink more than twice the daily limits (on their heaviest day in the last week) in the original HSE, to being equally likely as men to do so in revised scenarios one and two. The top two income quintiles become more likely to drink more than twice the daily limits than the poorest. The gradients observed for drinking more than twice the daily limits across income and IMD quintiles in scenario three appeared to oppose one another in the revised scenarios, with the most affluent income quintile and the most deprived IMD quintile more likely to do so. The reason for this is not known. It could be an artefact of the method of revising consumption (reporting accuracy may in fact vary by income or area deprivation), or might be explained by relatively high proportions of heavy drinkers living in deprived city centres.

The variation in the effect on the prevalence drinking above the guidelines can be partly explained by differences in the proportion of drinkers whose reported consumption was originally close to, but not yet above these thresholds. In scenario one the daily limits effectively became 2.4 units for men and 1.8 units for women. For women, this is exceeded by drinking a single 175ml glass of wine (at 12% ABV = 2.1 units), so it is perhaps not surprising that women

are more heavily affected. Similarly, in the North East where 71% of men and 64% of women drank more than the daily limits on their heaviest drinking day in the last week in the original HSE, this leaves less scope for the prevalence to increase if the majority are already drinking above the guideline. As such, the relative change in the prevalence is somewhat an artefact of the methodology.

However, these findings have interesting implications for public health. Even if under-reporting is assumed to be proportionate across all population groups (as it is in scenario one), the effect on the prevalence of drinking above these limits, and the risk factors for drinking above those limits, was not equal across population groups. As under-reporting is likely to vary by demographic, social, and alcohol-related factors, it is probable that this will introduce further variation in the impact on consumption and drinking above thresholds. This may result in greater disparities in the gradients observed across income, for example, or affect the consumption of those who drink certain types of drinks – such as spirits for which alcohol sales coverage is lowest (see Section 4.8) - disproportionately. The extent to which these kinds of variation may exist is currently not known.

5.8.1 Strengths

This chapter is the first piece of published research which considers the implications of under-reporting of alcohol consumption for drinking above Department of Health drinking guidelines. In a sense the results presented here can be interpreted as a 'worst case scenario' for the public health community and policymakers. This demonstrates that under-reporting is a serious issue, the importance of which reaches beyond the accuracy of measuring alcohol consumption for its own sake, and into consequences for public health.

It was shown in an earlier section (Section 2.5.2) that calculating alcohol consumption as a proportion of alcohol sales leads to a conservative estimate of the extent of under-reporting. A senior methodologist at a large market research agency (Anonymous, personal communication, 2011) agreed this is probable. Therefore the analyses presented in this chapter – with the exception of scenario two – are not likely to over-estimate alcohol consumption. Although it is not universally agreed that alcohol sales coverage of 100% should be sought (**43**), other studies have aimed for total sales coverage and been close to success (**42, 44, 45**). This chapter adds to a small but growing body of literature on what high alcohol sales coverage represents for alcohol consumption (**48, 121-123**), although it is the first to relate consumption to guidelines.

The revisions are necessarily simplistic, as little is known about the population distribution of under-reporting. Although under-reporting is also likely to vary by demographic, social, and

alcohol-related factors, there is little evidence to suggest the magnitude or the direction of these associations (see Section 6.1). This study highlights improving understanding the population distribution of under-reporting as a priority for alcohol researchers. Previous studies which have used the gamma distribution to align alcohol consumption with sales (**48, 121-123**), have found that this method to be successful when matched with disease and mortality outcomes. However, this method assumes that the extent of under-reporting varies by consumption level only, and therefore overlooks other potentially important sources of error in alcohol consumption estimates. These include drink type, drinking pattern or style, contextual factors, and socio-demographic and alcohol-related predictors of non-response, selective reporting, recall bias, mode effects, and under-estimation of units or drinks (see Chapter 2). Once the relative impact of each factor is known, these should be considered simultaneously in revised estimates of alcohol consumption.

5.8.2 Limitations

Revising average weekly alcohol consumption in the GLF using alcohol sales and self-reported average weekly alcohol consumption (based on beverage-specific quantity-frequency questions about the last 12 months) accounts for what is believed to be total alcohol consumption. The application of this same revision using the same multiplier to a single drinking occasion, heaviest drinking day in the last week in the HSE, assumes that recall of the alcoholic drinks drunk on the heaviest drinking day in the previous 7 days is comparable to recall of beverage-specific quantity and frequency of alcohol intake in the last 12 months. As it is probable that recall over a shorter time period is better than a longer period (see (**62, 93-97, 183**)), in the real world the under-reporting of the heaviest drinking day in the last week might not be as much as the 40% assigned. Therefore, while the results for weekly consumption and the weekly guidelines are likely to be reliable, it is possible that the results for the heaviest drinking day in the last week may be an over-estimate.

Scenario one – equal proportion of under-reporting among all drinkers - is an obvious simplification of the pattern of reporting accuracy in the population will actually be. Although this scenario does take consumption into account in the sense that participants who reported drinking three units are revised to close to five units, and participants who reported drinking six units are revised to close to 10 units, differential under-reporting was not accounted for. In reality, there will also be some participants who report drinking no alcohol who are in fact drinkers, and at varying levels of consumption. Previous studies have identified that self-reported non-drinkers in longitudinal studies have reported drinking at previous survey waves (**181, 182**) and that abstainer categories are problematic (**145**). However assessing misclassification of self-reported non-drinkers was beyond the scope of this chapter, and indeed

beyond the scope of this thesis as well. More relevant, however, is that reporting accuracy is also likely to vary among the participants who reported drinking alcohol. This was investigated in scenarios 2 and 3, which explored how variations in under-reporting would impact on alcohol consumption with mixed success.

Revised scenario 2 over-estimated alcohol consumption (average weekly alcohol consumption exceeded per capita alcohol sales). Therefore the results from this scenario need to be interpreted with caution, as they are not likely to be applicable in the real world. The decision to split consumption into tertiles and apply a different multiplying factor to each tertile was taken on the advice of a senior statistician at UCL. However the results from the multivariate analyses were broadly very similar to scenarios 1 and 3. Furthermore, by coincidence scenarios one and two were identical for drinking more than twice the daily limits for both men and women. In another sample where this was not the case, the results for the two scenarios may have shared fewer similarities. However, there are no other nationally-representative datasets which this kind of information on alcohol consumption available for England, which is the country that this thesis focuses on.

Revised scenario three was much more similar to scenario one. This similarity is in part attributable to the fact that the drink type-sensitive revision was only undertaken where participants reported drinking a single type of alcoholic drink (beer or wine or spirits) on their heaviest drinking day in the last week. As a substantial proportion (20% in GLF, 21% in HSE) of participants drank a combination of drink types their alcohol consumption was revised using the method in scenario one. Further, as scenario three in the GLF used information on the heaviest drinking day in the last week in order to revise average weekly consumption, this relied upon a) the participant having drunk in the last week (not everyone drinks every week), and b) if the participant did drink, that they reported their alcohol consumption (by drink type) on the heaviest drinking day. For almost 26% of the GLF participants (n=3,234 out of a total of 12,490), alcohol consumption by drink type on the heaviest drinking day in the last week was unavailable, therefore their consumption was revised using the method used in scenario one as well. Therefore particularly for the GLF scenarios one and three were very similar. Future studies may consider revising consumption of each alcoholic drink consumed independently, in accordance with alcohol sales coverage.

The research presented in this chapter does not use the gamma function to attribute an under-reporting level which has been done in some recent published papers (**48, 121-123**). There are three reasons for this. Firstly, the idea of using the gamma function is emergent; studies have been published as the research comprising this thesis has been conducted. The initial idea for this chapter was conceived, the analyses run, the results accepted for a conference presentation, and a paper drafted before all but one of these studies was published. Secondly,

to use the gamma function it appears from the published papers that it would have been necessary to learn the R programming language, and the time it would have taken to do so would have severely restricted the scope of this thesis in other areas. Finally, fitting alcohol consumption to a gamma distribution – whilst it takes account of that fact that reporting accuracy is likely to be proportional to consumption level – overlooks the fact that there are likely to be several other important socio-demographic and alcohol-related factors that influence reporting accuracy, aside from consumption level.

5.8.3 Conclusions

This chapter has shown that the implications of under-reporting of alcohol consumption are great. Attention has been drawn to the consequences of under-reporting for drinking above Department of Health drinking guidelines for the first time. The multivariate analyses show that even assuming an equal level of under-reporting (scenario one) does not have an equal effect on the prevalence of drinking above some of the limits described. The implications of under-reporting for the prevalence of drinking above the three thresholds are different in different population groups – with women, those on high incomes, and those in deprived areas particularly affected for drinking more than twice the daily limits. As the implications of under-reporting for alcohol consumption are variable even where an equal level of under-reporting among all drinkers is assumed, and an equal level of under-reporting in the population is unlikely, it is crucial that the distribution of under-reporting is better understood. Current understanding of the distribution of under-reporting is inadequate and largely putative. This will be addressed in Chapters 6-8.

Chapter 6 PART A. Study two: identifying risk factors for under-reporting: a quantitative study

This chapter uses intra-individual comparisons to identify risk factors for differences between responses to a seven-day prospective drinking diary and a retrospective direct interview in a large population-based sample in England. Demographic and social factors showed little association with any difference between the diary and the direct interview. In contrast, alcohol-related factors were more important. For both frequency and quantity of alcohol consumption, the diary estimates exceeding those of the direct interview were associated with weekly alcohol intake, number of drinking days, drinking a combination of drink types, and drinking exclusively in licensed premises. As a result, it is likely that the burden of under-reporting of alcohol consumption does not fall equally across the population, and that heavier drinkers and those with less routine drinking patterns may be disproportionately affected.

6.1 Background to the study

It was shown earlier in this thesis that the missing units of alcohol can be attributed to under-reporting of alcohol consumption (Section 2.5.2), and that this is equivalent to over 40% of alcohol sales in England (Chapter 4). However, the majority of the literature on under-reporting is largely methodological: concerning changes to the design and content of surveys and how this affects estimates of alcohol consumption. While it is helpful that the existence of the missing units has been established (Chapter 4), who consumes the missing units remains to be identified, and this will help to identify the nature and the causes of under-reporting. In Chapter 5 attention was drawn to the fact that little is known about the population distribution of under-reporting of alcohol consumption. This chapter goes some way to addressing this using data from a large and recent nationally-representative health survey, the Health Survey for England (HSE) 2011.

This chapter adds to a body of literature comparing different methods of collecting information on alcohol consumption, and how reporting varies by the method used. Generally methods which achieve the greatest estimates of consumption are considered to be the most accurate, as with these methods consumption is more closely aligned with sales. Four studies reviewed examined how survey mode – for instance, whether a survey is face-to-face or self-completion - influences alcohol consumption estimates (see Section 2.6.4). Three of these four studies compared alcohol consumption using the two methods across two different groups of participants (**78-80**). The fourth study was the report for the HSE 2011, which compared computer-assisted personal interview (CAPI) and seven-day prospective drinking diary measures of alcohol consumption using a test-retest methodology, that is to say the same participants were invited to complete both measures of drinking. Although this test-retest methodology was uncommon in the studies examining mode effects, it was much more prevalent in the eleven studies reviewed which compared different questionnaire designs, two of which were reviews (Section 2.6.5.1.2). The majority of these studies used the test-retest method, comparing alcohol consumption estimates within individuals, rather than between. The test-retest method requires fewer participants to detect a significant effect, as there is more statistical power making the comparison in one group. This is the method used in this chapter. Studies which compare two measures of consumption across two groups require large numbers of participants, and the characteristics of participants need to be similar in both groups (or statistically controlled for).

In terms of the methods of measuring alcohol consumption which have been compared, a prospective drinking diary was one of the measures used in six of the twelve studies (**1, 43, 82, 85, 89, 91**), including both of the reviews (**43, 85**). One of these was the report for the HSE

2011 which compared quantity-frequency questions and recent recall with a seven-day drinking diary, all of which were beverage-specific (**1**). Five of the six studies found that the prospective drinking diary achieved the highest estimate of alcohol consumption out of all the methods studied (**1, 43, 82, 89, 91**), with the remaining study - which was a review - finding that prospective diaries, whilst among the better measures of drinking, were similar to quantity-frequency measures (**85**). One of the perceived advantages of the prospective diary is the minimal recall period; however, the evidence that the length of the recall period affects reported alcohol consumption is uncertain (Section 2.6.5.2). So, although it is intuitive and probable that a self-completion prospective diary should achieve the highest estimates of alcohol consumption possible (at a population level), this is not something which was unanimously found in previous studies. Nevertheless, prospective drinking diaries achieve the most consistently high estimates of consumption currently obtained by social surveys in comparison with other methods, and therefore are the most closely aligned with alcohol sales.

Few previous studies which have used the test-retest method have attempted to identify risk factors for a difference between the two methods under study using multivariate analyses. The first of these was conducted among 49 men aged 35-45 in Finland in the early 1980s by Poikolainen and Karkkainen (**86**). Correlation coefficients and multiple linear regression showed that the difference between their quantity-frequency measure and their prospective diary measure was not dependent upon mean alcohol consumption in the diary, age, proportion of drinking days or the proportion of days intoxication was experienced (**86**). The next was conducted in two cities in Sweden in 1991 by Romelsjö and colleagues, and was included in one of the review articles (**85**) so does not appear in Chapter 2. This was a general health questionnaire of 4,000 adults aged 20-74 which used quantity-frequency questions and collected information on period-specific normal week (PSNW) consumption (**184**). The difference in the proportion of 'high alcohol consumers' between the two methods by age, education, marital status, location and occupation was greater among women than in men; with the overall proportion who were high consumers in the PSNW 182% of that in the QF for women, compared with 118% for men (**184**).

Heeb and Gmel's 1999 study of 767 adults in Switzerland compared beverage-specific quantity-frequency, graduated-frequency and a prospective seven day diary (**91**). In the comparison of the diary with the other two measures of consumption, Alcohol Use Disorders Identification Test (AUDIT) problem items were associated with higher mean consumption in the diary (difference between diary and quantity-frequency = 1.00 g/day, $P<0.05$, difference between diary and graduated-frequency = 1.36 g/day, $P<0.01$) and with inconsistencies in the alcohol consumption classification (light, low risk, hazardous, harmful) between the methods (diary compared with quantity-frequency = 0.13 inconsistencies, $P<0.05$, diary compared with graduated-frequency = 0.19 inconsistencies, $P<0.01$) (**91**). Further, in the comparison between the diary and the

graduated-frequency only, men also reported greater mean consumption (difference of 3.13 g/day, P<0.01) and fewer inconsistencies in classification (-0.43, P<0.05) (**91**). In Koppes and colleagues' study of 368 adults in the Netherlands in 2000, alcohol consumption was assessed by beverage-specific quantity-frequency questions and a dietary history interview (i.e. comparing 'usual' and 'actual' consumption) (**88**). Backward stepwise regression analysis of the difference between the two measures found that the difference was associated with a more irregular (irregularity was calculated by dividing the largest number of units consumed on one occasion in the last month by the average number on an average drinking day) drinking pattern in both beer (n=94) and wine (n=200) drinkers (coefficients 2.1, 95% CI 0.9-3.2 and 1.6, 95% CI 0.9-2.2 respectively), and in wine drinkers to the square of the quantity-frequency response (coefficient -0.027, 95% CI -0.038 - -0.016) (**88**).

Of the studies which have identified risk factors for a difference between multiple measures of alcohol consumption, the findings have been inconsistent, however demographic, social, and alcohol-related factors do seem to be important. Three of the studies conducted had a relatively small sample size (<1,000 participants), and although these studies were all conducted in Western Europe, none were conducted in England. As a result, the generalisability of these results is limited. Further, a prospective drinking diary was only used in one study. This chapter is the first piece of research which aims to identify risk factors for under-reporting of alcohol consumption in England, and uses a large, nationally-representative sample and the most accurate (i.e. greatest consumption) measure of self-reported alcohol consumption available: the prospective drinking diary.

6.2 Research question

Can socio-demographic and alcohol-related 'risk factors' for under-reporting be identified from a nationally-representative survey with extensive measures of drinking patterns?

6.3 Objective

Conduct analyses of existing survey data to identify socio-demographic and/or alcohol-related 'risk factors' for under-reporting of alcohol consumption.

6.4 Hypothesis

After adjustment for demographic and social factors, the level of alcohol consumption, types of alcohol consumed and drinking venue will be associated with differential reporting of alcohol consumption in an interview compared with a prospective diary.

6.5 Data: The Health Survey for England 2011

The data used in this chapter are from a nationally-representative annual cross-sectional health survey which began in 1991, the HSE. Data from the 2008 survey were used in Chapter 5. The sampling, data collection and weighting procedures used annually in the HSE were described in Section 5.5.2. These procedures were also used in the 2011 survey. As in previous years, the CAPI collected information on number of drinking days in the last week and alcohol consumption on the heaviest drinking day in the last week. In 2011 average weekly alcohol intake was also calculated using the method previously used by the General Lifestyle Survey (see Section 5.5.1.2). The rest of this section focuses on the features particular to the 2011 survey.

The 2011 survey continued with the core topics from previous years, and in addition, a new topic of social care was introduced to the core survey (**185**). The focus of the 2011 survey was cardiovascular disease, with additional modules of questions also included on chronic pain, attitudes to personal health and lifestyle, well-being, and dental health (**185**). Further, the core questions on alcohol consumption in the last week (see Section 5.5.2.2) were supplemented with questions on regular drinking similar to those used in the GLF (see Section 5.5.1.2), as well as a seven-day drinking diary (**185**).

As with previous years, the HSE 2011 was a stratified random probability sample of private households in England listed in the postcode address file (PAF) (**185**) (see Section 5.5.2.1). The core sample comprised 8,992 addresses randomly selected from 562 postcode sectors (**185**). When visited by interviewers, 9.6% of addresses were not found to contain private households and were therefore excluded (**185**). Of all the households sampled, 66% (5,338) took part in the HSE 2011 in some way (**185**). All the eligible adults and children in the household participated in 53% of sampled households (**185**). Among the estimated total number of adults in sampled households (estimated because the number of adults in households which did not co-operate is not known), the proportion interviewed was 59% (**185**). Response to the interview was higher among women than men (62% and 56%, respectively) (**185**). Household response also varied by region – with 71% households in the North East responding compared with 56% in London – and by type of dwelling, with 69% detached households compared with 56% of households in flats on the fourth floor or above (**185**). Households where at least one adult participated are known as co-operating households (**185**). Among co-operating households where at least one person was interviewed, the overall response rate was higher (87%), and the same pattern was observed for gender; with 91% women and 82% men in co-operating households being interviewed (**185**). These variations in response are very similar to the HSE 2008 described in Section 5.5.2.4. In total, 8,610 adults were interviewed (**185**).

Compared with the Office for National Statistics mid-year population estimates, men were under-represented relative to women (44% men in the HSE compared with 49% in mid-year population estimates) (**185**). By age group, there were some slight differences between the survey and population estimates. Men under 35 years of age were slightly under-represented in the survey, and men aged over 55 were over-represented (**185**). Women aged under 25 years of age were slightly under-represented, and women aged between 55 and 74 were slightly over-represented (**185**). This is a similar pattern to that seen in the HSE 2008 (Section 5.5.2.4). As a result of these differences, survey interview weights were calculated to account for household selection and household and individual (with household) non-response. The way the weights are calculated is similar to the method used in 2008 and is described in Section 5.5.2.3.

6.5.1 Drinking diary

The seven-day drinking diary was left with all participants aged 18 and over who had drunk alcohol in the previous 12 months at the end of the main survey interview and they were asked to complete it in the following week, usually starting on the day after interview (**1, 185**). Participants aged 16 and 17 were asked to complete the diary retrospectively during the nurse visit (**185**). As this is a different type of data to the prospective drinking diary the analyses in this chapter are restricted to adults aged 18 and over only. For each of the seven days, participants were asked to record whether they had drunk alcohol, and if so, the types and quantities of each drink were recorded using beverage specific questions taking into account drink size and strengths (**1**). Participants were asked to record alcoholic drinks rather than units consumed, and responses to the drinking diary were converted into units by the National Centre for Social Research (NatCen), who collect the data. In total, 6,256 adults were in the diary sample (**186**), and data were collected throughout the year. This is all adults who completed the survey interview including those who had not drunk alcohol in the last 12 months and were not asked to complete a diary. The number of adults who returned a complete diary aged 18 and over was 4,969. A copy of the drinking diary is available in Appendix I.

6.5.1.1 Response

Among adults who had drunk alcohol in the last 12 months and were asked to complete a diary, 69% men and 71% women returned a complete diary (**1**). The response rate increased with age, with 55% men and 61% women aged 18-24 returning a complete diary compared with 81% men and 80% women aged 65-74 (**1**). Those in the oldest age group were the most likely to refuse to take part in the diary (14% men and 19% women aged over 75) (**1**).

In addition to the types of weights calculated for the HSE in previous years (see Chapter 5.5.2.3), the 2011 survey also had drinking diary sample weights. The drinking diary was left with all participants aged 18 and over who had drunk alcohol in the previous 12 months at the

end of the main survey interview and they were asked to complete it in the following week (**187**). A logistic regression model was fitted for adults aged 18 and over eligible to complete the drinking diary, with the outcome variable whether the diary was completed or not (**187**). The covariates in the model were age group by sex, household type, strategic health authority region, social class of household reference person, smoking status and general health (**187**). This allowed for predictors of non-response to the diary to be identified, then weights were calculated as the reciprocal of the predicted probability of the diary being fully completed (**187**). The drinking diary weights also took into account the main survey interview weights and were re-scaled such that the weighted and achieved sample sizes for the diary were matched (**187**).

6.5.1.2 Drinking characteristics of diary participants

Aside from the fact that the response rate to the diary varied by demographic factors, it was possible that non-response to the diary may also vary by frequency and quantity of alcohol consumption. The full HSE 2011 sample (n=8,610) and the drinking diary sub-sample (n=6,256) were compared on drinking frequency and quantity to see if the samples differed. There was little difference between the full sample and the diary sample in the frequency of alcohol consumption in the last 12 months reported in the CAPI. Of participants who drank in the past 12 months, the proportion drinking in the last week was 72.8% in the full sample and 73.1% in the diary sub-sample (**186**). The number of drinking days in the last week was similar in the full sample and the diary sub-sample, with a mean of three drinking days in the last week for both (SE 0.03) (**186**).

The mean number of units consumed on the heaviest drinking day in the last week in the CAPI was also similar in the full sample (7.7 units in men and 5.0 units in women) and the diary sub-sample (7.8 units in men and 4.9 units in women) (**186**), and the proportion drinking more than the daily limits was also similar at around a quarter of adults (**186**). Average weekly alcohol consumption in the CAPI was also similar in the full sample (16.9 units for men and 9.2 units for women) and the diary sub-sample (16.7 units for men and 8.4 units for women) (**186**). Overall, there was little difference between the total HSE sample and the diary sub-sample.

6.5.2 *Outcome measures*

As a result of the core survey interview with the additional modules of questions on drinking, plus the seven-day drinking diary, the HSE 2011 contains detailed information on alcohol consumption. Data was collected both retrospectively and prospectively. Retrospective data were collected in the face-to-face CAPI, and prospective data were collected in the self-completion seven-day drinking diary.

Three distinct measures of drinking are available, each collected using two different methods: (1) number of drinking days in the week prior to interview (CAPI), and the diary week; (2) heaviest drinking day in the week prior to interview (CAPI), and the diary week; and, (3) weekly alcohol consumption based on beverage-specific quantity-frequency in the last 12 months (CAPI), and total weekly consumption in the diary (see Table 6.1). It is important to note that the CAPI and the diary week are not two measures of the same week for any one individual; the diary was completed in the week after the CAPI took place.

6.5.3 *Key risk factors*

Demographic, social and alcohol-related variables were investigated as risk factors for a difference between the diary and the CAPI. Demographic factors investigated were sex and age (in 10-year categories). Social factors investigated were equivalised household income quintile, highest educational qualification (including full-time student), Index of Multiple Deprivation (IMD) quintile, and Government Office Region (as Strategic Health Authority regions cease to exist this was thought to be more relevant). Alcohol-related factors investigated were number of drinking days in the diary week, units on the heaviest drinking day in the diary week, total weekly units in the diary week, units on heaviest drinking day in the diary week (highly correlated with total weekly units), drink type on the heaviest drinking day in the CAPI, drinking venue in the diary week (on trade only, off trade only, or mixed), and the participant's opinion on whether the diary week was a 'usual week'.

6.6 Methods

6.6.1 Identifying under-reporting

This chapter examines the risk factors for intra-participant variation in responses to the diary and CAPI. As the drinking diary is presumed to be the most accurate measure of consumption available – due to it being the most closely aligned with sales – the difference between the two measures may be a proxy for under-reporting. Thus, in this chapter consumption which is not identified in the CAPI but which is identified in the diary is described as differential reporting. There are three main measures of alcohol consumption available in the HSE 2011: number of drinking days in the last week, units on heaviest drinking day in the last week, and average weekly alcohol consumption (see Table 6.1). Each of these measures is available in the diary and the CAPI, and these are the three outcomes under investigation. The response to the CAPI is subtracted from the response to the diary for each outcome. As the diary and the CAPI concern two different weeks, a participant can truthfully report different consumption in the two measures. Therefore the difference between one participant's diary and CAPI is unlikely to reveal anything meaningful about under-reporting of alcohol consumption. However, on a

population level, if persistent significant differences between the two measures are found, the risk factors for these differences certainly warrant investigation.

Table 6.1: Alcohol consumption measures in the HSE 2011 used for comparison

Outcome	7-day drinking diary measure (prospective)	CAPI measure (retrospective)
1	Number of drinking days in the diary week (0-7)	Number of drinking days in the week prior to interview (0-7)
2	Heaviest drinking day in the diary week (units calculated from beverage specific questions with drink size)	Heaviest drinking day in the week prior to interview (units calculated from beverage specific questions with drink size)
3	Total weekly alcohol consumption (units calculated from beverage specific questions with drink size)	Average weekly alcohol consumption (units based on beverage-specific quantity-frequency questions on drinking in the previous 12 months)*

** This is the same method as used by the Scottish Health Survey, and the General Lifestyle Survey until it ended in 2011 (see Section 5.5.1.2).*

6.6.2 Statistical analyses

To explore the hypothesis that heavier drinkers are likely to under-report their alcohol consumption to a greater extent, Pearson's correlation coefficients describe the correlations between the difference between the diary and CAPI estimates and measures of drinking frequency and quantity. Demographic, social, and alcohol-related factors associated with a (positive or negative) difference between an individual's diary and CAPI estimates were investigated using multivariate linear regression. For those who drank alcohol in both the diary and the CAPI only, the CAPI estimates were subtracted from the diary estimates, such that positive values for the difference denote the diary being greater than the CAPI, and negative values denote the CAPI being greater than the diary. Complete case analysis was used due to a small number of missing values for exposure variables among the sub-sample for which full information on alcohol consumption (diary and CAPI) was available. Models presented are mutually adjusted for the other variables listed in the table. Likelihood ratio tests were used to assess the fit of the model with additional covariates. The covariates investigated for each of the three outcomes but not included in the model were: IMD quintile, equivalised household income quintile, highest educational qualification (including full-time student), Government Office Region, and units on heaviest drinking day in the diary week (highly correlated with total weekly units). Interactions between gender and drink type, gender and drinking venue, and age and drinking venue were investigated for each outcome. All analyses were completed in Stata version 12 (StataCorp, College Station, TX).

6.7 Results

6.7.1 Descriptive statistics

In the full survey sample, average weekly alcohol consumption in the CAPI based on consumption in the previous 12 months was equivalent to 10.8 units per adult aged 18 and over (n=8,411). Average weekly alcohol consumption based on the seven-day drinking diary was 12.0 units per adult aged 18 and over (n=4,969, 54% women). Of the diary participants, 73% recorded drinking alcohol at least once during the diary week (n=3,638). Data from the CAPI on drinking days in the last week and total weekly units was available for over 99% of participants who drank during the diary week. Heaviest drinking day in the last week from the CAPI was available for 85% men and 90% women who drank during the diary week. Of the remainder, 99% had not drunk alcohol in the last week when the CAPI took place and therefore data on consumption were unavailable. Both frequency and quantity of alcohol consumption were slightly higher in the diary than the CAPI for both men and women across all three outcomes (Table 6.2).

Table 6.2: Mean frequency of quantity of alcohol consumption in the diary and the CAPI

	Number of drinking days*		
	Diary	**CAPI**	
	Mean	Mean	*Weighted n*
Total	3.4	3.2	*3,356*
Men	3.6	3.3	*1,901*
Women	3.1	3.0	*1,454*
	Units on heaviest drinking day*		
	Diary	**CAPI**	
	Mean	Mean	*Weighted n*
Total	7.7	6.8	*3,333*
Men	8.9	8.2	*1,891*
Women	6.2	5.1	*1,442*
	Weekly alcohol consumption**		
	Diary	**CAPI**	
	Mean	Mean	*Weighted n*
Total	16.8	16.1	*3,796*
Men	20.3	19.8	*2,092*
Women	12.5	11.6	*1,704*

**Base = participants aged 18 and over who drank alcohol on at least one day in both the diary and CAPI weeks*
*** Base = participants aged 18 and over who drank alcohol on at least one day in the diary week and reported average weekly consumption in the last 12 months*

The difference between the diary and the CAPI in terms of three outcomes - number of drinking days in the relevant week, heaviest drinking day in the relevant week, and weekly alcohol consumption – is summarised by demographic and social factors in Table 6.3. There is no consistent trend in the difference in the number of drinking days by age group. For the heaviest drinking day, men aged over 55 drank more in their diary week than their CAPI week than

younger men, and women aged 18-24 and 45-64 drank more in their diary week than their CAPI week than other age groups. For weekly alcohol consumption, there was no clear pattern by age for men or women.

By education level, there was no clear pattern in the difference in the number of drinking days, heaviest drinking day, or weekly alcohol consumption in men or women. However, on average participants with foreign or other qualifications reported greater weekly alcohol consumption in their CAPI week than their diary week. This was true for men (3.8 more units in CAPI) and women (1.3 more units in CAPI). Although some variation was observed, there was no discernible trend in the difference between the diary and the CAPI weeks by income quintile, IMD quintile, or region for drinking days, heaviest drinking day, or weekly alcohol consumption.

Table 6.3: Difference between diary and CAPI by demographic and social variables for three outcomes in adults aged 18 and over in the HSE 2011

	Difference in number of drinking days (diary-CAPI)			Difference in heaviest drinking day (diary-CAPI)			Difference in weekly units (diary-CAPI)		
	Men	**Women**	**Total**	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**
Age (10 year bands)									
16-24	0.3	-0.2	0.1	-1.3	1.6	0.1	-0.5	-0.6	-0.6
25-34	0.3	0.3	0.3	0.1	0.3	0.1	0.6	1.8	1.1
35-44	0.2	0.3	0.3	0.8	1.5	1.1	0.6	2.3	1.4
45-54	0.4	0.2	0.3	0.5	1.3	0.9	1.2	0.2	0.7
55-64	0.2	0.2	0.2	1.7	1.3	1.5	0.6	0.8	0.7
65-74	0.3	-0.1	0.1	1.5	0.9	1.3	0.8	0.0	0.5
75+	0.1	0.1	0.1	1.4	0.5	1.0	0.0	-0.8	-0.4
Equivalised household income quintile									
1 (lowest)	0.4	0.1	0.3	0.0	1.5	0.7	1.1	-0.2	0.5
2	0.3	0.2	0.2	0.5	0.5	0.5	-0.3	0.3	0.0
3	0.1	0.3	0.2	1.2	1.1	1.1	0.4	1.4	0.9
4	0.1	0.2	0.1	1.0	1.6	1.3	0.8	0.9	0.9
5 (highest)	0.3	0.2	0.3	0.3	0.9	0.6	2.0	1.4	1.7
IMD quintile									
1 (least deprived)	0.2	0.2	0.2	1.0	0.9	1.0	0.3	0.9	0.6
2	0.3	0.1	0.2	1.0	1.0	1.0	0.4	0.4	0.4
3	0.2	0.2	0.2	0.4	1.1	0.7	0.5	1.0	0.7
4	0.2	0.2	0.2	0.8	0.9	0.8	1.8	1.4	1.6
5 (most deprived)	0.3	0.1	0.2	-0.1	2.0	0.7	-0.1	0.3	0.1
Region									
North East	0.2	0.1	0.2	0.9	0.6	0.8	1.9	0.9	1.5
North West	0.3	0.2	0.3	-0.2	0.9	0.3	0.9	-0.5	0.3
Yorkshire and The Humber	0.2	0.1	0.2	1.4	0.8	1.1	2.1	1.1	1.6
East Midlands	0.4	0.0	0.2	1.2	1.5	1.3	-3.3	-0.3	-1.8
West Midlands	0.3	0.2	0.2	-0.3	0.8	0.2	0.0	-1.7	-0.7
East of England	0.4	0.2	0.3	0.7	1.2	1.0	1.6	2.3	1.9
London	0.2	0.4	0.3	0.0	1.1	0.5	0.1	2.4	1.0

South East	0.2	0.1	0.1	1.1	1.1	1.1	0.2	1.4	0.7
South West	0.1	0.3	0.2	1.8	1.7	1.8	1.8	1.2	1.5
Highest educational qualification									
NVQ4/NVQ5/Degree equiv	0.4	0.2	0.3	0.2	1.2	0.7	-0.2	1.7	0.7
Higher education below degree	0.1	0.0	0.1	0.5	1.1	0.7	0.7	-0.5	0.2
NVQ3/GCE A Level equiv	0.3	0.4	0.3	0.8	1.0	0.9	1.4	0.7	1.1
NVQ2/GCE O Level equiv	0.2	0.3	0.2	1.6	1.7	1.6	1.2	1.0	1.1
NVQ1/CSE other grade equiv	-0.1	0.2	0.0	-1.0	0.1	-0.6	1.9	0.4	1.4
Foreign/other	1.0	-0.5	-0.5	-0.2	-0.7	-0.7	-3.8	-1.2	-1.4
No qualification	0.2	0.2	0.2	1.1	0.9	1.0	-1.1	0.4	-0.4
Full-time student	0.4	-0.1	0.2	0.5	0.4	0.4	3.5	0.4	2.1

Footnote to table: Among 1,882 men (weighted = 2,147) and 1,892 women (weighted = 1,726) who drank alcohol during the diary week and the CAPI week. Mean diff = mean difference between diary and CAPI. Positive values denote a greater diary than CAPI, negative values denote a greater CAPI than diary.

The difference between the diary and CAPI by alcohol-related factors is shown in Table 6.4. Participants who drank on five or more days in the diary week had a greater difference between their diary week and their CAPI week (0.76 more days in the diary) than participants who drank on one to four days only (no difference between the two measures). Drinking on five or more days in the diary week was also linked to a difference between the diary and the CAPI weeks for heaviest drinking day: those who drank on five or more days drank 2.3 more units in their diary than the CAPI compared with those who drank on one to four days, for whom the diary exceeded the CAPI by 0.41 units on average. The same was observed for weekly consumption, with those drinking on five or more days reporting 3.4 more units in their diary week than their CAPI week, compared with 0.2 units fewer among those who drank on 1-4 days in the diary week. A similar pattern was seen in both men and women.

Participants who drank more than twice the daily recommended limits (>8/6 units) on their heaviest drinking day in the diary week had a greater difference between their diary and CAPI heaviest day estimates, with the diary exceeding the CAPI on average by 3.3 units. A gradient in the extent to which the diary exceeded the CAPI was observed for the heaviest drinking day, whereby participants who drank less than the daily limits had a CAPI which exceeded the diary (by 1.5 units on average), compared with those who drank above the daily limits but less than twice, among whom the diary was slightly higher than the CAPI (by 0.3 units). For participants who drank more than twice the recommended limits on the heaviest drinking day in the diary week, weekly consumption in the diary exceeded that of the CAPI (by 5.0 units on average). Among those who drank above the recommended limits but below twice, or those who drank within the recommended limits had a CAPI that exceeded the diary (by 1.0 units and 2.1 units respectively). Again, these patterns were seen in both men and women.

Participants who drank more than the weekly recommended limits (>21/14 units) in the diary week also had a bigger difference between their diary and their CAPI weeks than participants drinking less than the weekly recommended limits. There was only a small difference in the number of drinking days (0.5 days), however in those who drank more than 21/14 units the heaviest drinking day in the last week was on average 2.9 units greater in the diary than the CAPI than for those who drank less than the recommended limits (for whom the CAPI exceeded the diary by 0.3 units). The same was observed for the difference in weekly alcohol consumption, with those who drank more than the weekly recommended limits drinking on average 5.3 more units in the diary than the CAPI over the course of the week, compared with -1.6 units among those who drank less than the weekly recommended limits. The patterns were similar in men and women.

Where a single drink type was drunk on the heaviest drinking day in the CAPI week, the difference between the diary and the CAPI weeks was similar across drink categories for both the number of drinking days and the heaviest drinking day. Weekly consumption in the diary week exceeded the CAPI week for those who drank only beer on the heaviest drinking day in the CAPI week by 1.7 units on average, whereas the effect for wine was minimal, and spirits was in the opposite direction (-0.8 units respectively). In contrast, those drinking a combination of drink types on the heaviest drinking day in the CAPI week on average had a diary which exceeded the CAPI for both heaviest drinking day (4.3 units) and weekly alcohol consumption (2.9 units). These differences did not appear to vary by gender.

Similarly, the difference between the on-trade and off-trade in the differences between the diary and the CAPI for drinking days, heaviest drinking day, and weekly consumption were small. However, participants that drank in a mixture of licensed and off-licence venues during the diary week on average had a diary which exceeded the CAPI by a larger amount than the other venues for each outcome: for drinking days (0.5 days), heaviest drinking day (1.5 units) and weekly alcohol consumption (3.4 units). Once more, these differences did not vary by gender. Finally, participants who reported that the diary week was not a usual week had a difference between their diary and CAPI that corroborated this for drinking days, heaviest drinking day, and weekly alcohol consumption. The majority of participants who completed the diary (70%) reported that the diary week was ‘about the same as usual’, with 19% reporting they drank more than usual and 11% reporting they drank less than usual.

Table 6.4: Difference between diary and CAPI by alcohol-related variables for three outcomes in 3,774 adults aged 18 and over in the HSE 2011

	Difference in number of drinking days (diary-CAPI)			Difference in heaviest drinking day (diary-CAPI)			Difference in weekly units (diary-CAPI)		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Drinking days (in diary week)									
1-4 days	0.0	0.0	0.0	0.0	0.9	0.4	-0.7	0.3	-0.2
5+ days	0.8	0.9	0.8	2.3	1.8	2.1	3.6	3.0	3.4
Units on heaviest drinking day (diary week)									
<4/3 units	0.0	-0.1	0.0	-1.9	-1.1	-1.5	-2.8	-1.3	-2.1
>4/3 and >8/6	0.3	0.4	0.3	0.1	0.5	0.3	-1.8	-0.4	-1.1
>8/6	0.4	0.2	0.3	2.9	3.9	3.3	5.2	4.6	4.9
Total weekly units (diary week)									
<21/14	0.1	0.0	0.0	-0.6	0.0	-0.3	-2.4	-0.7	-1.6
>21/14	0.5	0.5	0.5	2.6	3.3	2.9	6.0	4.3	5.3
Drink type (on heaviest day in CAPI)									
Beer	0.3	0.3	0.3	1.7	2.4	1.8	1.7	1.9	1.7
Wine	0.3	0.2	0.2	2.3	1.3	1.6	0.0	0.3	0.2
Spirits	0.1	0.2	0.2	0.8	1.1	1.0	-2.4	0.1	-0.8
Other drinks/combination	0.3	0.3	0.3	4.3	4.2	4.3	2.8	3.1	2.9
Drinking venue (diary week)									
Off trade only	0.1	0.1	0.1	0.6	0.9	0.7	-1.3	0.1	-0.6
On trade only	-0.1	-0.1	-0.1	-0.1	0.5	0.1	-0.4	0.8	0.1
Mixed	0.6	0.5	0.5	1.3	1.9	1.5	4.0	2.4	3.4
Was the diary week a usual week?									
About the same as usual	0.1	0.1	0.1	0.4	0.5	0.4	-0.3	-0.8	-0.5
Less than usual	-0.4	-0.5	-0.5	-2.6	-0.5	-1.7	-12.9	-7.1	-10.5
More than usual	0.8	0.8	0.8	2.6	3.2	2.9	8.0	7.1	7.6

Footnote to table: Among 1,882 men (weighted = 2,147) and 1,892 women (weighted = 1,726) who drank alcohol during the diary week. Mean diff = mean difference between diary and CAPI. Positive values denote a greater diary than CAPI; negative values denote a greater CAPI than diary.

The majority of participants reported that their alcohol consumption was 'about the same as usual' in the diary week (70%). Among the participants who reported that their alcohol consumption during diary week was 'about the same as usual' (n=3,408, 55% women), there are significant correlations between the difference between the diary and the CAPI weeks and alcohol consumption. The correlation coefficient between number of drinking days in the diary week and the difference between the diary and the CAPI numbers of drinking days was 0.2776 ($P<0.001$). The correlation between units consumed on heaviest drinking day in the diary week and the difference between the diary and the CAPI heaviest day is 0.4600 ($P<0.001$). The correlation between total weekly units in the diary and the difference between the weekly total between diary and CAPI was 0.2181 ($P<0.001$). Although these coefficients are not particularly strong, they are statistically significant and the sample was restricted to those who reported that the diary week was a normal week.

Figure 6.1 describes the difference between the diary and the CAPI using a heuristic of under/over reporters. Participants whose diary week exceeded the CAPI are described as possible or potential 'under reporters', and these participants often drank heavily on their heaviest drinking day in the diary week. Participants whose CAPI exceeded their diary are described as possible 'over reporters', and these tended to be the lighter drinkers.

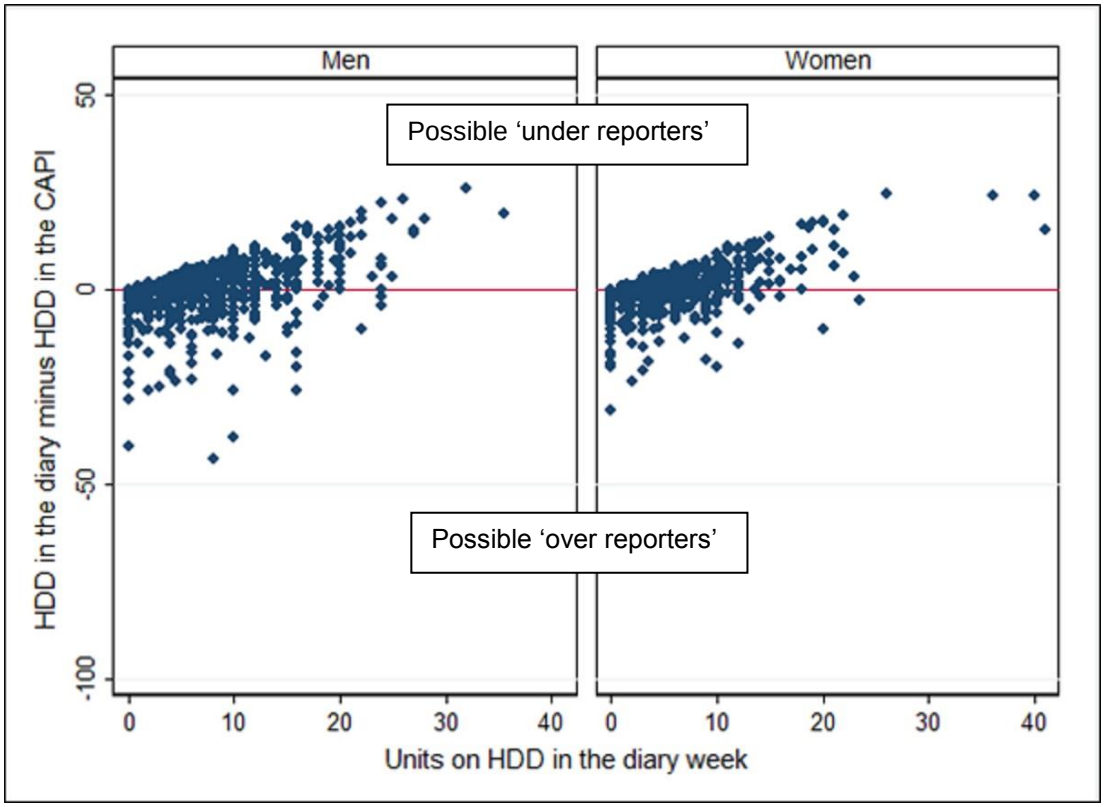


Figure 6.1: Scatter plot of correlation between units on heaviest drinking day in the diary week, and the difference in heaviest day between diary and CAPI weeks.

Note: The line indicates where the diary is equal to the CAPI. HDD = heaviest drinking day

6.7.2 Multivariate analyses

Multiple linear regression explored social, demographic, and alcohol-related risk factors that predicted a significant difference between the diary and the CAPI (Table 6.5). The results presented are mutually adjusted, including adjusting for total weekly alcohol consumption in the diary and whether or not the diary week was a normal week. Interactions between drink type (on heaviest day in the CAPI week) and gender, drinking venue and gender, and drinking venue and age were investigated for each of the three outcomes. There were no significant interactions between drink type and gender for drinking frequency or weekly consumption. However for heaviest drinking day there was an interaction between gender and drink type, with women who drank wine only drinking more in their CAPI week than their diary week (coefficient -1.99, P=0.001). There were no significant interactions between drinking venue and gender for drinking frequency or heaviest drinking day, however there was one for gender and weekly consumption. Unlike men, women drinking in a mix of on and off-trade venues drank more in their CAPI week than their diary week (coefficient -3.39, P=0.013). There were no significant interactions between drinking venue and age.

Table 6.5: Risk factors for differences between the diary and the CAPI from multiple linear regression, among adults aged 18 and over in the HSE 2011

	Difference in drinking days between diary and CAPI†				Difference in heaviest day between diary and CAPI††				Difference in weekly units between diary and CAPI†††			
	Coeff.	95% CI	P		Coeff.	95% CI	P		Coeff.	95% CI	P	
Sex (female)	-0.03	-0.15 to 0.08	0.564	ns	0.54	-0.02 to 1.09	0.057	ns	1.26	0.03 to 2.49	0.045	*
Age 25-34 (cf 16-24)	-0.07	-0.33 to 0.18	0.567	ns	-0.21	-1.78 to 1.36	0.793	ns	2.49	-1.30 to 6.28	0.197	ns
Age 35-44 (cf 16-24)	-0.26	-0.51 to 0.00	0.049	*	-0.03	-1.64 to 1.59	0.976	ns	2.01	-2.07 to 6.08	0.334	ns
Age 45-54 (cf 16-24)	-0.28	-0.53 to -0.03	0.027	*	-0.76	-2.31 to 0.79	0.338	ns	1.41	-2.81 to 5.63	0.512	ns
Age 55-64 (cf 16-24)	-0.45	-0.72 to -0.19	0.001	**	-0.04	-1.55 to 1.48	0.960	ns	1.46	-2.74 to 5.65	0.496	ns
Age 65-74 (cf 16-24)	-0.60	-0.88 to -0.31	<0.001	***	0.27	-1.27 to 1.82	0.729	ns	2.17	-2.07 to 6.41	0.316	ns
Age 75 (cf 16-24)	-0.71	-1.08 to -0.35	<0.001	***	0.34	-1.29 to 1.97	0.682	ns	2.31	-2.10 to 6.73	0.304	ns
Weekly units (diary)	-0.01	-0.02 to -0.01	<0.001	***	0.16	0.11 to 0.21	<0.001	***	0.23	0.05 to 0.42	0.015	*
Drinking days in diary week	0.34	0.29 to 0.38	<0.001	***	-0.55	-0.84 to -0.25	<0.001	***	-0.43	-1.31 to 0.46	0.344	ns
Drank wine on CAPI HDD (cf. beer only)	-0.10	-0.25 to 0.04	0.166	ns	0.37	-0.17 to 0.91	0.180	ns	-0.58	-2.53 to 1.38	0.562	ns

	Difference in drinking days between diary and CAPI†				Difference in heaviest day between diary and CAPI††				Difference in weekly units between diary and CAPI†††			
	Coeff.	95% CI	P		Coeff.	95% CI	P		Coeff.	95% CI	P	
Drank spirits on CAPI HDD (cf. beer only)	-0.14	-0.32 to 0.05	0.155	ns	0.18	-0.62 to 0.99	0.652	ns	-0.69	-2.73 to 1.36	0.510	ns
Drank other drinks/combination on CAPI HDD (cf. beer only)	-0.30	-0.51 to -0.09	0.006	**	1.23	0.36 to 2.10	0.006	**	0.94	-0.86 to 2.75	0.305	ns
Drank in on trade only in diary week (cf. off trade only)	0.17	0.02 to 0.32	0.024	*	-0.18	-0.84 to 0.49	0.605	ns	1.85	0.53 to 3.17	0.006	**
Drank in on & off trade in diary week (cf. off trade only)	0.11	-0.03 to 0.26	0.122	ns	0.44	-0.10 to 0.98	0.108	ns	1.93	0.34 to 3.52	0.018	*
Drank less than usual in diary week (cf. same as usual)	-0.36	-0.61 to -0.12	0.004	**	-2.18	-3.09 to -1.27	<0.001	***	-10.08	-14.59 to -5.58	<0.001	***
Drank more than usual in diary week (cf. same as usual)	0.59	0.45 to 0.73	<0.001	***	1.62	0.97 to 2.27	<0.001	***	6.09	4.66 to 7.53	<0.001	***

*Footnote to table: Coefficients from multiple linear regression accounting for complex survey design and using the drinking diary weight. Coeff. = coefficient, HDD = heaviest drinking day, P= p-value, ns = not significant. *=P<0.05, **=P<0.01, ***=P<0.001. †=among 2,722 adults with full information on all covariates. ††=among 2,700 adults with full information on all covariates. †††=among 3,135 adults with full information on all covariates*

6.7.2.1 Drinking frequency

Significant risk factors for the diary exceeding the CAPI for the number of drinking days were identified and are summarised in Table 6.6. For every extra drinking day in the diary week, the number of drinking days in the diary week exceeded that of the CAPI by an additional 0.34 days (P<0.001). A smaller effect was seen for drinking venue, with drinking exclusively in the on-trade for the diary week was associated with drinking on 0.17 more days in the diary than the CAPI (P=0.006) compared with drinking in the off-trade. As would be expected, drinking more than usual in the diary week was associated with 0.59 more drinking days in the CAPI than the diary (P<0.001), compared with drinking the same as usual.

6.7.2.2 Heaviest drinking day

There were fewer significant associations between the difference in the number of units consumed on the heaviest drinking day between the diary and the CAPI than there were for number of drinking days. The total number of units consumed in the drinking diary week was significantly associated with the heaviest drinking day in the diary exceeding the CAPI: for every extra unit consumed in the diary week, the diary exceeded the CAPI by an additional 0.16 units (P<0.001). Drinking a combination of drink types on the heaviest drinking day in the CAPI was associated with drinking 1.23 more units on the heaviest drinking day in the diary than the CAPI (P=0.006). Also, having drunk more than usual in the diary week was associated with an additional 1.62 units on the heaviest drinking day in the diary than the CAPI (P<0.001).

6.7.2.3 Weekly alcohol consumption

Significant risk factors for weekly alcohol consumption in the diary exceeding that of the CAPI were similar to those identified for drinking frequency and heaviest drinking day. However, gender also emerged as important, with women having on average 1.26 extra units in their weekly total in the diary compared with what they reported in the CAPI (P=0.045). However, this is treated as of borderline significance due to the multiple comparisons observed. Weekly alcohol consumption in the diary was associated with a difference between the diary and the CAPI. For each additional unit of alcohol consumed in the diary week, the diary exceeded the CAPI by an additional 0.23 units (P=0.015). Drinking venue was important for weekly consumption, with drinking exclusively in the on-trade for the diary week associated with 1.85 more units in the diary than the CAPI for the week (P=0.006), and drinking in a combination of the on and off trade associated with 1.93 more units in the diary than the CAPI (P=0.018), compared with drinking exclusively in the off-trade for the diary week. Drinking more than usual in the diary week was also associated with the diary exceeding the CAPI; with 6.09 more units in the diary than the CAPI compared with those who drank the same as usual (P<0.001).

Table 6.6: Significant risk factors for the diary estimates exceeding those of the CAPI

	Number of drinking days	Units on heaviest drinking day	Weekly alcohol consumption
Being female			✔ (borderline)
Older age			
Weekly alcohol intake		✔	✔
Drinking frequency	✔		
Drink type		✔ (combination)	
Drinking venue	✔ (on-trade only)		✔ (on-trade or mixed)

Based on multivariate linear regression analyses of approximately 3,000 adults in the HSE 2011

6.7.2.4 Risk factors for the CAPI estimates exceeding those of the diary

Although there was a tendency for the diary estimates to exceed those of the CAPI, for each of the three outcomes investigated there were also significant risk factors for the CAPI estimates exceeding those of the diary. For all three outcomes, drinking less than usual in the diary week was significantly associated with the estimates from CAPI week exceeding those of the diary: 0.36 additional drinking days (P=0.009), 2.18 additional units on the heaviest drinking day (P<0.001), and 10.08 additional units across the whole week (P<0.001). Other significant risk factors were not consistent across outcomes. These were age over 35 years (P<0.05 for each age group) and weekly alcohol consumption for number of drinking days. For every extra unit of alcohol consumed per week, the number of drinking days in the CAPI exceeded that in the diary by an additional 0.01 days (P<0.001). Drinking a combination of drink types was associated with drinking on 0.30 more days in the CAPI week than the diary week compared with those who drank beer (P<0.05), despite also being associated with drinking more on the heaviest drinking day in the diary week. The heaviest drinking day was associated with number of drinking days in the CAPI week exceeding that of the diary were drinking days in the diary week – with 0.55 extra units of alcohol in the CAPI for each additional drinking day (P<0.001). There were no other significant risk factors for weekly consumption in the CAPI exceeding that of the diary.

6.8 Discussion

The descriptive statistics show little variation in the difference between alcohol consumption in the diary and the CAPI weeks by the demographic and social factors investigated (Table 6.3). In contrast, substantial variation in the difference between the diary and the CAPI was observed for alcohol-related factors (Table 6.4). Drinking on a greater number of days in the diary week, greater quantity of alcohol consumption on either the heaviest drinking day or across the entire diary week, drinking a combination of drink types, and drinking in licensed or in a mix of licensed and unlicensed premises were linked to the diary measures exceeding those of the

CAPI. Greater relative differences were observed for measures of quantity (heaviest day and weekly alcohol consumption) rather than frequency (number of drinking days).

The multivariate analyses partially confirmed what was observed in the descriptive findings. Few demographic or social factors were included in the final models as likelihood ratio tests showed that they did not improve the fit of the model. Significant risk factors in the multivariate analyses were not consistent across the three outcomes investigated (number of drinking days, units on the heaviest drinking day, and weekly alcohol consumption). Risk factors for the diary exceeding the CAPI that were significant for two of thsee outcomes were total weekly alcohol consumption (diary), and drinking exclusively in licensed premises (diary) (Table 6.6). Drinking frequency, drinking a combination of licensed and unlicensed venues (both in the diary week), and drinking a combination of drink types (on the heaviest drinking day in the CAPI week) were significant for one outcome each, and gender was of borderline significance for one outcome.

While higher weekly alcohol consumption and drinking on more days - after adjusting for whether or not the diary week was a usual week - could be expected to be associated with under-reporting of alcohol consumption (under-reporting increasing as consumption increases) the reasons for the other risk factors are uncertain. The findings for drink type suggest that those who drink a mixture of drinks (or unusual drinks) may experience difficulties estimating quantity of consumption, (but not frequency). This could be related to low levels of awareness regarding serving sizes among this group. The reason that drinking exclusively in licensed premises was associated with the diary exceeding the CAPI is especially unclear. It is not simply that on-trade drinkers tend to drink more heavily, as weekly consumption and whether the week was a usual week were controlled for. It could be that drinking in the on-trade (or a mixture of on and off-trade) is more difficult to remember retrospectively if a number of different venues have to be recalled, meaning that some whole drinking occasions (of parts thereof) are omitted. In contrast, home drinking taking place at a single venue may be easier to recall as one discrete event. This may be why the diary captured more drinking for those who drank in licensed premises only as the recall problem is minimised. This counter-intuitive finding highlights that under-reporting is likely to be complex and nuanced, and as a result risk factors are difficult to pinpoint from survey questions.

Units on heaviest drinking day was not included in the model as it was very highly correlated with total weekly units (which was included in the model). Therefore it could be that drinking a combination of drink types being associated with the diary being greater than the CAPI (the heaviest drinking day outcome) is simply because those who mixed drinks drank more on this day. The analysis for the difference in number of drinking days was repeated restricted to those who drank more than two units on their heaviest drinking day (i.e. those who are likely to have

had more than one 'drink', n=2,477) only, and the significance of the relationship was maintained (P<0.001). As a single pint of lager can contain up to three units, this was repeated again among those who drank more than three units (n=2,217), and the result was still significant (P<0.001). If the analysis for the difference in the heaviest drinking day between the diary and the CAPI is repeated among those who drank more than two units (n=2,208) or three units (n=2,002), significance was also maintained (P=0.007 and 0.011 respectively). Therefore it does not seem that drinking a combination of drink types simply reflects drinking more, rather, that it is in some way indicative of drinking behaviours, patterns, or style.

Although the majority of participants reported that their alcohol consumption during the diary week was 'about the same as usual' (70%), the proportions drinking more or less than usual were quite different. 19% drank more than usual, compared with 11% who drank less than usual. These proportions were the same for men and women. As this is a nationally-representative survey conducted year-round, it would be expected that the proportions drinking more or less than usual would be similar, so already this may be some insight into how the diary captures more alcohol consumption than the CAPI. Perhaps the diary therefore influences drinking, and in some way encourages participants to drink more than usual. Or instead, perhaps the diary simply captures drinking in a somewhat better way. There is evidence in a later chapter (Chapter 7) to suggest that the diary does not influence consumption, however this remains a possibility. It is more probable that the differential under-reporting observed in the CAPI relative to the diary is largely accidental (although between-week variations in drinking will also have a role), rather than deliberate. If it is the case that participants' perceptions of their alcohol consumption are often inaccurate, this may be evident through quantitative exploration of actual and perceived amounts of alcohol in pub measures as well as bottles and home-poured glasses of a variety of alcoholic drinks.

6.8.1 Strengths

While the research presented in this chapter is not the first study to identify demographic, social or alcohol-related 'risk factors' for under-reporting of alcohol consumption, no other studies have been identified which compares two measures of drinking with the primary aim of identifying risk factors for differences between the two. This is also the first of any kind to be conducted in England. Previous studies on variations in under-reporting were small (<1,000 participants) (**86**)(**88, 91**) or did not attempt to identify risk factors beyond basic demographic factors (**184**). However, alcohol-related factors were previously identified as important (**88, 91**), therefore this chapter corroborates these earlier findings, and heavier drinking or more disordered drinking patterns are 'risk factors' for under-reporting of alcohol consumption. As the HSE 2011 was

conducted in a nationally-representative sample, these findings are broadly generalisable across England.

The comparison of different methods of measuring alcohol consumption adds to much larger and established body of literature comparing question types and questionnaire design (see Section 2.6.4 and Section 2.6.5), adding to the evidence that prospective questioning achieves higher consumption estimates than retrospective, and that question detail and beverage and drink size specificity are important. The prospective seven-day drinking diary used in the HSE 2011 is therefore the 'gold standard' way of measuring alcohol consumption among adults in a country where alcohol consumption is prevalent and typically frequent, such as England.

The drinking diary used in the HSE 2011 was the first drinking diary to be completed by a large general population sample in the UK (**1**). One measure of its success is that the diary does seem to capture more drinking than the CAPI. The number of drinking days in the week under study, the units consumed on the heaviest drinking day, and the total weekly alcohol consumption in units were all slightly higher in the seven-day drinking diary than in the CAPI, for both men and women. For the financial year 2010/11 (the most recent year for which sales data are available as of May 2013), alcohol sales were equivalent to 10.59 litres per adult aged 16 and over (**11**), or 20.4 units per week per adult. This represents alcohol sales coverage of 53.2% for the CAPI and 58.8% for the diary. However, these figures exclude consumption among young people aged 16 and 17 because the diary was completed retrospectively. Consumption among young adults is lower than among the main adult population. If young adults aged 16 and 17 are taken into account, the disparity between the two methods is greater: sales coverage is 51.9% in the CAPI compared with 58.3% in the diary. Therefore the diary leads to a modest but worthwhile improvement on alcohol sales coverage and reducing the missing units.

6.8.2 Limitations

The most notable limitation of this chapter is that it was not possible to identify potential risk factors of under-reporting of alcohol consumption that was not captured by the drinking diary. Indeed there is still a large difference between alcohol consumption reported in the diary and alcohol sales, with alcohol sales coverage below 60% even in the drinking diary. The missing units remain substantial. While the drinking diary is clearly preferable to the CAPI, it is still not a complete picture of the nation's drinking patterns. As a result, while the risk factors identified in this chapter are predictive of a modest improvement in alcohol sales coverage of somewhere between five and 10 percentage points, the risk factors of under-reporting of alcohol consumption that was not captured by the drinking diary remain unknown. It is possible that

these are similar to those which predicted the difference between the diary and the CAPI, but they could equally be more related to demographic and social factors which only appeared to be of minimal importance in the analyses in this chapter.

In particular, it is likely that reported alcohol consumption does not capture drinking in informal settings well, because drink volumes are difficult to estimate. This concerns drinking in the off-trade (i.e., for consumption away from licensed premises), where substantial changes in the composition of alcohol sales since the middle of the 20th century have led to two-thirds of alcohol sales taking place in Britain by 2010 (**7**). Little is known about the accuracy of participants' estimates of their own drinking in terms of the amount of alcohol in drinks that are self-poured (see Section 2.6.6), and this will be addressed in Chapter 8. Additionally, reported alcohol consumption may be especially inaccurate for heavy drinking episodes where alcohol 'blackouts' mean consumption is impossible to recall. Only an observational method - such as that used recently by Northcote & Livingston's Australian study of young people drinking in urban nightlife (**136**) – or a continuous biological measurement of drinking such as transdermal alcohol concentration, would be appropriate here, and this would require methodological innovation which has been relatively scant in recent alcohol research (a more detailed discussion of this is in Section 2.7).

The analyses presented here used a 'test-retest' methodology and make intra-individual comparisons. It should be re-iterated here that the analyses do not compare two measures of drinking in the same week: the diary week and the CAPI week were two different weeks. As such, this intra-individual comparison is of little value on an individual level. On an aggregate level, however, it is possible to observe whether the diary measures of drinking display a tendency to exceed those of the CAPI. In the multivariate analyses whether the diary week was a normal week (or not) was included as a covariate so this has not influenced the results.

Finally, very little is known about the size of a 'usual glass' of alcoholic drinks consumed by the public when drinking at home (Section 2.6.6.2), and how well this corresponds to the particular size of glass used as standard in the survey used to convert a 'glass' into units. Where drinks are topped up before they are finished this may impact on the accuracy of estimation of alcohol consumption also. These influences affect wine and spirits more than beer as beer tends to be sold in cans or bottles which constitute one 'drink'.

6.8.3 Conclusions

Alcohol-related factors linked to greater quantities of alcohol consumption and a more varied drinking pattern appear to predict under-reporting of alcohol consumption as interpreted as a

difference between the CAPI and diary measures of drinking. The absence of demographic and social risk factors for under-reporting also suggests specific research will be necessary to understand the distribution of under-reporting of other health behaviours as well, including: sexual behaviours, drug taking, tobacco smoking, diet and physical activity.

From a public health perspective it is concerning that the burden of under-reporting may fall on heavier drinkers (who may or may not respond to social surveys, or could be outside the sampling frame). Estimates of the prevalence of drinking above the recommended levels, hazardous levels, or even harmful levels that are based on self-reported consumption may be disproportionately under-estimated. It is vital that new and innovative approaches to accurately measure alcohol consumption at a population level are developed.

Chapter 7 PART B. Study one: identifying further potential risk factors under-reporting: a qualitative study

This chapter explores other factors that may be associated with under-reporting of alcohol consumption, which would not be possible to investigate in a questionnaire-based survey. Ten semi-structured interviews were conducted with HSE 2011 participants who completed the seven-day drinking diary and who drank on at least four days of the diary week. The interviews identified that having a non-routine drinking pattern and usually using 'experiential approaches' (such as how intoxicated they felt rather than quantity of consumption) to track alcohol consumption were more strongly associated with drinking more than expected when completing the diary. In conjunction with what was found in the previous chapter, this suggests that under-reporting may be more strongly associated with alcohol-related factors, as opposed to demographic or social factors.

7.1 Background to the study

In Chapter 6 it was shown that alcohol-related factors were more strongly associated with under-reporting of alcohol consumption than demographic or social factors, in a comparison of two measures of drinking in the Health Survey for England (HSE) 2011. In addition to quantity of alcohol consumption being important, drinking frequency, drink type, and drinking venue were found to be independently associated with the diary exceeding the survey interview. This suggests that certain types of drinkers could under-report their consumption to a greater extent than others. The investigation in the previous chapter was constrained by the availability of variables in the HSE 2011 dataset (or those that could be derived from this dataset). There may be further factors by which under-reporting could vary, or characteristics which could be important for under-reporting, which were not identifiable from the HSE 2011. For example, do the alcohol-related factors that were linked to under-reporting in the previous chapter remain important, or do other demographic, social, or alcohol-related factors emerge? This chapter will explore the extent to which this is the case, investigating a quantitative problem using qualitative methods.

Qualitative methods can be used to gain a deeper and more nuanced understanding of factors that may influence the distribution of under-reporting. There has been much valuable qualitative work on alcohol (see Section 2.4.2) conducted by researchers in the social sciences, however there is a tendency for this to be concerned with public order as opposed to public *health*. There has also been qualitative research on drunkenness as a state or an experience which describes emotional, embodied and affective aspects of intoxication, along with the relationship between this and identity, and how this should be incorporated in future research (**22, 188**). This bears more relation to health than the research which concerns public order, however, there has been very little qualitative work that explores under-reporting of alcohol consumption. Perhaps this is in part due to the methodological nature of under-reporting, essentially the purpose of qualitative work on under-reporting is to provide a new perspective on a quantitative problem. This means that researchers interested in survey methodology and design, which is necessarily quantitative, have dominated the field.

One study included in the review of pouring studies in Section 2.6.6.2 by Gill and colleagues also conducted qualitative interviews with female undergraduates in Scotland to identify definitions of ‘binge drinking’ (**111**). However under-reporting of alcohol consumption was not the focus of this study. One qualitative study which has addressed issues of under-reporting was the Drinking Places study conducted by Valentine *et al*. This found that, among heavy drinkers, a greater proportion of adults aged 25 years and over under-estimated their consumption than those aged 18-24, based on comparisons of retrospective survey and

interview descriptions of drinking (**24**). Further, it was found that for both men and women, only around half of those who reported drinking heavily in the survey actually described their drinking in this way in the interview (**24**). The interviews also revealed these 'older' drinkers had a casual attitude towards the alcohol content of different drinks and the drinking guidelines (**24**). The Drinking Places study was focused on where consumption takes place and the distinction between public and private (home) drinking, therefore that under-reporting emerged shows that it is a pertinent issue which can be explored using qualitative methods.

It was stated in Section 2.7.2 that there has been relatively little methodological innovation in the field of under-reporting. Although numerous previous studies have attempted to measure and quantify under-reporting, qualitative methods are potentially important tools that could identify under-reporting of alcohol consumption and have so far been relatively overlooked. As a result, it was important to explore several possible avenues for the qualitative component of this thesis in order to identify how under-reporting can be best understood with a qualitative study. One of the methods explored but not used was participant observation of drinkers in various social settings, with a comparison of observed consumption with a self-report the following day, similar to a quantitative study that was conducted recently in Australia (**136**). A second method explored was semi-structured interviews combined with either go-along interviews to shopping venues, or a photo-diary and photo-elicitation. These ethnographic methods were used together in a recent (2012) PhD thesis by Claire Thompson (**189**), and would have given a detailed understanding of alcohol purchasing or routine drinking practices but the associations with under-reporting may have been less obvious. Each of these methods of conducting the qualitative study on under-reporting was discussed with supervisors, peers, and qualitative researchers in the field of health geography.

The approach that was chosen was best placed to focus on under-reporting of alcohol consumption and identifying factors related to under-reporting. This was to conduct conventional semi-structured interviews with a sample of participants who may already be alert to some extent of the issue of under-reporting. Participants in the HSE 2011 completed a seven-day drinking diary in addition to the core computer-assisted personal interview (CAPI) about alcohol consumption (see Section 6.5), and had therefore experienced detailed questioning about their alcohol consumption and had also experienced monitoring their drinking. Diary interviews have previously been described as an under-used and valuable source of information by human geographers such as Latham (**190, 191**), therefore recruiting a sample of HSE 2011 drinking diarists for such a purpose also responded to previous calls for such methods. This was able to unpack some of the issues surrounding under-reporting that the corresponding quantitative study presented in Chapter 6 was not able to, and provided a good fit with the rest of the thesis.

7.2 Research question

Can socio-demographic and alcohol-related 'risk factors' for under-reporting in surveys be identified from qualitative interviews?

7.3 Objective

Conduct qualitative interviews to identify socio-demographic and/or alcohol-related 'risk factors' for under-reporting of alcohol consumption.

7.4 Hypothesis

As this is a qualitative study, a hypothesis was not formally tested. The interviews set out to explore the research question and to identify socio-demographic and/or alcohol related factors that may be linked to under-reporting of alcohol consumption.

7.5 Source of data

7.5.1 Ethical approval

Data protection registration was applied for in May 2012, and awarded on the 21st May 2012 from the UCL Data Protection Office, reference number Z6364106/2012/05/25, under Section 19, Research: Health Research. Ethical approval was then sought for the study, which was named 'Ordinary drinking patterns and your experience of drinking diaries', from UCL REC. This was awarded on the 30th May 2012 with the reference number 2832/001. Copies of the data protection form, ethical approval application form, correspondence with NatCen, and information sheets and consent forms supplied to the REC and later used in the study are available in Appendix J through to N.

7.5.2 Pilot study

Two people (who were not HSE participants) were asked to take part in a pilot study to test the interview schedule and practise using the recording equipment. The pilot study participants were given a blank copy of the HSE 2011 drinking diary and asked to fill this in for the following seven days. This was similar to the procedure in the HSE 2011, except participants were not asked to return the diary to the researcher. The diary was completed so that participants could reflect on this in the interview, rather than making comparisons between diary responses and responses in the semi-structured interview. A week or two after the diary was completed the interviews took place in participants own homes and were recorded on an Olympus Dictaphone with an internal microphone. After the interview there was an informal discussion about any questions that were particularly difficult or felt to be leading and how this could be overcome.

This discussion was not recorded in order to facilitate exchange of ideas and recommendations. As a result of this, some minor changes were made to the wording of the interview schedule and the prompts used for the main interviews. Pilot interviews were transcribed and recommendations made for future interviews (see Appendix O). The pilot study participants were not remunerated.

7.5.3 Sample selection

In total, over 3,500 adults aged 18 and over recorded drinking alcohol at least once during the diary week in the HSE 2011, which was equivalent to 73% of the total who completed the seven-day drinking diary. From this, a sample was selected by NatCen to be contacted about taking part in a subsequent research study. NatCen charged a fee to cover the data manager's time, postal costs of sending letters, and hosting a Freephone number. For the convenience of the participants, the interviews were to take place face-to-face in participants' own homes. In order to keep travel costs to a minimum, this meant that they needed to live within a reasonable distance of London to be interviewed. NatCen requested that London boroughs were selected for sampling to take place from. Ten London boroughs were chosen:

- Camden
- Hammersmith and Fulham
- Kensington & Chelsea
- Kingston
- Lambeth
- Merton
- Richmond
- Southwark
- Wandsworth
- Westminster

As the interviews were to focus on issues surrounding under-reporting of alcohol consumption, it was decided that only participants who drank alcohol in the diary week should be selected. Further, to reduce the probability of interviewing only occasional drinkers - for whom issues of under-reporting are likely to be less pertinent in terms of the absolute amount of drinking not captured – the sample was restricted to those who drank on four or more days in the diary week only. Selection on quantity rather than frequency of alcohol consumption was considered but this was not done because frequency gave a clearer idea of a regular drinking pattern than quantity. There was no selection on demographic or social variables meaning the demographic and social characteristics of those selected were random. Finally, only one individual was selected in each household to avoid the risk of two interviews being conducted with members of

the same household, as this would narrow the demographic and social variation if at least 20% (i.e. two out of 10 interviewees) of the participants interviewed lived together.

7.6 Methods

7.6.1 Recruitment

Once ethical approval had been awarded and sent to NatCen, the data managers selected the sample based on the criteria in Section 7.5. In total, NatCen identified 26 eligible survey participants from the HSE 2011 dataset. Each of these participants was sent a letter by NatCen (which was written jointly by NatCen and UCL) informing them about the study 'Ordinary drinking patterns and your experience of drinking diaries'. The letter was sent on 11th September 2012 on NatCen headed paper. HSE 2011 participants who did not wish to be contacted by the researcher could telephone a Freephone number within two weeks of receipt of the letter to withdraw (n=1). After this time, the details of the remaining 25 participants were passed on securely in a password-protected compressed Excel spreadsheet. The details passed on were full name, address and telephone number, and crucially, did not include identifiers which would make the participant identifiable in the HSE 2011 dataset. Therefore it was not possible to explore survey responses of the participants interviewed; this was intentional such that their anonymity in the dataset was protected. Participants were contacted and interviews arranged by telephone in late September 2012. Six selected participants were unreachable (daytime and evening calls were attempted), four survey participants declined to take part in the study, and four were not contacted and kept as reserves (the least accessible in terms of public transport), in case of withdrawal after interviews were arranged.

7.6.2 Procedure

In total, 10 interviews were completed. These primarily took place in participants' own homes (n=9), with the remaining interview taking place in a workplace (which was a café after lunch service had finished). After a brief and informal introduction to put the participants at ease, participants were asked to read the information sheet and then sign the consent form before the interviews commenced. The interviews were recorded on an Olympus Dictaphone with an internal microphone (as used in the pilot study). The majority of visits took around 45 minutes to an hour, although a small number of visits were shorter at approximately 30 minutes, and one was closer to two hours. The first part of the interview concentrated on participants' experience of the drinking diary, then a more in-depth discussion of routine drinking practices, drinking patterns and styles, and under-reporting followed. The interview schedule is available in Appendix P. Participants were given a £10 gift voucher at the end of the interview as a thank-you for their participation. Interviews took place in daytimes, evenings and weekends in October and November 2012.

Efforts were made to make participants feel at ease and to build up a similar rapport with each such that participants' willingness to share information was maximised. Although this was compromised to some extent by the researcher sharing more characteristics with some participants than others, all the interviews were conducted by the same researcher. There was a range of responses in the interviews, and the level of detail that participants provided varied. Some participants were more talkative and willing to share their experiences and views than others. A small number of participants whose responses were less detailed may not have been confident with their level of English, as it was apparent that it was not their first language. This may have acted as a barrier to gaining the depth of responses that was achieved in some of the other interviews.

7.6.3 Analysis

Interviews were transcribed manually on a MacBook using a USB foot pedal and trial versions of transcription software. All interviews were transcribed within one or two days of the interview taking place, such that the experience of conducting the interview was still recent. Any identifiable information or personal information (e.g. if a participant mentioned their spouse by name) was removed from interview transcripts at this stage. Comments and coloured fonts were used to flag parts of the transcript that appeared important at this initial stage. All interviews were completed and transcribed before the analysis took place in Microsoft Excel. This was suitable for analysing the 10 interviews, especially because only one person was working on the data. It is important to note here that all interviews were conducted, transcribed and analysed before the quantitative analyses presented in the previous chapter (Chapter 6) commenced. Therefore the interpretation of the interviews was not influenced in any way by the findings of the previous chapter.

A framework was created in Excel with a row for each participant, and columns that related to the different areas that were discussed in each of the semi-structured interviews. Participant's responses along with brief quotes were recorded in the spreadsheet, with page and line numbers used to refer to relevant points in the interview transcripts. Responses were then colour-coded across participants to identify how themes identified in one area of the interview related to those themes and areas identified in other participants. Thus the analysis allowed for both emic and etic coding (**192**). Emic coding was applied to things participants described during the interview, such as drinking to achieve a 'nice buzz' or becoming 'tipsy' when they were talking about their drinking practices and experiences of drunkenness. Etic codes were developed by the researcher while analysing the transcripts. These were used to group participants' responses into a category or theme, such as embodied aspects of drunkenness or describing drinking patterns as routine.

7.7 Results

The 10 participants interviewed (7 men, 3 women) ranged in age between 25-90 years. Nine were employed at the time of the HSE interview, and one was retired. Participants lived in areas from all area deprivation quintiles, but most were from the highest two income quintiles (two withheld information on income). Almost all participants said that the week they completed the diary was, or probably was, a fairly typical week (9/10). One participant remembered drinking a lot more than usual because he attended a stag weekend while he was completing the diary. Other participants described the week as not out of the ordinary but perhaps slightly lighter (2/10) or heavier (1/10) than an average week. This recall is slightly different to what HSE 2011 participants on average said at the end of the diary week (Section 6.7.1), but some change is to be expected given the small sample size and that the diary was completed in any one week in 2011 and the interviews took place in October and November 2012.

All participants stated that doing the drinking diary did not influence their alcohol consumption during that seven day period. Three people had changed their drinking patterns somewhat since the time when they did the diary, aiming to either drink less often, not drink alone, or simply cut down the quantity of alcohol they drank. All three of these people said that the reasons that they had changed their drinking patterns were wholly unconnected to the diary.

7.7.1 Mode effects: honesty and recall

Many of the participants made a clear distinction between the drinking diary and the CAPI questions about drinking. Whilst it was commonly stated that this was not a case of preferring the privacy of doing the diary, when asked if doing the diary was different to talking to the interviewer about alcohol consumption (referring to the CAPI), six of the 10 participants (one woman) volunteered that the anonymity of the self-completion diary led to increased honesty. These participants believed they were likely to make generalisations in the CAPI, whereas the diary was viewed as an objective measure of drinking:

> *If somebody asks you, like about your drinking habits I think you automatically put up a sort of, a little bit defensive and a little bit glossy on um, what you do…I suppose it's more truthful [the diary], it's more, like because it's there in black and white…it would just be, as it is I s'pose. Rather than, um, finessing certain bits or missing certain bits out.*
>
> Male, age 35-44, most deprived quintile, second highest income quintile, employed

For the remaining four participants, the diary and the CAPI were seen as equivalent. These participants tended to have routine drinking patterns so perhaps to have put this 'gloss' on their drinking would have required more extensive modification of their alcohol consumption than for

those whose consumption was less routine. In contrast to this general sense that the privacy of the diary promoted honesty, one participant (who perceived the diary and the CAPI as equivalent) believed others could report more drinking in the CAPI, or that consumption not reported in the face-to-face interview would not be reported in the diary either:

> *Whether I can offer more by one-to-one I think probably more does come out, especially if you're recording it. You know. You get more, maybe more if you do it in person.*

> *Y'know, well, is it beneficial having it on paper? If they're gonna tell lies they're gonna tell lies…are you gonna get the truth one-to-one, or are you gonna get the truth on paper?...Not at all. Neither!*

Male, 75+, second least deprived quintile, income withheld, employed

This may have been in reference to the interviewers' ability to probe and ask questions. This participant described a very established drinking routine – one glass of red wine a night - and thought *other* people may be unwilling to report how much they drink. For him, drinking is so routine that it is easy to recollect, but his scepticism of others' willingness to tell the truth is corroborated by the 'gloss' that other participants believed they may have put on their consumption in the CAPI.

Quite set apart from this is the recall issue which was identified by other participants. For a small number of participants, the diary was seen as a more objective measure of drinking than the CAPI, not because it promoted 'honesty with yourself' (a recurrent emic code) but rather because of the recall period involved. One participant gave both these reasons. As the diary is completed in closer proximity to the drinking occasion, recall is made easier. Three participants, two of whom were women, found this noticeable:

> *You do it, sort of, much quicker after the event. Much more proximity to the event. I mean even if you'd sat down and at the end of the week tried to remember you'd have struggled.*

Female, age 45-54, second most deprived quintile, highest income quintile, employed

> *I suppose I might put, be more prepared to put it chapter and verse on the form. Um, but again I think it comes more likely comes back to, to pure recollection. It's not trying to kind of, you know, gloss over the facts.*

Female, age 55-64, least deprived quintile, highest income quintile, employed

So although there was a general consensus across all 10 interviews that the diary is a better and more objective measure of drinking than the CAPI, the reasons for this belief varied. Why some participants view this in terms of honesty and social desirability and others view this in terms of recall - with only one participant identifying both reasons – is interesting and shows that the reasons for under-reporting of alcohol consumption are likely to be multiple.

7.7.2 Actual and perceived drinking pattern

Half of participants (5/10) described their drinking pattern in ways which meant it was coded as routine. This tended to be expressed primarily in terms of frequency of drinking, although quantity was also mentioned to a lesser extent. Three further participants described their drinking pattern as semi-routine, with some aspects of their drinking pattern being quite entrenched but others being more unpredictable. Participants who had a routine drinking pattern generally felt they had a good idea of how much they drank before they did the diary:

> *I knew exactly, pretty well, what I was drinking and I was aware for some time that I was probably exceeding, certainly exceeding 21 units…no I'm quite open about it.*
>
> Male, 75+, least deprived quintile, second highest income quintile, retired

The routine drinkers tended to be older participants, and also did most of their drinking in the home. Participants with a more varied or chaotic drinking pattern more commonly recalled experiencing some element of surprise at their alcohol consumption when they completed the diary. Although this surprise concerned the quantity of alcohol consumed to an extent, the frequency of drinking was of particular mention:

> *I was slightly shocked that I'd gone out so many times that week…it was all perfectly normal…it did sort of make me realise that's actually quite a lot in a week.*
>
> Male, 25-34, middle deprivation quintile, highest income quintile, employed

> *Yeah I was sort of surprised, when it's down on paper you think 'oh yeah'. Y'know when you see that I'm drinking nearly every day.*
>
> Male, 65-74, least deprived quintile, income withheld, employed

Two groups therefore emerged: routine drinkers with accurate perception of consumption, and non-routine drinkers with what they thought was a less accurate perception of consumption. This may mean that the reported alcohol consumption (in the CAPI) of participants with routine drinking patterns is more reliable than that of those whose consumption is more varied.

Therefore under-reporting is not just associated with level of consumption as previously thought (Section 2.6.7), rather drinking pattern may also play a part. In addition, participants reflected on their perceptions of their own drinking patterns, and how these corresponded with what they put in the diary. Inaccurate perceptions of drinking patterns also may contribute to under-reporting, and there was evidence that for some participants the diary uncovered inaccurate perceptions of alcohol consumption:

> *It was actually the fact that sort of done [sic] two or three days in the week where I also drank. Whereas normally I think 'I don't drink for four days a week so it's fine'.*
>
> Male, 25-34, middle deprivation quintile, highest income quintile, employed

> *I tend to think of myself as somebody who just drinks, you know, maybe Friday and Saturday, and sometimes I thought 'ooh, I've actually had four nights when I've had some alcohol this week.'*
>
> Female, age 45-54, second most deprived quintile, highest income quintile, employed

These inaccurate perceptions may be genuine, or may emerge resulting from attempting to adhere to social norms. Someone who sees themselves as a 'weekend drinker' may be unlikely to report midweek drinking in the CAPI (i.e. fewer drinking days, and thus lower weekly total), but this is something which would be recorded in the diary. Therefore both drinking pattern itself and the accuracy of perceptions of that pattern are both linked to drinking more in the diary than expected.

7.7.3 Usual methods of tracking drinking

Drinking more in the diary week than expected, or a sense of surprise at the diary was not limited to having a non-routine drinking pattern. The usual methods by which participants tracked their drinking was also associated with whether they experienced any surprise at their alcohol consumption when they completed their diary. Most commonly, drinking was tracked in terms of numbers of drinks or fractions of bottles (8/10). Put simply:

> *If the bottle's empty I know I drank a bottle, don't I?!*
>
> Male, 65-74, least deprived quintile, income withheld, employed

Much less common was to use units of alcohol to track consumption, with only one participant mentioning units as a helpful way of tracking drinking. This participant said he had been using units since the early 1990s on the advice of a health professional, and this became increasingly

important as he got older and the risks of diseases such as dementia became more real. He had been keeping his own drinking diary on a calendar for a few weeks prior to interview after resolving to reduce his alcohol intake around two months before the interview took place:

> *So I reckon that increasingly, certainly this year I was drinking, making a bottle of wine last two days. And I reckon I was probably exceeding, well I was certainly exceeding 21 units a week…Now that continued, until the first week of August this year…I decided quite strictly to mend my ways…I decided that I would only have one bottle of red wine per week. That bottle should last three days. I would then have shorts – a double whiskey, a double vodka, 50ml – I've got a proper measure…on the next three days if I did two days of red wine, or the next two days if I did three days of red wine. And I would have a holiday from booze, preferably on Saturday and Sunday.*
>
> Male, 75+, least deprived quintile, second highest income quintile, retired

This participant was not only aware of the units in certain drinks but also very aware of the weekly and daily drinking guidelines. Together we calculated his weekly alcohol intake in units under his new regime: 14-16 units per week. For him, this pattern of drinking was an acceptable amount of alcohol to drink, and he was delighted that he was well within the guidelines as he saw these as an objective figure below which the risk of alcohol-related harm was negligible. However, he was dismissive of the Royal College of Psychiatrists report (**193**) suggesting over 65s drink no more than 1.5 units per day which he had recently seen reported on television (**194**):

> *I'm not going down to 1.5 units that's ridiculous.*
>
> Male, 75+, least deprived quintile, second highest income quintile, retired

Adherence to the drinking guidelines was only viewed as acceptable if the prescribed level of drinking fitted in with this participant's desired lifestyle. This sense that if the drinking guidelines are incompatible with your lifestyle then they are irrelevant was also observed in other participants:

> *…It doesn't suit my lifestyle so there's always going to be a little bit of…'we can poo-poo that'…'it's some bearded civil servant whose come up with this'. 'There's no real science behind it', you know.*
>
> Male, aged 45-54, second least deprived quintile, highest income quintile, employed

This participant attempted to displace what appeared to be his views as a common or stereotyped response. He began by talking about his scepticism as to whether a single drinking

guideline for everyone of the same gender regardless of age, body size and physical fitness can really be appropriate from a scientific perspective. However the fact that he defaulted to stating a common response - despite being very articulate otherwise – may be indicative of his wariness of making his opinions known in the presence of an 'expert' health researcher. Due to this ambivalence towards drinking guidelines it could be expected that few participants 'drank in units'. Of the participants who exclusively used units (1/10, see above) or counted drinks (4/10) to track their drinking, few said that they recorded higher alcohol consumption than they would have expected in their drinking diary. The routine drinkers tended to fall into this category of tracking drinking. Interestingly, the methods used to track drinking were commonly used in combination with one another (5/10), and this appeared to be related to the extent to which they were surprised at their diary or they recorded more drinking than they expected to drink. Participants who used more experiential approaches to track their consumption tended to recall drinking either larger quantities of alcohol or more frequently than they expected when they completed their drinking diary.

These experiential approaches included embodied aspects (the level of intoxication perceived) or individualised approaches. Participants who used these approaches to track drinking had varying drinking patterns. Embodied aspects of tracking drinking were used by three participants. For some, when drinking a certain pleasurable level of intoxication was sought, and the amount of alcohol consumed to reach that point was of little relevance:

> *Friday and Saturday probably not [able to estimate drinks]. You know I wouldn't be able to put a number on it…it's how you feel on it. You know, it's, you get that nice little buzz.*
>
> Male, aged 45-54, second least deprived quintile, highest income quintile, employed

For this participant, consumption can only be tracked using an experiential approach. The focus of drinking is to reach a pleasurable level of intoxication, and embodied aspects best guide the pursuit of this. Counting a certain number of drinks would not have the same efficacy due to the changing experience of intoxication in different contexts, and further, increasing tolerance to alcohol over time. However for two other participants, both women, these embodied aspects of drinking are something to be avoided:

> *I'd never allow myself to get tipsy.*
>
> Female, age 55-64, least deprived quintile, highest income quintile, employed

> *Um, I try not to get drunk. I know when to stop, make sure I pour some, I pour the drinks. [Laughs] so I pour other people more than me! ...So I drink white wine so I*

> *water it down with some soda water lots of the time. So it always appears I have a full glass of wine but when I'm with everybody else I drink I top it up with soda water. So, they don't top it up with wine.*

Female, age 25-34, second most deprived quintile, second highest income quintile, employed

Individualised approaches were created and used by only a minority of participants (2/10), both of whom were men. For those who used them, these were an important tool used in their daily lives to track their drinking. One participant dichotomised drinking occasions into lighter and heavier drinking occasions using a three-pint rule. For him, drinking was tracked by counting drinks if he had three pints of beer or less, but drinking more than three pints made the drinking occasion qualitatively different. After three pints, consumption was no longer monitored in terms of numbers of drinks, and the embodied aspects of intoxication took over:

> *I have sort of a, self-conscious limit of three. Um, so if I go over three then it's sort of like, a bigger, bigger night…I know how much I drink. To a point. If it's a big night and I get drunk, I lose track…it's sort of like a point, a tipping point almost…Um, so if I go over three then it's sort of like, a bigger, bigger night …where, you're starting to go over to getting a bit, um, you're on your way to get plastered then. Put it that way.*

Male, age 35-44, most deprived quintile, second highest income quintile, employed

This method groups drinking occasions into two distinct categories. The other individualised approach used was more of a continuum, whereby consumption was monitored by the time elapsed since the start of the drinking occasion. For this participant, time was crucial in approximating how much he had had to drink:

> *I went out to the pub after work with some colleagues, and were just were doing rounds and all drinking beer…at some point, I asked them 'what's the time?', must be getting on for sort of half eight quarter to nine and they said 'no it's quarter to 11'. And that was quite shocking because you realise wow I've been in here for nearer five hours, I thought it was coming up for three and it's actually five. Therefore, I'd probably drunk about three more pints than I thought I had.*

Male, 25-34, middle deprivation quintile, highest income quintile, employed

Participants who have these sorts of experiences and approaches demonstrate the scope for qualitative research to contribute to understanding low alcohol sales coverage. This participant not only under-estimates his alcohol consumption from using this method, but also effectively loses time. Estimating consumption based on duration of drinking is an intuitive method, but by the participant's own admission is not always accurate. Contributing to this may be that the perception of time can vary, and also the speed of drinking can do so as well for many reasons

including occasion, mood, time of day, and level of intoxication. The two participants who used individualised approaches to track their drinking were quite aware that there were limitations to these, and the origin of these approaches was unclear for both.

Along with the use of embodied aspects to track consumption, together these 'experiential approaches' to track drinking were linked to participants recalling that they were surprised at their consumption or drank more than they expected they would in their diary week. However, these participants tended to use the qualitative assessment in combination with a quantitative assessment of consumption. Participants who tracked their drinking in terms of glasses, bottles or cans, or alcohol units, and did not also employ experiential approaches to track their drinking did not tend to say they were surprised at their diary or that they drank more than they expected. Therefore people who use these approaches appear to have a more accurate perception of how much they drink. It appears that adopting an experiential approach to tracking drinking somehow clouds the ability to monitor consumption, and perhaps people who track their drinking in this way may be more prone to under-report their alcohol consumption.

7.8 Discussion

The 10 interviews conducted with HSE 2011 participants who completed the seven-day drinking diary identified factors which were linked to drinking more than expected in the diary week or feeling surprised at the diary, which may in turn be linked to under-reporting of alcohol consumption. Having a non-routine drinking pattern, and usually tracking drinking using experiential approaches were linked to experiencing surprise at the diary or drinking more than they would have expected. With the exception of older participants – who had more routine drinking patterns – not commonly stating that they drank more than they expected to, demographic and social factors appeared to be less important.

Whilst this is not definitive due to the small number of interviews conducted, this appears to corroborate what was observed in the previous chapter (Chapter 6), in which demographic and social factors did not predict differential reporting of alcohol consumption but some alcohol-related factors did. In summary, there is no evidence from either this chapter or Chapter 6 that demographic and social factors independently predict drinking more than perceived in the diary, or recording more drinking in the diary week than the CAPI week. Instead, alcohol-related factors appear to be much more important. Alcohol consumption appears to be important to an extent, but drinking habits perhaps even more so, with people who have less routine or more 'chaotic' drinking patterns - mixed venues, mixed drink types, or a non-routine pattern – more strongly associated with under-reporting in standard social surveys.

7.8.1 Strengths

This is a qualitative study of what is essentially a quantitative problem. It is the first qualitative study specifically designed to better understand under-reporting of alcohol consumption, and responds to the lack of methodological innovation identified in the literature review (see Section 2.7). The design of this study emerged after much deliberation of proposed study designs in conjunction with supervisors and other researchers. This chapter has identified possible risk factors for under-reporting that would have been difficult to identify using a quantitative methodology such as a questionnaire. The fact that participants could volunteer their own experiences and ideas about how they found doing the diary has led to a richer and more nuanced understanding of *why* alcohol consumption is under-reported in social surveys.

For most of the participants interviewed, drinking was quite an ordinary part of everyday life, an unremarkable event which did not warrant being committed to memory. For the majority, the HSE 2011 was the first time they had completed a drinking diary and as a result was also the first time they had to review or monitor their alcohol consumption. Current standard survey questions may not be suitable for everyone, and a more intensive approach (such as the drinking diary) is necessary to more accurately record alcohol consumption in those whose consumption is not likely to be recorded as well using retrospective recall or quantity frequency questions. For many participants to recognise during the interview that they did not previously realise how much they drank was an interesting finding in itself. Perhaps this sort of reflexive practice promoting mindful alcohol drinking or reviewing consumption could even form part of health promotion packages such as drinking diary mobile phone apps. In particular, this would be beneficial if under-reporting groups could be identified, such as has been done in this thesis.

Latham has acknowledged the utility of diaries in qualitative research (**190, 191**), and diary-interviews have been described as an excellent supplement to a written diary (**191**). Whilst the interviews in this study were not diary-interviews *pe se* - the diary was not obtained by the researcher conducting the interview – they were very focused on the drinking diary. This chapter responds to this call for using a relatively under-used method. This chapter has had contrasting findings to that in human geography which has identified embodied aspects of drinking to be particularly important for domestic drinking routines (**24, 188**). Instead this study supports the idea that such experiential approaches to track drinking are associated with varied drinking practices, and that more routine drinkers count their consumption in various ways.

7.8.2 Limitations

A relatively small number of interviews were conducted due to the limited financial resources available to conduct the study. While the financial costs of conducting the interviews themselves

(Dictaphone, travel, etc) were moderate, the cost of selecting HSE participants through NatCen was considerable (several hundred pounds). To extend the sampling to recruit more participants would have cost a similar amount of money to the initial sampling. As a result, saturation was not reached in the interviews and it is possible that more, or conflicting factors could have emerged which could have been linked to either drinking more than expected in the diary week or under-reporting more generally. While a more casual method of recruitment could have recruited a greater number of participants as it would have been less expensive, this approach allowed for the interviews to be very focused on the seven-day drinking diary. The ten interviews conducted were a rich source of data and have been able to both supplement and complement the quantitative study in the previous chapter.

The diversity among the participants interviewed was quite limited. Although there was a wide age range and participants lived in areas from each deprivation quintile, only three participants were women, and seven were in the top two income quintiles (N.B. two had also withheld information on income). This skew towards men and higher income groups may in part have been driven by the selection on drinking on four or more days in the diary week, as men and those in higher income groups are among those who drink most frequently. However, of the 25 names and addresses provided by NatCen, 12 were men. There was little difference in the proportions of men and women who were contacted, however women were more likely to decline to take part (no men declined to take part once they had been contacted by telephone).

Selecting participants based on quantity rather than frequency of drinking may have avoided the skew towards those on high incomes; however, those on high incomes do tend to drink more as well as more frequently so this may not solve this problem. Income and deprivation characteristics were only obtained for those interviewed therefore it is not known whether there was any social patterning to non-response as there was with gender (evident from the names provided). Future studies on under-reporting among participants who have completed a diary and a questionnaire or interview-based measure of drinking could use a more targeted approach using the available data. Participants could be selected if their diary exceeded their CAPI, for example, or whose diary exceeded their CAPI by a certain amount. This was not possible for this chapter, however, as the selection was carried out while the analyses for the HSE 2011 report were still being completed, meaning that variables that would have been required to select on these characteristics had not yet been created.

Establishing whether a participant recalled experiencing any surprise when they completed the diary or that they drank more than expected, or whether it looked like an ordinary week, was reliant on their recall of completing the diary. The diaries were completed between 11 and 20 months prior to the interviews taking place. Therefore participants' recall of how their

perceptions of their drinking changed when they did the diary may not be fully accurate. Ideally the interviews would have been conducted in closer proximity to the diary being completed. However, participants were recruited from the HSE 2011 as soon as a dataset was completed which participants could be selected from. Future studies may wish to recruit participants from the general population to complete a diary and then to conduct interviews with these participants in much closer proximity to consumption taking place.

As much as these interviews provided much useful insight into how and why people might under-report their alcohol consumption, as well as identifying additional risk factors for under-reporting, the interviews were an edited version of drinking practices which the participants were willing to share with the researcher. The story participants told could be either influenced by the way the participant wished to be perceived, or by the participant attempting to tell the researcher what they thought the researcher wanted to hear. Indeed, anthropologists and others have shown that people will often say one thing about their consumption practices but actually do something quite different. Miller has shown that this is true for household provisioning and shopping (**195**), and as drinking is a much more sensitive subject, this is likely to also hold for alcohol consumption to an even greater extent. Therefore, observational and ethnographic studies on under-reporting of alcohol consumption are welcomed. These approaches would require substantially more resources than were available for this study but may uncover interesting reasons for the discrepancies between actual and perceived consumption that would not be identified in a quantitative study.

7.8.3 Conclusions

The qualitative interviews identified having a non-routine drinking pattern and usually tracking drinking using experiential approaches as linked to participants recalling experiencing surprise at the diary or drinking more than they would have expected. Combined with the previous chapter, this can be seen as a mixed-method approach to identify risk factors for under-reporting of alcohol consumption in the HSE 2011. From this novel approach it appears that demographic and social factors are of lesser importance than alcohol-related factors. Whether this would be maintained if consumption by those outside the sampling frame and among non-responders is unknown. These findings both supplement and complement those of the previous chapter (Chapter 6). The fact that these findings supplement the quantitative study shows that qualitative research does have a place in understanding under-reporting of alcohol consumption. Further, that these findings were similar to the quantitative findings suggests that there is value in these results, and that alcohol-related factors may be important for identifying those who under-report their consumption.

The public health implications of the findings of this chapter are unclear, due to this being a qualitative study on an issue predominantly explored using quantitative surveys. Whether identification of people with non-routine drinking patterns would consistently be able to identify people who are not aware of how much alcohol they drink is uncertain. However, if future studies can confirm that that people who have repeated episodes of heavy or binge drinking have a less accurate perception of how much alcohol they drink, this population could be targeted for brief interventions or feedback about alcohol. The use of experiential approaches to track consumption being linked to not being aware of consumption may indicate that knowledge of the amount of alcohol in certain drinks – particularly self-poured drinks – is poor, and that engagement with the concept of units is minimal. For those who perceive alcohol consumption in terms of states of intoxication rather than numbers of drinks consumed, perhaps alcohol education initiatives may be helpful.

Chapter 8 PART B. Study two: investigating how accidental under-estimation of home drinking may contribute to under-reporting

The work presented in this chapter is the first published study that has investigated both actual and perceived units of alcohol poured in a self-defined 'usual' glass of alcoholic drinks in a general population sample. A convenience sample (n=283) of adults recruited at a six sites in South East England selected from eight types of drinking glass and poured their usual glasses of wine and spirits (465 glasses in total). The mean amount of alcohol poured was 1.9 units for both wines and spirits. Of the drinks which participants estimated the alcohol content, 52% wine estimates and 42% spirits estimates were within half a unit either side of the actual amount poured. Of the remainder, for wine 29% over-estimated and 19% under-estimated their glass, and for spirits 42% over-estimated and 17% under-estimated. Systematic under-estimation of the amount of alcohol in a self-defined usual glass was not identified. However, independent risk factors for under-estimating emerged. These were increasing volume poured for both wine and spirits, and belonging to a non-white ethnic group and being unemployed or retired for wine only.

8.1 Background to the study

One reason why under-reporting of alcohol consumption may take place is due to accidental under-estimation of the amount of alcohol in certain drinks (Section 2.6.6.2). This particularly concerns alcohol consumption in the off-trade, where drinks are not served in standard volumes as they are in the on-trade in the UK. As two-thirds of all alcohol sales in the UK now take place in the off-trade (see Section 2.4.1), there is the potential for this under-estimation to contribute substantially to the missing units. There is evidence that although the majority of the population has heard of alcohol units, the proportion correctly able to identify the drinking guidelines or the number of units in a standard glass of alcoholic drinks is low (see Section 2.6.6.1). One way this can be investigated empirically is by conducting studies in which participants complete a pouring task of their 'usual glasses' of alcoholic drinks.

In the literature review, 16 studies which have asked participants to pour glasses of alcoholic drinks were identified (Section 2.6.6.2). The majority of these studies measured participants' usual glass (**66, 102-105, 108, 109, 111, 114, 116**) and a smaller number of studies focused on participants' ability to pour a standard drink (**101, 107, 110**), with one study from England asking participants to pour both (**115**). Just one of the 'usual glass' studies identified attempted to quantify participants' perceptions of the number of standard drinks poured in a usual glass, and this was conducted in Australia and among 65-74 year olds only (**114**). The study which asked participants to pour both a usual glass and a standard drink (a unit) was conducted among 434 16-25 year olds in South East England by De Visser and colleagues (**115**), and was conducted at about the same time that the work presented in this chapter took place. A usual glass was poured first, and then participants were asked to pour a unit of alcohol afterwards (**115**). The reason for this was to avoid biasing the participants' pour of a 'usual glass' if they had attempted to pour one unit immediately before (**115**).

Common features of the design of previous studies were that a selection of glass types was typically offered and participants were free to choose the glass that was most similar to what they would normally use for that beverage. The majority of previous studies used either water or coloured water (to look like the beverage they were supposed to be pouring) (**66, 101-103, 107, 109, 114, 115, 196**), although some others used real alcoholic drinks (**104, 105, 108, 111, 112**). One study asked respondents to point to a level on a marked vessel instead of pouring a glass themselves (**116**). Some previous studies conducted in participants' own homes have allowed for ice when considering spirits, either by allowing for ice melt in volume calculations (**109**), or by using plastic ice rocks (**114**).

These studies found that respondents frequently pour more than one alcohol unit or standard drink when asked to pour either their usual glass or one standard drink (see Table 2.3). UK studies that have asked participants to pour their usual glass found that a usual glass of wine and spirits was close to two units of alcohol (**108, 111, 115**). However two of these studies were conducted among school and university students (**111, 115**), therefore relatively little is known about the general population. The Australian study which investigated actual and perceived amounts of alcohol in a self-defined usual glass among 65-74 year olds found that men poured on average 1.33 standard drinks (SE 0.03), while women poured on average 1.15 standard drinks (SE 0.02) (**114**). On average, men under-estimated the amount of alcohol they poured by 23%, and women by 16% (**114**). While this study was able to identify under-estimation in the elderly population sampled, this may not be true of a general population sample in England. It is known that in England, older people – as well as drinking less and being more likely to abstain from drinking alcohol - tend to have a poorer knowledge of units than younger people (**99**), therefore a general population sample may be more accurate at estimating the alcohol content of their drinks than a sample of older adults.

Chapter 6 and Chapter 7 found that alcohol-related factors were more important in identifying under-reporting of alcohol consumption - as drinking that may not be captured using standard survey practices - than demographic or social factors. Therefore it is important that alcohol-related factors are investigated with respect to drink pouring practices as well as demographic and social factors. Part of the work presented in this chapter is the first published study from the UK, and indeed Europe, of actual and perceived amounts of alcohol poured in a self-defined usual glass of alcoholic drinks.

8.2 Research question

Do drinking adults know how many units of alcohol are in their ‘usual glass’ of alcoholic drinks?

8.3 Objective

Conduct a face-to-face survey investigating estimation accuracy of a self-defined usual glass of wines and spirits.

8.4 Hypothesis

Participants will tend to under-estimate the amount of alcohol in their usual glass and the extent of this may vary by drink type and socio-demographic factors: for instance older participants who may not be aware of units will be more likely to under-estimate than younger participants who are more aware of units.

8.5 Source of data

8.5.1 Ethical approval

The University College London Research Ethics Committee (UCL REC) was consulted when this study was being designed. The aims of the study, the information collected in the questionnaire, and the procedure were explained. The REC said that ethical approval was not required. This was because the survey procedure used collected data which were non-identifiable and names and contact information were not obtained as there was no follow-up to the study.

8.5.2 Pilot study

The questionnaire and survey procedure were piloted on 16th May 2011 at the Health Survey for England (HSE) 2009 report launch reception held at the Department of Epidemiology and Public Health, UCL. Approximately 75 people attended the report launch, 27 of whom took part in the pilot study. Most of those who attended the launch but did not take part in the study did not stay for the reception. The pouring task was piloted with wine only to avoid confusion, as spirits were not on offer at the reception. Of the pilot study participants, 18 were women and nine were men. Almost all of the participants were white British, and education level, income category, and employment grade tended to be high. All participants had heard of units, although the knowledge of the drinking guidelines and number of units in standard drinks was variable. Almost all the participants (n=25) drank alcohol at least occasionally, and 90% (n=24) drank on at least one day in the last week.

The volume of wine poured did not vary by whether the participant selected red or white wine: with the mean volume poured for white wine (n=8) and red wine (n=18) at 125ml (SD 56.8, range 57-238ml) and 126ml (SD 47.6, range 70-267ml) respectively. This is equivalent to one-sixth of a bottle, known as a 'small' glass. The mean perceived number of units poured was similar for both types of wine as well: at 1.5 (SD 0.83, range 1-3.5) for white wine and 1.5 (SD 0.46, range 1-2.5) for red wine. However as the red wine had a slightly higher alcohol by volume (ABV) than the white wine, the actual number of units poured varied between the two drink types, with the mean number of units poured at 1.5 (SD 0.68, range 0.7-2.9) for white wine and 1.7 (SD 0.64, range 0.9-3.6) for red wine. There was a moderate positive correlation between perceived and actual units poured of 0.507 (P=0.008). Of 26 participants who estimated the number of units poured, 17 were within half a unit either side, six under-estimated (by >0.5 units), and three over-estimated (by >0.5 units). The results from the pilot study were used in a sample size calculation for the main study.

8.5.3 Recruitment of study sites

Participants were to be recruited from a range of venues undertaking different activities, on different days of the week, and at different times of the day. These venues fell into three main categories: shopping venues, drinking venues, and workplaces. In June 2011, Majestic Wine, the 'big four' supermarkets (ASDA, Morrisons, Sainsbury's, and Tesco), as well as Marks and Spencer and Waitrose, were contacted by email. Majestic Wine did not agree to data being collected on their premises, and said they were concerned their customers would think that they were involved in or endorsed the project. They recommended a supermarket chain saying that the greater footfall would also be more appropriate for the study. ASDA, Morrisons, Sainsbury's, Marks and Spencer and Waitrose did not reply with a personalised response.

Tesco requested that head office was consulted by letter. Tesco head office later gave permission for this to be taken up with a local store (Tesco Superstore Kennington, London). The store was visited and an impromptu meeting with the store manager resulted in co-operation from the store and support for the study. The managers asked that they were advised of planned data collection session times a few days in advance. On data collection days, the store provided a table from the staff training room to be used outside at the front of the store. Between data collection sessions, the study equipment was stored securely in the stock room for the cigarette counter which was conveniently located close to the entrance of the store. The second shopping venue was outside shops near the entrance to UCL students' union. Data collection here was arranged in liaison with one of the sabbatical officers for the students' union. For the drinking venues, pre-existing links were used and data were collected at a postgraduate student trip to Windsor and a flat warming party in Battersea. For the workplaces, again pre-existing links were used and data were collected at a charity's head office in Shoreditch and at UCL during the summer holidays.

8.6 Methods

8.6.1 Procedure

In line with a number of studies identified in the literature review (**104, 105, 108, 111, 112**), real alcoholic drinks were used in this study. Real alcoholic drinks were chosen over water or an imitation beverage as it was thought that associated visual and olfactory cues may guide participants in pouring a glass most similar to that which they would pour at home. Use of real ice cubes would not have been practical in this study. Use of plastic ice rocks was considered but it was decided that these are not a perfect substitute for real ice due to their often large size and artificial colour. Instead participants were asked to imagine that they were going to add ice afterwards. The decision was made to have a separate set of glasses, cylinders and funnels for

light (white wine, vodka, gin) and dark (red wine, dark rum, whiskey) drinks. This was so that the same glasses could be used throughout a data collection session without the need for rinsing glasses to avoid residue from dark drinks mixing with the light drinks and affecting the colour.

Upon arrival at a study site for data collection, a table was set up with 16 glasses (eight different types, in pairs), two 250ml measuring cylinders, two 100ml measuring cylinders, four funnels, two types of wine (white wine at 12% ABV, red wine at 13.5% ABV), four types of spirits (gin at 37.5% ABV, vodka at 37.5% ABV, whiskey at 40% ABV, and dark rum at 40% ABV), an information sheet, and three clipboards with questionnaires and pens. All the drinks were bought from a supermarket and the spirits were well-known brands. For ease of portability the spirits used were in original 35cl bottles. The study set up is shown in Figure 8.1. The information sheet (bottom left in Figure 8.1) is available in Appendix Q.

Figure 8.1: Study setup

Shoppers and passers-by were invited to take part in a study of home drinking and to 'test their knowledge of units'. Participants were eligible to take part in the study if they drank alcohol or poured drinks for other people. As this was quite clearly a study about alcohol consumption, instances where people were non-drinkers and non-pourers expressing interest in taking part in the study were rare. Participants completed the questionnaire (one side of A4) first, and then

took part in the pouring task. Each participant was asked to choose a wine and a spirit from those available, based on what they drank at home most often, and to select a glass which was most similar to what they would use for that drink. If a participant did not ever drink or pour one of the two drink types they were requested to pour a glass of the drink that they do drink (or pour) only.

Participants were asked to pour their usual glass of both drinks before the volumes poured were measured and units estimated. Drinks poured were measured using the funnels and measuring cylinders. The number of units poured was approximated from a printed table (Appendix R) kept out of sight of participants, and this was reported back to participants unless they said that they did not wish to find out how many units they had poured. The study procedure is summarised in Figure 8.2. The survey took around ten minutes in total for each participant to complete.

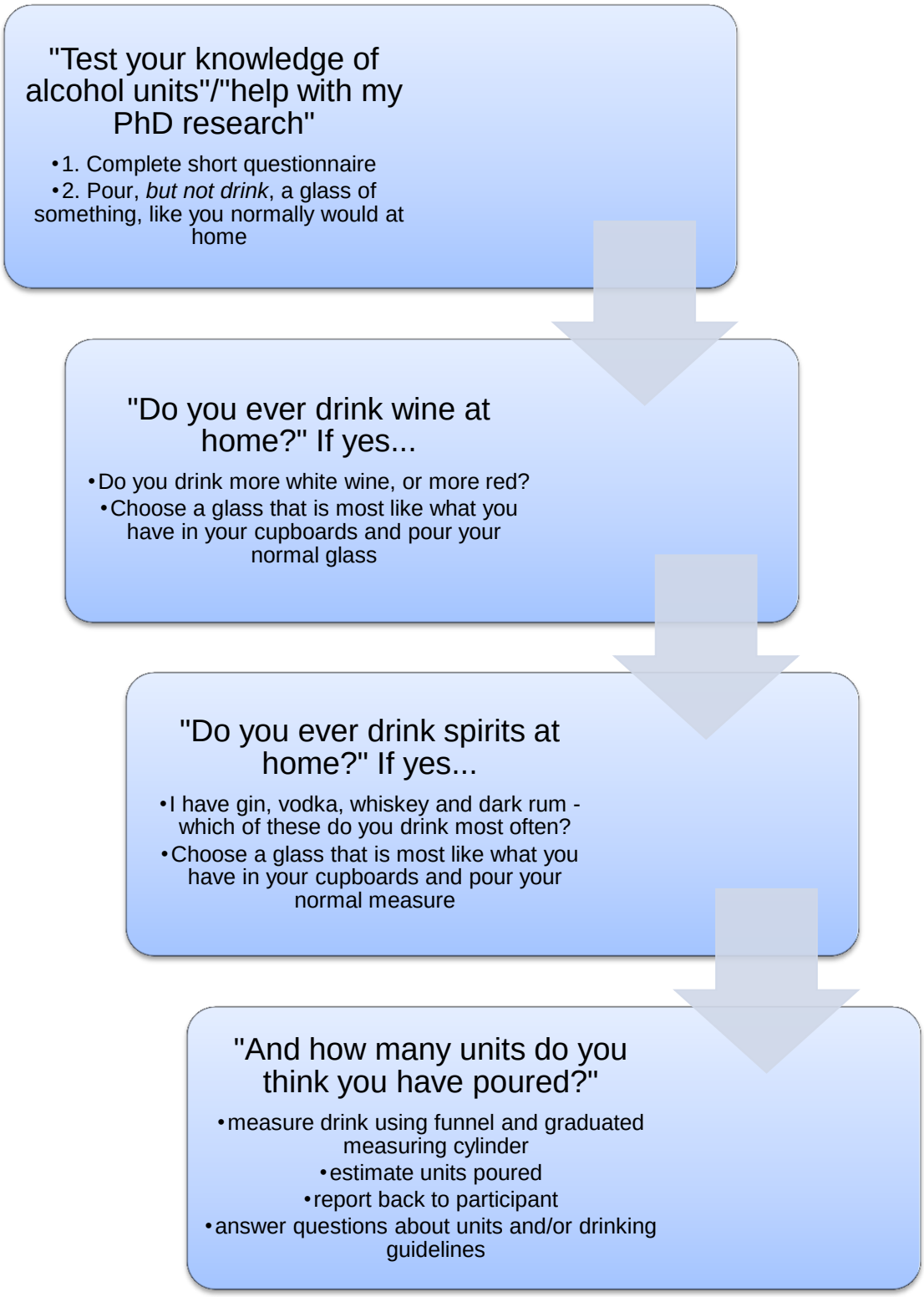


Figure 8.2: Study procedure flow diagram

A mid-study sample size calculation revealed that the required sample size was actually larger than originally calculated due to the standard deviation being substantially larger in the main study than the pilot (see Appendix S). The target sample size was revised and data collection continued until this was achieved. All study sites were visited just once with the exception of the Tesco Superstore which was visited seven times. Data collection took place on 12 separate occasions from July to October 2011 with a short break in August due to the London riots.

8.6.2 Measures

The questionnaire contained demographic questions, and questions on quantity and frequency of alcohol consumption and alcohol unit awareness. A copy of the questionnaire is available in Appendix T. The demographic questions and alcohol quantity and frequency questions were taken from the HSE 2008 (**197**), and the alcohol awareness questions were taken from the HSE 2007 (**198**) (of which the focus was 'healthy lifestyles: knowledge attitudes and behaviour'). The drink and glass type selected by the participant was recorded. The perceived number of alcohol units poured and volume poured were recorded on-site. The actual number of units poured was calculated during data entry.

8.6.3 Statistical analysis

Cross-tabulations describe the distribution of participants across study sites, demographic characteristics, alcohol drinking patterns and unit knowledge. Wine and spirits were considered separately in the analyses of the pouring task as many (64%) participants poured both drinks. The number of units poured was calculated accurately based on the ABV of the drink selected and the volume poured to the nearest millilitre. Cross-tabulations describe units poured by drink type, glass choice and with respect to drinking guidelines.

The difference between actual and perceived units poured was calculated for each participant (actual minus perceived units) who estimated how many units they thought they had poured. Positive values denote a usual glass that was under-estimated, and negative values a usual glass that was over-estimated. Cross tabulations and histograms explore estimation accuracy after removal of outliers (+/- >5 standard deviations from the mean). Scatter plots and correlation coefficients were used to describe the relationship between estimated and actual units poured.

To explore the hypothesis that inaccurate estimation of a self-defined usual glass may vary by demographic, social, and (most importantly) alcohol-related factors, such 'risk factors' for under-estimating or over-estimating were explored using multinomial (polytomous) logistic regression. 'Estimation accuracy' (actual minus perceived units of alcohol) was categorised as 'correct' (+/-

0.5 units), 'over-estimate' (<-0.5 units), or 'under-estimate' (>0.5 units). This tolerance of classifying estimates that were within +/- 0.5 units as correct was chosen thought to be an appropriate threshold for estimation accuracy. If this was too narrow, some participants with a fairly accurate idea of the number of units in drinks but facing limitations of the potentially unfamiliar glass shapes and drink types on offer may have been 'penalised'. A +/- 0.5 unit tolerance was thought to be suitably generous not to penalise those who were only slightly inaccurate but still to identify those whose estimation accuracy was poor.

Covariates were included in the multinomial logistic regression model if the likelihood ratio test for inclusion was statistically significant at the 5% level. If the likelihood ratio test was not significant the covariate was not included in the model. For wine estimating accuracy the covariates investigated but not included are sex, age category, income category, drinking frequency in the last year, drinking days in the last week, units consumed on heaviest drinking day in the last week, never drinking wine, drink drunk most often, glass chosen, and type of wine poured (red or white). For spirit estimation accuracy the covariates investigated but not included are sex, age category, income category, employment status, drinking frequency in the last year, drinking days in the last week, never drinking spirits, drink drunk most often, glass chosen and type of spirit poured (gin, vodka, whiskey or dark rum). All analyses were completed in Stata version 12 (StataCorp, College Station, TX).

8.7 Results

8.7.1 Descriptive statistics

A total of 283 participants (54% women) completed the questionnaire and pouring task. The distribution of participants across study sites is shown in Table 8.1. The majority of participants (61%) were from the site which was visited seven times. The other study sites were visited once each.

Table 8.1: Distribution of participants across study sites

Study site	Men		Women		Total	
	n	%	n	%	n	%
Total sample	130	100.0	153	100.0	283	100.0
Shopping/leisure	98	75.4	109	71.2	207	73.1
Supermarket	*83*	*63.8*	*90*	*58.8*	*173*	*61.1*
Students' union	*15*	*11.5*	*19*	*12.4*	*34*	*12.0*
Drinking venues	14	10.8	30	19.6	44	15.5
Postgraduate trip in SE England	*4*	*3.1*	*22*	*14.4*	*26*	*9.2*
Flat warming party	*10*	*7.7*	*8*	*5.2*	*18*	*6.4*
Workplaces	18	13.8	14	9.2	32	11.3
UCL during summer	*17*	*13.1*	*8*	*5.2*	*25*	*8.8*
Charity head office	*1*	*0.8*	*6*	*3.9*	*7*	*2.5*

The characteristics of the participants are shown in Table 8.2. The sample was relatively young - with over 50% under 35 years of age. Over 70% of participants were white. Two-thirds of participants were employed, 60% had University degree (or equivalent), and incomes were relatively high with 36% in the top income group, based on the cut-offs used for the quintiles in HSE 2008.

Table 8.2: Participant socio-demographic characteristics

	Men		Women		Total	
	n	%	n	%	n	%
Total sample	130	100	153	100	283	100
Age group						
16-24	28	21.5	32	20.9	60	21.2
25-34	45	34.6	51	33.3	96	33.9
35-44	22	16.9	21	13.7	43	15.2
45-54	20	15.4	31	20.3	51	18.0
55-64	7	5.4	12	7.8	19	6.7
65-74	4	3.1	5	3.3	9	3.2
74+	3	2.3	1	0.7	4	1.4
Region						
London	94	72.3	128	83.7	222	78.4
Elsewhere	33	25.4	17	11.1	50	17.7
Ethnic group						
White	99	76.2	108	70.6	207	73.1
Asian/Asian British	5	3.8	7	4.6	12	4.2
Black/Black British	13	10.0	20	13.1	33	11.7
Chinese	2	1.5	2	1.3	4	1.4
Mixed	8	6.2	9	5.9	17	6.0
Other	3	2.3	7	4.6	10	3.5
Highest educational qualification						
NVQ4/NVQ5/degree or equivalent	78	60.0	93	60.8	171	60.4
Higher education below degree	9	6.9	13	8.5	22	7.8
NVQ3/GCE A level equivalent	16	12.3	15	9.8	31	11.0
NVQ2/GCE O level equivalent	4	3.1	8	5.2	12	4.2
NVQ1/CSE other grade equivalent	6	4.6	7	4.6	13	4.6
Foreign/other	10	7.7	8	5.2	18	6.4
None	4	3.1	8	5.2	12	4.2
Employment status						
Employed	94	72.3	93	60.8	187	66.1
Unemployed	4	3.1	10	6.5	14	4.9
Unemployed & receiving benefits	0	0.0	8	5.2	8	2.8
Retired	8	6.2	4	2.6	12	4.2
Full-time education	23	17.7	38	24.8	61	21.6
Total household income						
<£10,655.74	16	12.3	38	24.8	54	19.1
£10,655.75-16,900.00	5	3.8	18	11.8	23	8.1
£16,900.01-26,787.88	24	18.5	15	9.8	39	13.8
£26,787.89-£41,864.41	27	20.8	29	19.0	56	19.8
>£41,864.42	52	40.0	51	33.3	103	36.4

There were a small number of missing values for each variable (<4%) which were not included in further analyses

The drinking characteristics of the participants are summarised in Table 8.3. All but one of the participants were current drinkers, and the participant who did not drink alcohol poured drinks for other people and therefore was eligible to continue with the study. The drink type consumed most often among men was beer/lager/cider/shandy (32%) and among women was wine (54%). The majority of participants (86% men, 69% women) drank at least once a week. Around 50% drank on two to four days in the last week, with a further 20% drinking on five or more days. Respondents reported drinking heavily, with 40% men and 28% women reporting that they drank more than twice the recommended daily limits (>8/6 units) on their heaviest drinking day in the last week. Additionally, a quarter of men and a fifth of women reported drinking more than the recommended daily limits (>4/3 units) on their heaviest drinking day in the last week.

Table 8.3: Drinking frequency and consumption in the last week by sex

	Men		Women		Total	
	%	*n*	%	*n*	%	*n*
Total sample	100.0	*130*	100.0	*153*	100.0	*283*
Ever drinks alcohol						
Yes	99.2	*129*	99.3	*152*	99.3	*281*
No	0.0	*0*	0.7	*1*	0.4	*1*
Ever pours alcoholic drinks for other people						
Yes	92.3	*120*	93.5	*143*	92.9	*263*
No	6.2	*8*	6.5	*10*	6.4	*18*
Drink type consumed most often						
Any wine	29.2	*38*	53.6	*82*	42.4	*120*
Any beer/lager/cider shandy	31.5	*41*	9.8	*15*	19.8	*56*
Spirits or liqueurs	10.8	*14*	11.1	*17*	11.0	*31*
Other drinks	0.8	*1*	2.0	*3*	1.4	*4*
Two or more drink types	20.8	*27*	20.3	*31*	20.5	*58*
Drinking frequency (past 12 months)						
Almost every day	23.1	*30*	20.9	*32*	21.9	*62*
At least once a week	63.1	*82*	48.4	*74*	55.1	*156*
At least once a month	10.8	*14*	23.5	*36*	17.7	*50*
Less than once a month	3.1	*4*	7.2	*11*	5.3	*15*
Drinking days in the last week						
0 or 1	16.2	*21*	28.8	*44*	23.0	*65*
2 to 4	52.3	*68*	47.1	*72*	49.5	*140*
5 to 7	22.3	*29*	16.3	*25*	19.1	*54*
Units on heaviest day in the last week						
Not applicable	1.5	*2*	3.9	*6*	2.8	*8*
Don't know	10.8	*14*	11.8	*18*	11.3	*32*
Less than daily limits (<4/3 units)	16.9	*22*	29.4	*45*	23.7	*67*
Above daily limits, but below twice	25.4	*33*	21.6	*33*	23.3	*66*
More than double the daily limits (>8/6 units)	40.0	*52*	28.1	*43*	33.6	*95*

There were a small number of missing values for each variable (<5%) which were not included in further analyses

Knowledge of units is summarised in Table 8.4. Nearly all (95%) of the participants had heard of alcohol units. Of the 12 participants who said they had not heard of units, around half went on to estimate the number of units in drinks or the daily guidelines in each subsequent question. It is likely that these subsequent questions served as a prompt or memory-jogger among these participants and that they actually had heard of units. Therefore these participants were permitted to continue with the study and estimate units in the pouring task.

A pint of normal strength beer (4-5% ABV) contains 2.3-2.8 units of alcohol, a 125ml glass of wine (12% ABV) contains 1.5 units of alcohol, and a usual pub measure (25ml) of spirits (40% ABV) contains 1.0 units of alcohol. For beer, participants who estimated between two and three units were put into the 'correct' category (if 2.3-2.8 units is used instead, only 4% men (n=5) and 7% women (n=10) would be classified as correct). Fifty five percent of men and 47% of women correctly estimated the number of units in a pint of beer, and the proportions over and under-estimating were similar in both genders. Fewer than 10% of participants correctly identified the number of units in a small glass of wine. Around 40% men and women under-estimated the number of units in a small glass of wine, and this may reflect increases in the ABV of wine in recent decades. One-third of participants correctly identified that there is one unit of alcohol in a pub measure of spirits. For spirits, a greater proportion of men over-estimated the number of units in a pub measure than women (46% men vs. 33% women), and as with beer, a greater proportion of women said they did not know (27% women vs. 21% men). The number of alcohol units in standard measures of beer (the lowest ABV drink) was the most well-known, while the number of units in the moderate ABV drink (wine) was most commonly under-estimated, and the number of alcohol units in high ABV drinks (spirits) was most commonly over-estimated.

UK drinking guidelines specify a range which should not be regularly exceeded (3-4 units a day for men and 2-3 units a day for women). With regards to the drinking guidelines, 45% identified the recommended daily limits for men within the correct range, and 50% identified this guideline for women within the correct range. The proportion of men who correctly identified the drinking guidelines was higher than the corresponding proportion of women who did so, by 5-7% points. However, 24% men and 19% women thought the daily limits were higher than they actually are, with the proportion thinking the daily limits are lower than they actually are similar (15% and 14% respectively). Some confusion in responses was apparent, with some participants quoting the weekly drinking guidelines (21 and 14 units respectively, n=8) used by the Department of Health until 1995, and others the thresholds for binge drinking previously used by the Department of Health (of twice the upper threshold of the daily limit: eight and six units for men and women, n=7).

There were participants who thought the daily limits were higher than they actually are and that there were fewer units in drinks than there actually are concurrently. Among men who over-estimated the daily guidelines (n=67), 50% under-estimated the number of units in a pint of beer, and 39% under-estimated the number of units in a small glass of wine. Among women who over-estimated the daily guidelines (n=58), 49% under-estimated the number of units in a pint of beer and 38% under-estimated the number of units in a small glass of wine.

Table 8.4: Knowledge of units in standard drinks and UK drinking guidelines by sex

	Men		Women		Total	
	%	*n*	%	*n*	%	*n*
Total sample	100.0	*130*	100.0	*153*	100.0	*283*
Heard of units						
Yes	94.6	*123*	96.1	*147*	95.4	*270*
No	4.6	*6*	3.9	*6*	4.2	*12*
Guess units in pint beer						
Not applicable	0.8	*1*	0.7	*1*	0.7	*2*
Don't know	14.6	*19*	19.6	*30*	17.3	*49*
Under-estimated	13.8	*18*	11.8	*18*	12.7	*36*
Correct (2.0-3.0)	55.4	*72*	47.1	*72*	50.9	*144*
Over-estimated	3.8	*5*	2.6	*4*	3.2	*9*
Guess units in 125ml glass wine						
Not applicable	0.8	*1*	0.7	*1*	0.7	*2*
Don't know	17.7	*23*	17.6	*27*	17.7	*50*
Under-estimated	38.5	*50*	42.5	*65*	40.6	*115*
Correct (1.5)	9.2	*12*	5.9	*9*	7.4	*21*
Over-estimated	32.3	*42*	32.0	*49*	32.2	*91*
Guess units in measure of spirits						
Not applicable	0.8	*1*	0.7	*1*	0.7	*2*
Don't know	20.8	*27*	26.8	*41*	24.0	*68*
Under-estimated	0.0	*0*	0.0	*0*	0.0	*0*
Correct (1.0)	30.0	*39*	37.3	*57*	33.9	*96*
Over-estimated	46.2	*60*	32.7	*50*	38.9	*110*
Recommended daily limit for men						
Not applicable	0.8	*1*	0.7	*1*	0.7	*2*
Don't know	11.5	*15*	20.3	*31*	16.3	*46*
Less than three units	15.4	*20*	14.4	*22*	14.8	*42*
Three or four units	48.5	*63*	41.2	*63*	44.5	*126*
More than four units	23.8	*31*	23.5	*36*	23.7	*67*
Recommended daily limit for women						
Not applicable	0.8	*1*	0.7	*1*	0.7	*2*
Don't know	13.1	*17*	18.3	*28*	15.9	*45*
Less than two units	10.8	*14*	14.4	*22*	12.7	*36*
Two or three units	53.1	*69*	47.7	*73*	50.2	*142*
More than three units	22.3	*29*	19.0	*29*	20.5	*58*

'Not applicable' means the participant specified that they had not heard of units and did not go on to estimate units in drinks or the guidelines. There were a small number of missing values (<5%) for each variable which were not included in further analyses

The number of units poured by drink type, glass type, and with respect to the daily drinking guidelines is shown in the following three tables. In total, the 283 participants poured 465 drinks. The mean number of units poured was 1.9 units (SD around 0.8) for both wine and spirits, and there was little variation across the types of wines and spirits under study (Table 8.5). Men and women poured a similar number of units for all drink types except for gin; in which the mean pour among men was 2.0 units (SD 0.8), compared with 1.7 units (SD 0.8) in women.

Table 8.5: Units poured by drink type selected

		Drink type		
		Men	**Women**	**Total**
All wine	**n**	116	148	264
	mean	1.90	1.89	1.90
	SD	*0.57*	*0.95*	*0.80*
Red wine	**n**	77	71	148
	mean	1.92	2.03	1.97
	SD	*0.58*	*1.04*	*0.83*
White wine	**n**	39	77	116
	mean	1.87	1.76	1.80
	SD	*0.55*	*0.84*	*0.76*
All spirits	**n**	99	102	201
	mean	1.99	1.88	1.93
	SD	*0.77*	*0.78*	*0.78*
Gin	**n**	29	33	62
	mean	2.04	1.66	1.84
	SD	*0.81*	*0.79*	*0.82*
Whiskey	**n**	39	17	56
	mean	1.98	1.89	1.96
	SD	*0.65*	*0.74*	*0.67*
Vodka	**n**	14	37	51
	mean	2.01	2.06	2.04
	SD	*0.51*	*0.75*	*0.68*
Dark rum	**n**	17	15	32
	mean	1.90	1.90	1.90
	SD	*1.12*	*0.86*	*0.99*

There was a relationship between the glass type selected and the amount of alcohol poured (Table 8.6). For wine, where wine glasses only are considered, more alcohol tended to be poured into the larger glasses than the smaller glasses. This was true for both men and women. For spirits, more alcohol was poured into the larger glasses by men, but there was no clear trend among women. Neither wine nor spirits were filled to the brim in any glass type so this

observation is not simply a reflection of the maximum capacity of the glass. However, caution needs to be taken interpreting these results as the sample size in some of the groups is small.

Table 8.6: Units poured by glass type selected

		Wine			Spirits		
		Men	**Women**	**Total**	**Men**	**Women**	**Total**
Shot glass	n	0	0	0	12	13	25
	mean				1.26	1.12	1.18
	SD				*0.55*	*0.40*	*0.47*
Small tumbler/'old fashioned'	n	4	7	11	64	53	117
	mean	1.49	1.89	1.75	2.00	2.05	2.02
	SD	*0.26*	*0.50*	*0.46*	*0.58*	*0.89*	*0.73*
Medium tumbler/'collins'	n	2	0	2	17	25	42
	mean	1.48		1.48	2.19	1.85	1.99
	SD	*1.17*		*1.17*	*0.91*	*0.54*	*0.72*
Large tumbler/'highball'	n	0	2	2	5	7	12
	mean		3.17	3.17	2.96	2.20	2.52
	SD		*2.62*	*2.62*	*1.49*	*0.46*	*1.04*
Small wine glass	n	17	30	47	1	3	4
	mean	1.44	1.15	1.25	1.76	1.55	1.60
	SD	*0.35*	*0.25*	*0.32*		*0.13*	*0.15*
Medium wine glass	n	22	29	51	0	0	0
	mean	1.65	1.57	1.60			
	SD	*0.37*	*0.39*	*0.38*			
Large wine glass	n	59	66	125	0	0	0
	mean	2.12	2.21	2.17			
	SD	*0.55*	*0.95*	*0.78*			
XL wine glass	n	12	13	25	0	1	1
	mean	2.18	2.55	2.37		2.25	2.25
	SD	*0.59*	*1.42*	*1.10*			

The majority of participants poured more than one unit but less than the daily limits as their usual glass for both wine (97% men and 78% women) and spirits (91% men and 78% women) (Table 8.7). Women were more likely than men to pour more than their daily limit as a usual glass for both wine (10% women vs. 0% men, P<0.001) and spirits (7% women vs. 2% men, P=0.097). One woman poured more than twice her daily limit as her usual glass of wine (6.3 units). The mean number of units poured for men and women was similar for both wine and spirits but the proportion pouring more than the daily limits into a glass is higher in women because the daily limits are lower for women (three units) than men (four units).

Table 8.7: Units poured with respect to UK drinking guidelines

		Wine			Spirits		
		Men	Women	Total	Men	Women	Total
Less than one unit	n	4	17	21	7	15	22
	%	3.4	11.5	8.0	7.1	14.7	10.9
	mean	0.85	0.88	0.87	0.78	0.84	0.82
>1 unit but <4/3 units	n	112	116	228	90	80	170
	%	96.6	78.4	86.4	90.9	78.4	84.6
	mean	1.94	1.76	1.85	2.01	1.90	1.96
	SD	*0.54*	*0.51*	*0.53*	*0.55*	*0.47*	*0.52*
More than daily limits (>4/3)	n	0	14	14	2	7	9
	%	0.0	9.5	5.3	2.0	6.9	4.5
	mean		3.84	3.84	5.21	3.79	4.11
More than a twice daily limits(>8/6)	n	0	1	1	0	0	0
	%	0.0	0.7	0.4	0.0	0.0	0.0
	mean		6.34	6.34			
	SD						

Where the perceived number of units poured was available, the difference between actual and perceived units poured was calculated for wine (n=248, 94% of poured glasses) and spirits (n=192, 96% poured glasses). Outliers where the difference between actual and perceived units poured was greater than five standard deviations either side of the mean were excluded. This excluded a small number (<1% of glasses poured for either drink type) of participants whose knowledge of units was questionable: for example a participant who poured 2.7 units of vodka and estimated that she had poured 100 units of alcohol. Histograms of the accuracy of participant's estimates of the number of units in wine and spirits are shown in Figure 8.3 and Figure 8.4. Estimation accuracy for wine appears fairly normally distributed but for spirits there is skewness towards over-estimation.

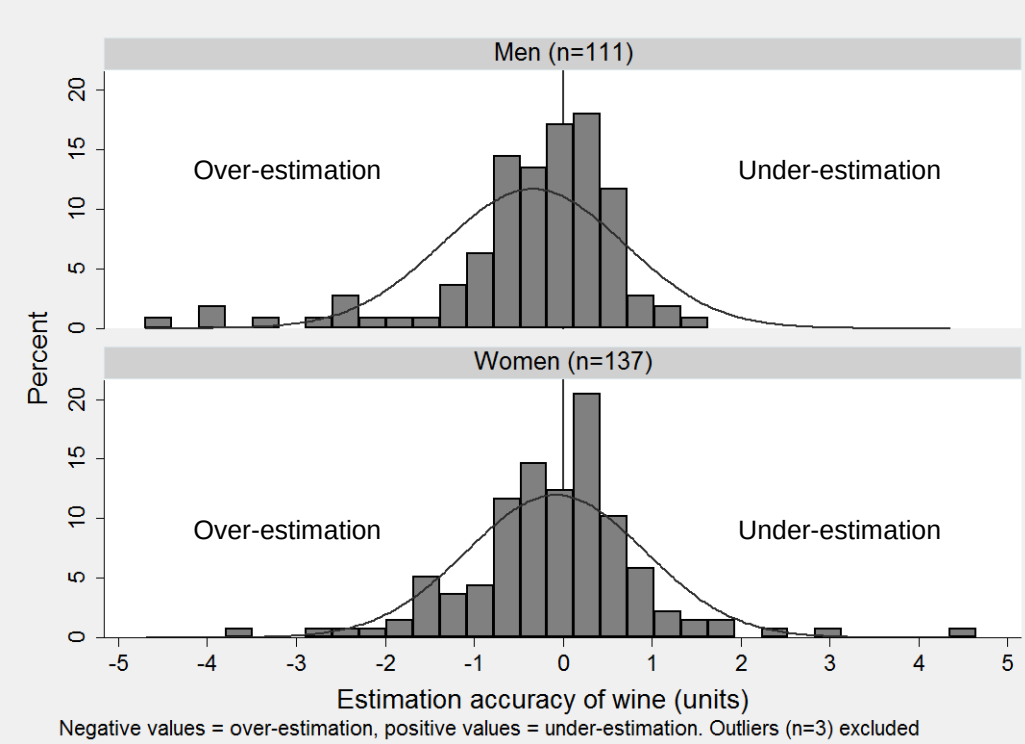


Figure 8.3: Histogram of the distribution of estimation accuracy of wine by sex

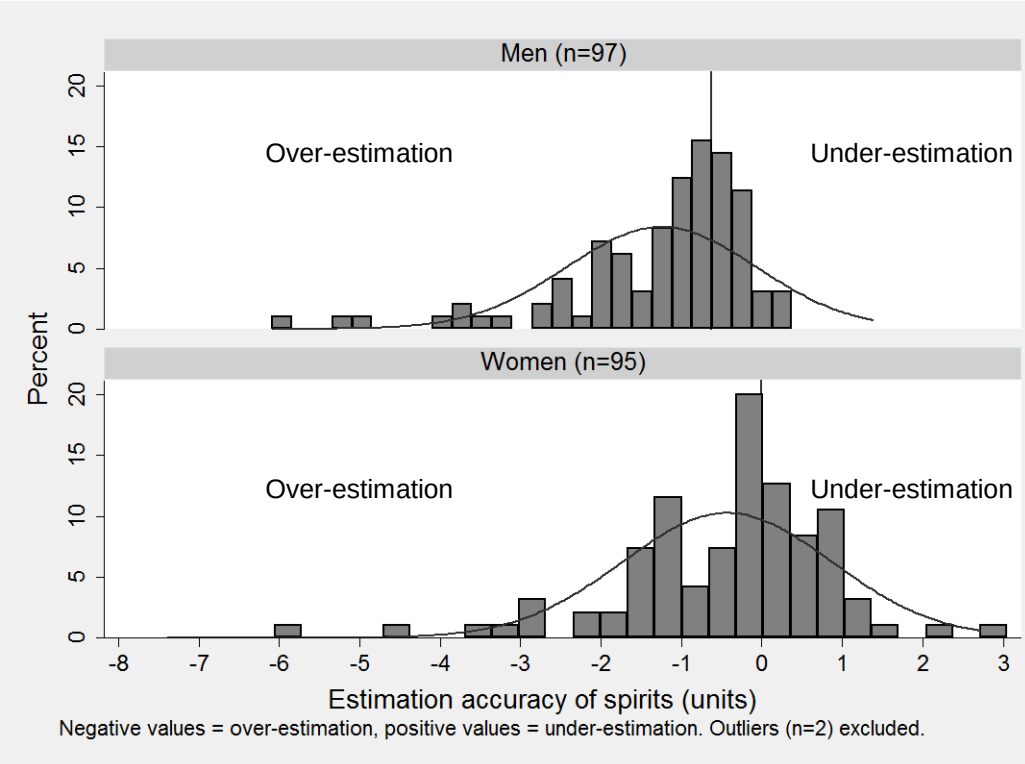


Figure 8.4: Histogram of the distribution of estimation accuracy of spirits by sex

Table 8.8 describes the accuracy of participants' estimates of the number of units they poured. Participant's estimates were classified as 'correct' if they are within a tolerance of 0.5 units either side of the actual value (see Section 8.6.3). For wine, 55% men and 50% women estimated within half a unit of what they had actually poured. For spirits, 43% men and 40% women estimated within half a unit of what they had actually poured. A larger proportion of women than men under-estimated poured units of both wines (23% and 14% respectively) and spirits (21% and 12%). The mean number of units poured as a usual glass varied by estimation accuracy category. Mean number of units poured was similar among participants who estimated correctly (+/- 0.5 units) and participants who over-estimated (>0.5 units) at between 1.7-1.9 units for wines and spirits. However, among the under-estimaters (>0.5 units), the mean number of units poured was 2.5 for wine and 2.4 for spirits.

The amount (mean difference between actual and perceived units poured) participants under-estimated by was greater among women than men for both wine (women: mean 1.1 units SD 0.83, men: mean 0.8 units SD 0.31) and spirits (women: mean 1.0 units SD 0.55, men: mean 0.8 units SD 0.20). A larger proportion of men than women over-estimated both wines (32% and 28% respectively) and spirits (44% and 39%). The difference between sexes is less marked for over-estimation. The amount participants over-estimated by was greater among men than women for both wine (men: mean -1.43 units SD 1.11, women: mean -1.20 units SD 0.69) and spirits (men: mean -2.12 units SD 1.62, women: mean -1.66 units SD 1.17).

Table 8.8: Estimation accuracy by sex and drink type

Estimation accuracy		Wine			Spirits		
		Men	Women	Total	Men	Women	Total
Overall	n	111	137	248	97	95	192
	%	100	100	100	100	100	100
	Mean units poured	1.9	1.9	1.9	2.0	1.9	1.9
	Mean diff*	-0.34	-0.08	-0.20	-0.84	-0.43	-0.64
	SD of mean diff	*1.03*	*1.00*	*1.02*	*1.61*	*1.31*	*1.48*
Within 0.5 units	n	61	68	129	42	38	80
	%	55.0	49.6	52.0	43.3	40.0	41.7
	Mean units poured	1.9	1.5	1.7	1.8	1.8	1.8
	Mean diff*	0.02	0.00	0.01	0.00	0.00	0.00
	SD of mean diff	*0.28*	*0.31*	*0.30*	*0.29*	*0.24*	*0.27*
Under-estimated by >0.5 units	n	15	31	46	12	20	32
	%	13.5	22.6	18.5	12.4	21.1	16.7
	Mean units poured	2.1	2.7	2.5	2.4	2.4	2.4
	Mean diff*	0.77	1.11	1.00	0.80	1.02	0.94
	SD of mean diff	*0.31*	*0.83*	*0.72*	*0.20*	*0.55*	*0.46*
Over-estimated by >0.5 units	n	35	38	73	43	37	80
	%	31.5	27.7	29.4	44.3	38.9	41.7
	Mean units poured	1.8	1.9	1.9	2.0	1.6	1.9
	Mean diff*	-1.43	-1.20	-1.31	-2.12	-1.66	-1.91
	SD of mean diff	*1.11*	*0.69*	*0.92*	*1.62*	*1.17*	*1.44*

** mean diff = mean difference between actual and perceived units of alcohol poured. SD = standard deviation.*

8.7.2 Inferential statistics

8.7.1.1 Bivariate analysis

There was a positive association between the estimated and actual units poured of both wine and spirits. This is shown for wine in Figure 8.5. Overall, there is a moderate statistically significant (r = 0.48, P<0.001) correlation between estimated and actual units poured. The coefficient for women is slightly higher than it is for men (r=0.54, P<0.001 and r= 0.43, P<0.001 respectively). Although estimated and actual units of wine poured are significantly correlated, the mean drink size differed across estimation accuracy groups (Table 8.8).

Figure 8.5: Relationship between estimated and actual units of wine poured by sex

The association between estimated and actual units poured of spirits is shown in Figure 8.6. Again, there is a moderate statistically significant (r = 0.46, P<0.001) correlation between estimated and actual units poured. This time, the coefficient for men is slightly higher than it is for women (r=0.54, P<0.001 and 0.35, P<0.001 respectively). As with wine, mean drink size differs across estimation accuracy groups for spirits.

Figure 8.6: Relationship between estimated and actual units of spirits poured by sex

8.7.1.2 Multivariate analysis

The results of the regression analyses are shown in Table 8.9. Wine and spirits were considered in separate models because many participants (64%) poured both types of drink and therefore they should not be included in the same model as they are two measures of estimation accuracy and thus highly correlated. The relative risk ratio (RRR) describes the risk of under-estimating or over-estimating. As Model 1 and Model 2 are very similar (with the exception of binge drinking on the heaviest drinking day in the last week losing significance as a risk factor for over-estimating spirits), results for Model 1 are described unless mentioned otherwise.

Table 8.9: Risk factors for under/over-estimating the number of units of alcohol in a self-defined 'usual glass' of wines and spirits from multivariate multinomial logistic regression

	Model 1				Model 2			
	RRR	**95% CI**	**P**		**RRR**	**95% CI**	**P**	
Wine estimation[a] (n=248)								
Within 0.5 units (n=129)		1.00 (reference)				1.00 (reference)		
Under-estimated by >0.5 units (n=46)								
Sex (female)	-	-	-		1.68	0.76-3.69	0.200	
Age 35-54 (vs.16-34)	-	-	-		1.07	0.44-2.63	0.88	
Age 55+ (vs.16-34)	-	-	-		2.26	0.60-8.53	0.23	
Volume wine poured (ml)	1.02	1.01-1.02	<0.001	***	1.02	1.01-1.02	<0.001	***
No degree (vs.degree or equiv.)	0.49	0.19-1.26	0.137		0.53	0.20-1.37	0.188	
Non-white (vs. white)	3.66	1.60-8.37	0.002	**	3.88	1.65-9.16	0.002	**
Unemployed or retired (vs. employed)	6.11	1.63-22.91	0.007	**	4.30	1.08-17.07	0.038	*
Full-time student (vs. employed)	0.71	0.26-1.95	0.511		0.71	0.24-2.11	0.543	
Over-estimated by >0.5 units (n=73)								
Sex (female)	-	-	-		1.08	0.58-1.99	0.813	
Age 35-54 (vs.16-34)	-	-	-		1.30	0.64-2.65	0.476	
Age 55+ (vs. 16-34)	-	-	-		1.55	0.51-4.72	0.439	
Volume wine poured (ml)	1.00	1.00-1.01	0.216		1.00	1.00-1.01	0.166	
No degree (vs. degree or equiv.)	1.96	1.04-3.71	0.038	*	1.89	0.99-3.59	0.053	
Non-white (vs. white)	1.51	0.73-3.10	0.268		1.44	0.68-3.02	0.341	
Unemployed or retired (vs. employed)	2.71	0.83-8.91	0.100		2.40	0.70-8.20	0.164	
Full-time student (vs. employed)	0.95	0.46-1.96	0.894		1.10	0.50-2.44	0.812	

	Spirits estimation[b] (n=192)							
Within 0.5 units (n=80)	1.00 (reference)				1.00 (reference)			
Under-estimated by >0.5 units (n=32)								
Sex (female)	-	-	-		2.03	0.72-5.71	0.179	
Age 35-54 (vs.16-34)	-	-	-		0.59	0.18-1.93	0.381	
Age 55+ (vs.16-34)	-	-	-		0.18	0.01-2.76	0.217	
Volume spirits poured (ml)	1.04	1.01-1.06	0.005	**	1.04	1.01-1.06	0.003	**
No degree (vs. degree or equiv.)	1.61	0.55-4.74	0.385		1.77	0.59-5.35	0.311	
Drank >4/3 on HDD/7	1.06	0.32-3.56	0.924		1.00	0.28-3.59	0.998	
Drank >8/6 on HDD/7	0.57	0.16-1.99	0.375		0.52	0.14-1.95	0.330	
Over-estimated by >0.5 units (n=80)								
Sex (female)	-	-	-		0.92	0.44-1.92	0.820	
Age 35-54 (vs.16-34)	-	-	-		0.74	0.32-1.71	0.479	
Age 55+ (vs.16-34)	-	-	-		0.64	0.16-2.55	0.529	
Volume spirits poured (ml)	0.99	0.97-1.02	0.538		0.99	0.97-1.02	0.514	
No degree (vs. degree or equiv.)	2.83	1.31-6.14	0.008	**	2.78	1.28-6.07	0.010	*
Drank >4/3 on HDD/7	1.22	0.43-3.48	0.704		1.15	0.40-3.31	0.798	
Drank >8/6 on HDD/7	2.79	1.08-7.22	0.035	*	2.52	0.95-6.63	0.062	

*Footnote to table: RRR = relative risk ratio, 95% CI = 95% confidence interval, P = P-value, *=P<0.05, **=P<0.01, ***=P<0.001, HDD/7 = heaviest drinking day in the last week.*
Model 1: adjusted for covariates 'a' and 'b'. Model 2: As model 1, but additionally adjusted for sex and age.
(a) Adjusted for volume of wine poured (continuous), education (degree or equivalent vs. no degree), ethnicity (white vs. non-white) and employment
(b) Adjusted for volume of spirit poured (continuous), education (degree or equivalent vs. no degree), heaviest drinking day in the last week with respect to drinking guidelines

8.7.1.2.1 Wine

The risk of under-estimating wine increased with increasing volume of wine poured (RRR 1.02, 95% CI 1.01-2-1.02, P<0.001). For each extra millilitre of wine poured, the risk of under-estimating wine increased two per cent. Education was not associated with under-estimating wine. Non-white ethnicity was associated with increased likelihood of under-estimating wine (RRR 3.66, 95% CI 1.60-8.37, P=0.002). Compared to being employed, being unemployed or retired was predictive of under-estimating wine (RRR 6.11, 95% CI 1.63-22.91, P=0.007), but being a full-time student was not.

The risk of over-estimating wine was not associated with the volume of wine poured, ethnicity or employment status. Having educational qualifications below degree level was associated with an increased risk of over-estimating wine (RRR 1.96, 95% CI 1.04-3.71, P=0.038).

8.7.1.2.2 Spirits

As with wine, the risk of under-estimating spirits was associated with increasing volume poured (RRR 1.04, 95% CI 1.01-1.06, P=0.005), equivalent to a 4% increase in the risk of under-estimating with every additional millilitre poured. None of the other covariates was predictive of under-estimating spirits.

The risk of over-estimating spirits was not significantly associated with volume poured, or drinking more than the recommended limits (but less than twice) on the heaviest drinking day in the last week. However as with wine, having educational qualifications below degree level was associated with an increased risk of over-estimating spirits (RRR 2.83, 95% CI 1.31-6.14, P=0.008). Drinking more than twice the daily limits on the heaviest drinking day in the last week was also associated with over-estimating spirits compared with drinking within the recommended guidelines (RRR 2.79, 95% CI 1.08-7.22, P=0.035), however this lost significance after additional adjustment for age and sex (Model 2).

8.8 Discussion

Estimation of the number of units in a self-defined usual glass of wines and spirits was inaccurate, with only 52% wine estimates and 42% spirit estimates within half a unit either side. Of the remainder, more men and women over-estimated both wines and spirits than under-estimated. This was contrary to what was hypothesised (Section 8.4), and this study therefore suggests that accidental under-estimation of the amount of alcohol in drinks poured at home may not contribute substantially towards the missing units. Rather, if more people over-estimate how much alcohol is in their usual glass, then taking this into account would actually make the gap between reported alcohol consumption and alcohol sales even wider. However, this was a relatively small study and these findings are not necessarily generalisable to the wider population, and there are also limitations to this study which may explain why over-estimation appeared to be more common than under-estimation (see Section 8.8.2).

The multivariate analyses conducted to examine whether demographic, social and alcohol-related factors may be independently associated with under-estimation (or over-estimation) of the number of units in a usual glass revealed some interesting findings. Factors associated with under-estimating the number of units in a usual glass of wine were the volume poured, non-white ethnicity, and being unemployed or retired. The volume of spirits poured was significantly associated with under-estimating the number of units in a usual glass of spirits. That volume of the drink poured was associated with under-estimation for both wines and spirits adds to the evidence that alcohol-related factors may be particularly important for under-reporting of alcohol consumption identified in Chapter 6 and Chapter 7. With regard to over-estimation, not having a

degree was significantly associated with over-estimating the number of units in a glass of wine and spirits, and additionally drinking more than twice the daily limits on the heaviest drinking day in the last week was predictive of over-estimating spirits.

In this sample, awareness of drinking guidelines was better than the population average based on HSE 2007 (see Section 2.6.6.1), and in the questionnaire participants were more likely to over-estimate than under-estimate the number of units in standard drinks. However, 15% of women poured more than the recommended daily limits as their usual glass of wine and 9% poured more than this as their usual glass of spirits. No men poured more than the daily limits as their usual glass of wine, but 2% poured this for spirits. Although this gender difference is reflective of the different drinking guidelines for men and women rather than differences in pouring *per se*, it does suggest that lack of knowledge of units and disregard for drinking guidelines when drinking at home may be particularly important for women.

8.8.1 Strengths

This was the first study in the general population which has asked participants to pour their usual glass of alcoholic drinks and asked them to estimate the number of units poured, and the first in Europe (one previous study from Australia has compared perceived and actual units poured in 65-74 year olds) (**114**). A previous study conducted in South East England asked participants to pour their usual glass, and then a unit of wine, spirits, and beer (**115**). While this does permit triangulation of perceived amount of alcohol in a usual glass, this study was conducted among 16-25 year olds only. Indeed, there have been relatively few studies investigating drink pouring practices, despite their scope for complementing investigations into low alcohol sales coverage, screening for alcohol problems, or testing the effectiveness for feedback or interventions designed to reduce alcohol consumption.

The survey procedure was piloted and the questionnaire subsequently refined. The particular strengths of the method used are the range of glasses available and the use of actual alcoholic drinks so that visual and olfactory cues in pouring were not suppressed. Additionally, the use of real alcoholic drinks appeared to initiate interest in the study among drinkers, and may have served as an aid to recruitment (although the same would likely have been the case if coloured water was used from alcohol bottles). A substantial proportion (61%) of the sample was recruited from a supermarket. At this site members of the public occasionally made jokes about the alcohol on display being a free sample or taster. This highlights the importance of having signage to describe the research being conducted, which in this case was the information sheet about the study (Appendix Q), which was helpful in avoiding confusion, and none of the participants attempted to drink what they had poured.

The demographic information collected shows the sample was relatively young, well-educated and affluent. Drinking was often frequent and/or heavy. For these reasons it would be expected that knowledge of units would be relatively accurate compared with the general population (see HSE 2007 tables 7.9, 7.10, and 7.13-16) (**99**), and perhaps also estimation could be expected to be accurate in this sample relative to the population as a whole. It could be hypothesised that knowledge of units may be associated with estimation accuracy (better knowledge meaning more accurate estimation). Although it is possible that knowledge of units has changed since 2007 there is no evidence to suggest that the social patterning of this knowledge has changed. It was therefore useful to explore estimation accuracy in this context, as the inaccurate estimation observed here indicates that there may be very low levels of estimation accuracy in the general population.

8.8.2 Limitations

The findings of this study indicate that estimation accuracy may be low, but due to the characteristics of the sample, these findings are not generalisable to the wider population. The sample size of this study is modest (n=283), but it is larger than pouring tasks conducted in several previous studies (**101, 104, 107, 108, 110, 111, 116**). Despite pre- and mid-study sample size calculations, the study may have lacked power to detect significant differences between some groups. For instance, gender was not significantly associated with under-estimation of wine or spirits although the proportion under-estimating was much higher in women than men (around 9% higher for both wines and spirits, see Table 8.8). As a result of the small number of participants in subgroups for knowledge of units and drinking guidelines, it was not possible to quantify how estimation accuracy varied in these subgroups with much statistical confidence. Although a power calculation was conducted, this was not to detect differences between these subgroups. It remains unknown how this estimation would vary with knowledge of drinking guidelines and units in standard drinks, but it is hypothesised that accuracy would decrease as unit awareness and knowledge of drinking guidelines decreases.

Due to the mobile nature of the study it was not possible to provide ice cubes to participants who would normally pour alcohol on top of ice. Instead participants were asked to imagine that they were going to add ice afterwards. Previous studies (**109, 114**) that have allowed for ice were conducted in participants' own homes. Participants who mentioned they normally use ice were asked if they thought plastic ice rocks would have been a good substitute for ice and this generally received a positive response. Future studies should take this into account.

The divide between the researcher and the researched was minimised by the researcher dressing casually and speaking to participants in an informal way. However it is probable that

the unexpected results are due to social desirability bias and researcher effects in that participants' reported estimates may be artificially high. Drinking is frequent and heavy in the sample and many participants said they knew they drank more than they should. Participants may have made 'safe' high estimates to avoid being told by the researcher that they were wrong, or because they were anxious that they would be told to drink less. The possibility that this took place was reinforced in things heard repeatedly from 'over-estimaters' such as "I'm OK then" and "oh, I can drink more then!". This is an issue which would be difficult to overcome in a face-to-face survey, particularly where the researcher is affiliated with a medical school or health institution.

Further, the participants in the study were (or at least appeared to be) sober. It is of no doubt that very often when alcoholic drinks are being poured, they are also being consumed. It is possible that the amount of alcohol that is poured as a 'usual glass' will change with level of intoxication. A participant's perception of that amount may also vary. Therefore the actual and perceived amounts of alcohol discussed in this chapter are only truly relevant for the first drink of any drinking occasion. Subsequent consumption once any level of intoxication has been achieved is likely to be subject to different perceptions of what 'a glass' means, and how many units of alcohol this is likely to equate to.

It could be hypothesised that the size of a usual glass increases as intoxication increases, and that the perception of that amount either decreases or stays the same. This could explain some of the missing units, although the relative contribution would be difficult to quantify. However the reverse could also be hypothesised, that once the embodied aspects of intoxication (pleasant and unpleasant sensations associated with drunkenness Chapter 7) are being experienced, pouring and estimation may become more cautious in order to avoid the unpleasant aspects of drunkenness. There have been no studies of drink pouring practices among intoxicated individuals, possibly due to ethical challenges around competency and consent. Future studies should consider recruiting intoxicated individuals and to record breath alcohol concentration and correlate this with actual and perceived amounts of alcohol poured as a usual glass, or the actual amount of alcohol poured as a unit.

8.8.3 Conclusions

While this chapter has identified that estimation of the perceived amount of alcohol in a usual glass is inaccurate, the evidence from this chapter does not support the hypothesis that under-estimation of the amounts of alcohol in drinks drunk at home contributes substantially (if at all) to the missing units. However, it was identified that the risk of under-estimating increased as the volume of a usual glass increased, for both wines and spirits. This corroborates what was found

in Chapter 6 and Chapter 7, that alcohol-related factors explain under-reporting of alcohol consumption better than demographic or social factors.

If large glasses are particularly likely to be under-estimated, perhaps broad public health education messages to emphasise that, for example, a bottle of wine contains six (small) glasses (125ml x 6 =750ml) could help to reduce under-estimation of the amount of alcohol in drinks drunk at home. On the other hand, it could be that this chapter has served to reinforce the idea that emerged in Chapter 7 that units are not widely-used by members of the public, and that it is not under-estimation of units that we should be concerned with. Rather, under-estimation of *drinking* in terms of numbers of drinks themselves, or social norms about the level of intoxication that is socially acceptable, which are required to change in order to reduce the missing units.

Chapter 9 Discussion

The findings of the preceding empirical chapters of this thesis are summarised. This thesis speaks to the debate around low alcohol sales coverage and while it has been able to quantify the missing units and indicate where these may be, the 44% of alcohol sales not accounted for in surveys still cannot be attributed to particular groups. However substantial improvements may be possible: on a sample size of one, survey interview questions used to calculate weekly alcohol consumption amounted to just 55% of the weekly average from a 12 month drinking diary. The implications of under-reporting for Department of Health drinking guidelines are discussed with reference to commentary from both academics and members of the public stating that accounting for under-reporting means that the drinking guidelines should be raised. This however does not consider the differential nature of under-reporting and that individuals will still under-estimate their consumption if the guidelines are raised. The public health implications of this research are described with reference to the relationship between consumption and harm. Recommendations for policy are made in terms of both how existing policies could be improved and new policies that could be introduced. Finally, directions for future research that build on this thesis, and focus on under-researched areas are described.

9.1 Summary of findings

In essence this thesis takes a new look at what has been a long-standing and almost accepted problem in social surveys attempting to measure alcohol consumption. The literature review is comprehensive, summarising previous research relevant for under-reporting of alcohol consumption. Previous research on under-reporting of alcohol consumption is varied in terms of the objectives of the studies conducted: from improvement of survey design, to examining recall of drinking occasions, to understanding home drinking practices. The most significant finding from the literature review was described in Section 2.5.2: that alcohol sales data are likely to under-estimate consumption to a greater extent than social surveys under-estimate consumption (for reasons other than under-reporting). This synthesis of pre-existing data verifies that the calculation of alcohol sales coverage (reported alcohol consumption as a percentage of total alcohol sales) is a useful one, and proves that the discrepancy between the two can be attributed to under-reporting. This is something which has been disputed previously and as such this contribution is valuable.

The five empirical chapters in this thesis have explored under-reporting of alcohol consumption in novel and different ways. Each is an original contribution to knowledge and of value independently of the others. Firstly, Chapter 4 used national survey data on drinking and alcohol sales data to calculate alcohol sales coverage; quantifying the extent of under-reporting of alcohol consumption in England. Trends over time showed that this has been persistent over time, as well as in other countries as described in the literature review (Section 2.5.1). Further, alcohol sales coverage was explored by drink type. The substantial differences in alcohol sales coverage by drink type were the first indication that drinking habits may be important for the extent of under-reporting of alcohol consumption, going above and beyond the relationship between consumption level and reporting accuracy that was identified in the literature (Section 2.6.7).

In Chapter 5, self-reported alcohol consumption in the Health Survey for England (HSE) 2008 was revised in three putative scenarios intended to align self-reported consumption with alcohol sales. In the revised scenarios, the proportion of adults drinking more than weekly or daily drinking guidelines increased substantially, such that alarming estimates of the prevalence of drinking above these thresholds were observed. These estimates resulted in an abridged version of the work presented in Chapter 5 receiving extensive media coverage when it was published in the European Journal of Public Health and press-released by UCL. There were some interesting implications of this coverage, which are discussed in detail in Section 9.3 of this chapter.

In Chapter 5, the risk factors for of drinking above the weekly drinking guidelines (>21/14 units) were similar in the original survey and the revised scenarios, and although some changes to the risk factors for drinking more than the daily limits (>4/3 units) on the heaviest drinking day in the last week were observed these were inconsistent across scenarios. However, where drinking more than double the daily limits (>8/6 units) on the heaviest drinking day in the last week was concerned, the risk factors for drinking above this level changed in the revised scenarios. Women went from being significantly less likely to drink more than twice the daily limits on their heaviest day in the last week, to being equally likely as men to do so in revised scenarios one and two. The top two income quintiles became more likely to drink more than twice the daily limits than the poorest. As such, this chapter showed that even if under-reporting of alcohol consumption was proportionate across the population, the effect this would have on the prevalence of drinking above guidelines in different groups varied. Under-reporting to differing extents may have more extreme effects on the prevalence of drinking more than these or any other guidelines. This draws attention to the importance of improving understanding of the distribution of under-reporting.

As the population distribution of under-reporting was not well-understood, the distribution of under-reporting of alcohol consumption in the three revised scenarios was not specified in detail. Chapter 6 went on to address whether demographic, social, or alcohol-related 'risk factors' for under-reporting of alcohol consumption could be identified from intra-individual comparisons of two survey methods in the Health Survey for England 2011. Here, a difference between the two measures – where seven-day drinking diary estimates exceeded those of the main survey interview – was used as a proxy for under-reporting. There was little variation in this difference by demographic or social factors, alcohol-related factors were much more important. Those which were independently associated with diary estimates exceeding those of the interview were total weekly alcohol consumption in the diary week, number of drinking days in the diary week, drinking a combination of drink types on the heaviest drinking day, and drinking exclusively in licensed premises (risk factors were not consistently significant across outcomes investigated). Surprisingly, drinking in the off-trade was not linked to under-reporting, but drinking in the on-trade was. This is contrary to what was hypothesised based on previous research. Identification of alcohol-related factors which could be linked to under-reporting means that under-reporting is not likely to be proportionate across all groups (as was proposed in scenario 1 in Chapter 5). In addition to the extent of under-reporting varying by alcohol consumption level and drink type as previously suggested (Section 2.6.7 and Section 4.8 respectively); frequency, mixing drinks, and drinking in licenced premises may also be important factors to consider. With further research, these kinds of risk factors for under-reporting could be incorporated into new survey weights to improve the representativeness of national surveys, or used to target health promotion activities.

The qualitative study presented in Chapter 7 is complementary to the preceding chapter in that it shares the aim of identifying risk factors for under-reporting. However the use of a qualitative method to gain a deeper understanding of the issue has led to the identification of additional risk factors for under-reporting that would not have been discernible from a quantitative study. The qualitative interviews found that having a non-routine drinking pattern and tracking drinking using experiential aspects of drunkenness and intoxication to be potentially linked to under-reporting. This corroborates the findings from Chapter 6 that having varied drinking patterns may be important for under-reporting of alcohol consumption, independent of consumption level. That these two chapters with different methodologies identified similar findings suggests that drinking pattern or style certainly warrants further investigation with respect to under-reporting in future research.

Finally, whether the missing units could be due to under-estimation of home drinking - as was suggested by the literature identified in Section 2.6.6 - was investigated in Chapter 8. In this sample of 283 adults, the mean amount of alcohol poured in a usual glass of wine and spirits was 1.9 units. Estimation of the amount of alcohol poured was inaccurate, with just 52% of wine estimates and 42% spirits estimates within half a unit (either side) of the true value. The amount that participants under-estimated their usual glass by was larger than the amount other participants over-estimated by. However this study did not identify systematic under-estimation of the amount of alcohol poured in a usual glass: with 29% over-estimating wine compared with 19% under-estimating, and 42% over-estimating spirits compared with 17% under-estimating. This finding is contrary to what was hypothesised, and suggests that under-estimation of home drinking may not be a significant factor in explaining the missing units. This corroborates what was found in Chapter 6 where there was no evidence that drinking in the off-trade was linked to under-reporting (however drinking in the on-trade or a mixture of the two was linked to under-reporting).

Nevertheless, independent risk factors for under-estimating emerged. These were increasing volume poured for both wine and spirits, and additionally belonging to a non-white ethnic group and being unemployed or retired for wine only. That pouring a larger volume as a usual glass was significantly associated with under-estimating both wine and spirits is a potential target for future interventions, and also echoes the findings from Chapter 6 and Chapter 7 that alcohol-related factors may be more strongly associated with under-reporting of alcohol consumption than demographic or social factors.

This thesis has shown that a substantial proportion of alcohol sold is not covered in consumption figures, and that the difference between the two can be attributed to under-reporting of alcohol consumption (Section 2.5.2). That under-reporting is widespread and

persistent, and varies by drink type, was described in Chapter 4. Chapter 5 showed that the implications of under-reporting - in terms of how this would impact on alcohol consumption if taken into account – are enormous and this highlighted the public health importance of research on under-reporting. In terms of identifying the population distribution of under-reporting, combining the evidence from Chapters 6-8, this thesis has found that heavier drinking, having varied drinking patterns, and drinking large drinks are all associated with under-reporting of alcohol consumption. How these areas could be targeted by public health interventions or policy to improve alcohol awareness and reporting accuracy, and how future research can further address under-reporting, is discussed in Sections 9.5 and 9.6 respectively. However the limitations noted in the discussion section of each chapter should be borne in mind in any future plans arising from this research. Additionally, this thesis addresses under-reporting based on contemporary research in England, and while these issues have been shown to persist over time and in different countries, the findings of this thesis may not be applicable to different points in time and space.

9.2 Where are the missing units?

So where are the missing units, and has this thesis been successful in identifying them? Alcohol sales coverage for 2010 was 56%, and this thesis has shown that the remainder – equivalent to almost a bottle of wine a week per adult (see Chapter 4) – can be attributed to under-reporting of alcohol consumption. As the literature review (Chapter 2) found, there are multiple causes or types of under-reporting, and the difference between reported consumption and sales will be comprised of a combination of these causes. In 2010 when this PhD project began, the original proposal was to estimate the relative contribution of each in turn. For instance, if it had been found in Chapter 8 that on average participants under-estimated their usual glass of alcoholic drinks by 50%, this factor could have been applied to reported off-trade alcohol consumption in order to revise consumption to this effect. As a result, if alcohol sales were envisaged as a pint glass, and reported consumption as a volume of beer (see Figure 9.1), this would have the effect of gradually topping up the pint glass as the PhD progressed.

Figure 9.1: Alcohol sales coverage; with sales represented by a pint glass and the volume of beer representing reported consumption

However, once the literature search was underway, sources of secondary data were identified, and primary research studies were being planned, it became apparent that to 'fill up' this pint glass would be a prohibitively difficult task for this (or any) PhD thesis to achieve. This led to a departure from the idea of solving the problem of low alcohol sales coverage – quite literally 'finding the missing units' – to instead identifying factors which may be associated with under-reporting. In doing so this has highlighted areas where future research could focus, and eventually the empty space in the pint glass could be filled. The missing units have been quantified in this thesis, and are certainly understood in much more detail than before. It has been found that under-reporting is linked to drinking spirits or beer rather than wine (Chapter 4), heavier drinking, more frequent drinking, drinking a combination of drink types on the heaviest drinking day in the past week, drinking exclusively in licensed premises (all Chapter 6), having a non-routine drinking pattern, tracking drinking using qualitative approaches (both Chapter 7), and pouring larger glasses (Chapter 8). All these areas can be drawn upon in future research on under-reporting (see Section 9.6). This thesis found little evidence that demographic or social factors are independently associated with under-reporting of alcohol consumption across the three studies presented in Chapters 6-8. This suggests that under-reporting is not necessarily to do with specific population groups who are particularly prone to under-report their consumption, rather, it is more related to alcohol consumption and drinking patterns.

Further, this thesis has also served to draw attention to the issue of under-reporting of alcohol consumption on a broader scale than has arguably ever been done before. An abridged version of Chapter 5 was published in the European Journal of Public Health in February 2013 (**199**). The paper was press released through UCL press office and the resulting media attention was

enormous. I was interviewed by numerous news organisations which then featured the report online (**200-206**) and in print. The story appeared on the front page of the Metro newspaper on 27th February 2013. I was also interviewed on live radio for the BBC Radio 5 Live Drive Programme, the BBC Radio 4 Today Programme by John Humphrys, and the BBC London Breakfast Show, as well as a range of regional and international radio stations. Nicola Shelton (co-author on the paper) also appeared live on television, on BBC News and on Channel 5 evening news. An NHS Choices 'Behind the Headlines' summary of the study was also published (**207**). This shows that this research was very widely disseminated, and will have been heard or read by millions of people worldwide. Arguably, this should be a priority of public health research which aims to make a difference to the population's health and health behaviours. Of course, whether this coverage resulted in anyone having increased awareness, or reducing their alcohol consumption, is open for debate. Moreover, this coverage and attention was not without its negative points, which are discussed in detail in Section 9.3.

Research currently being conducted by other academics is likely to also make important contributions to this field. A team at Liverpool John Moores University led by Bellis is currently working on the paradox seen with respect to the social patterning of consumption and alcohol related harm (discussed in Section 3.2) as part of an Alcohol Research UK flagship grant programme. The research plan was presented at the Alcohol Research UK conference in March 2013 (**208**), and includes surveying groups that are not represented in surveys (such as the homeless, those in the military, and those in institutions or prisons), or are traditionally under-represented (such as students, those in care, and dependent drinkers). Further, omission of alcohol consumption on 'special occasions', consumption by UK residents while abroad on holiday, and the relationship between drink type and reporting accuracy were acknowledged by this team as important for under-reporting. This research may make 'filling up' the glass in Figure 9.1 possible at least to some extent.

But should it even be theoretically possible to fill up the glass in Figure 9.1? There is some disagreement about this in the literature. The highest estimate of consumption achievable is not necessarily the best in terms of its fit with alcohol-related outcomes (Gmel, G. personal communication, 2013). Rehm argued in a 1998 review on measuring alcohol consumption that alcohol sales coverage will never be 100% in a survey of self-reported consumption (**43**). Rehm reasoned that because of the approximately log-normal distribution of consumption – meaning that a substantial proportion of the alcohol is consumed by a small minority of the population – if this minority of heavy drinkers is not sampled in social surveys then high coverage is unachievable (**43**). However, the literature review in this thesis (Section 2.5.2) has suggested that the best estimates for the amount of alcohol that is consumed by these groups is outweighed by opposing factors such as legal and illegal imports of alcohol, and consumption

by UK residents while overseas. This consumption is not captured in alcohol sales statistics. As a result, high alcohol sales coverage is a possibility. This has also been shown in more recent surveys using detailed beverage and location-specific questions in New Zealand (**42, 44**), where alcohol sales coverage has been found to be as high as 94% (**42**).

This method has also been used in England: in a sample of 2,000 adults in Manchester, which found mean reported consumption to be on a par with alcohol sales for the UK (**45**). As such, these more recent studies justify the intentions of studies identified in the literature review, and this suggests that high alcohol sales coverage is a possibility and should be an aim for future surveys. However, while this method appears to be very successful, it has only been used among 14-65 year olds. By omitting older adults, many of who drink but only do so moderately or infrequently, mean consumption is inflated, which in turn may boost alcohol sales coverage. Therefore other survey methods which can achieve high coverage are still desirable. In doing so, there may be a place for diary methods, using a longer time period than the Health Survey for England 2011 was able to.

After reading an article in The Telegraph in December 2009 about an NHS smartphone application to monitor alcohol consumption which had received reviews on the iTunes store where users had stated that they wanted a league table to compare their high scores (**209**), I became interested in how this tool presented users' consumption and how advice about drinking was delivered. I downloaded the NHS Drinks Tracker application and completed a drinking diary for all of the year 2010 (**210**). Alcohol consumption was recorded either on the same day or the following day as consumption, with the exceptions of a festival attended in July and a holiday in August where consumption was estimated upon return from the trip. In late 2011 I was asked the survey interview questions about weekly alcohol intake (used continuously in the General Lifestyle Survey (GLF), and also in the HSE in 2011) in reference to alcohol consumption in 2010 (the diary period). My responses to the interview questions amounted to just 55% of the consumption I had recorded in the diary app; remarkably similar to the proportion of alcohol sales that the same interview questions are able to uncover (56% for 2010 – see Chapter 4). In addition to the sample size of one, there are other biases: the long recall period (answering quantity-frequency questions in late 2011 about alcohol consumption in 2010), and the fact that I was aware of the investigation that was being carried out. However, this striking similarity between the interview-annual diary comparison and the interview-sales comparison suggests this is an area worthy of future investigation, and that diary methods are of value in measuring alcohol consumption more accurately.

In contrast, the HSE 2011 seven-day drinking diary did not identify a difference between interview and the diary measures on this sort of scale. Using the diary estimates improves

alcohol sales coverage by between five and seven percentage points above the interview estimates (Section 6.7.2.1). This suggests that changes to survey methodology perhaps can only go so far in addressing under-reporting of alcohol consumption. Why were the interview and diary measures in this survey so much more similar? There are several reasons. Firstly, completing a drinking diary for a more extended period of time provides a more accurate reflection of drinking habits than doing so for just one week. It could also be that survey participants who knew that their alcohol consumption was likely to be heavy in the subsequent week were more likely to refuse to complete the diary when asked to do so by the interviewer. Further, perhaps those who did not return the diary, or who returned an incomplete diary, were those who had been on holiday or had special occasions where a larger than 'usual' amount of alcohol was consumed. Finally, as a result of my background and interests, I have good knowledge of units in standard drinks and standard drink sizes, which I (consciously and unconsciously) used when I recorded consumption in the app. However, this does not make me infallible to recall bias, and this could explain why the responses to the interview questions were so much lower. The impact of longer term drinking diaries on alcohol sales coverage remains to be seen but is potentially interesting and important, and will vary depending on the variability of any individual's drinking patterns.

So although the glass shown in Figure 9.1 remains to be filled, the contributions this thesis has made towards identifying factors associated with under-reporting and raising awareness are valuable ones. As studies which compare survey modes or questionnaire designs have been the dominant types of studies conducted on under-reporting to date (see Chapter 2), this indicates that innovation is required in the field. Chapters 6-8 provided new insights as to where the missing units may be, and this thesis has identified important alcohol-related factors which can independently predict under-reporting of alcohol consumption. Although the relative importance of these factors is not yet known, it has been shown that particular types of drinking patterns and behaviours contribute to the missing units. These areas can be the target of public health and policy recommendations, as well as future research, each of which will be discussed in the remainder of this chapter.

9.3 Does this thesis have implications for 'safe' drinking guidelines?

Before the public health implications of this thesis are introduced, policy recommendations made, and future research directions suggested, it is important to reflect on what under-reporting of alcohol consumption means for population health. Beyond the debate around methodological improvements to surveys attempting to measure alcohol consumption that this thesis is able to contribute to, the reality is that this research was aimed to protect and improve public health. In Section 3.2 the idea that under-reporting of alcohol consumption may have

implications for the perception of what a 'safe' level of consumption is, and in turn the level at which the official drinking guidelines should be, was introduced. The majority of the research evidence about the relationship between alcohol consumption and the levels at which alcohol-related harm is experienced is based on studies which used or collected information on alcohol consumption that was self-reported. The studies on which the relationship between consumption and harm was estimated are all liable to the types of under-reporting that this thesis has described. As a result of under-reporting, the relationship between consumption and harm may have been over-estimated; that is, consumption is not as 'harmful' as we originally thought. If there had been no under-reporting, and participants in these studies had all reported their alcohol consumption accurately, then the resultant amount of alcohol consumption that constitutes unsafe or higher risk drinking (what this means is an entirely separate debate) would be higher than it is today. In essence, the curve would shift to the right (Figure 3.2). This is a point which was raised when I presented a poster of my planned research three months into my PhD studentship, and as a result I have been aware of this consequence of under-reporting throughout this research.

Does consideration of under-reporting of alcohol consumption imply that official drinking guidelines should be increased to reflect this? Following the publicity of the research presented in Chapter 5 discussed in the previous section, it became clear that various people from a range of backgrounds certainly think so. Firstly, members of the academic community discussed the paper and the associated coverage on the Kettil Bruun Society for Social and Epidemiological Research on Alcohol mailing list. The first person to raise the paper as a discussion point was Professor Robin Room from Australia, who stated some methodological points about British/English survey design, the fact that consumption among self-reported abstainers was not accounted for, and that the extensive international literature on under-reporting was not well discussed. This triggered responses from Dr Paul Lemmens at Maastricht University in the Netherlands and Dr John Duffy from Edinburgh in Scotland. Lemmens wrote on the KBS list:

> *What struck me in the pieces on underreporting is the uncritical comparison of UK survey self-reports with the UK safe limits. These very safe limits are based on research using alcohol self-reports too, so equally prone to this underreporting bias. How to solve this issue? Do we simply top up the safe limits too?*
>
> *Authorities have a task in defending public health, and the public wants to have a clear message about their own 'safety' when drinking. That is why these safe limits have been constructed. However, in my opinion research cannot come up with an optimal strategy for each individual. Drinking patterns are unstable in time, and may change over the life course, and are quite diverse. This variation is often not included in the epidemiological research on which the safe limits are based. Apart from the under-reporting, any claim about safe drinking has to be taken with more than a pinch of salt.*

28th February 2013

Soon after this message was posted, John Duffy circulated a jpeg image of a paragraph from a book which he published over 20 years ago with the short message:

> *Paul is right.*
>
> *The attached is from a publication of mine 20 years ago...*
>
> *Pity they didn't read it before issuing the press-release*

28th February 2013

The attached paragraph (from the end of Chapter 2 in Duffy's 1992 book 'Alcohol and Illness: the epidemiological viewpoint') read:

> *The under-reporting of consumption by individuals, known to occur in population surveys, has considerable implications for epidemiological studies of alcohol and illness. If, as seems likely, under-reporting also occurs in assessment of alcohol consumption in epidemiology, then relationships between consumption and risk of harm will be 'too steep'. The risk increase apparently corresponding to a particular amount of alcohol will in fact correspond to a greater amount. Thus, if a particular level of risk increase obtained from epidemiological study is used to set a 'safe' limit or threshold, the apparent limit will be lower than the actual quantity of alcohol corresponding to the risk increase. To put this another way, a particular level of risk established from an epidemiological study is associated not so much with consuming a particular amount of alcohol, but with reporting the consumption of that amount.* (**211**)

Despite that this consequence of under-reporting has not been widely discussed in the peer-reviewed literature, it is implicitly understood by researchers working on alcohol worldwide. One reason it may not have been more widely circulated or discussed could be because of the risk that it creates perverse incentives for alcohol policy, meaning that academics interested in public health are reluctant to discuss this publicly. Indeed, it is true that considering under-reporting of alcohol consumption in epidemiological studies may mean that alcohol is 'safer' than was previously thought (because the threshold used for safety is inaccurate). It seems that researchers are reluctant to discuss the issue, and one of those who is willing to has been funded by the alcohol industry (**212**) and therefore may have questionable motives for doing so.

Media coverage of the paper also attracted hundreds of comments on news articles from readers. In these comments, members of the public also occasionally picked up on this issue of how under-reporting may have implications for the drinking guidelines. A reader with the username Seffrid commented on the BBC article:

> *I wonder how much longer they're going to take to come up with revised guidelines? This study doesn't help Nanny State one bit, given that it indicates more people are exceeding the existing guidelines while the numbers of those harmed by drink hasn't changed.*
>
> *But then those of us who enjoy two glasses of wine with a meal but are told a third glass makes us binge drinkers knew it was nonsense!*
>
> 27th February 2013

A reader with the username Representoid posted a similar comment on the Guardian article:

> *…More importantly - how does this effect* [sic] *the Department of Health's alcohol consumption guidelines, if they are based on false figures? Surely, it's not the case that there is now a sudden explosion of problem drinkers, but that the thresholds over years were based on reported levels that were way below the actual ammount [sic] drunk by individuals.*
>
> *Doesn't this mean we can nearly double our safe weekly booze allowance, or assess our proximity to having a problem against a higher threshold?*
>
> 27th February 2013

With the hindsight that this issue would be addressed widely in the wake of the paper being published, more attention would have been paid to this issue in the paper, as well as the press release. While the implication of considering under-reporting *may* mean that alcohol consumption is 'safer' than previously thought, whether consideration of under-reporting necessitates upward revision of drinking guidelines depends on the aim of the drinking guidelines (to reflect the objective relationship between consumption and harm, or to act as a useful benchmark for the public), as well as the distribution of under-reporting. In stating that under-reporting of alcohol consumption by 40% means that the guidelines can be increased by this amount, it is implicitly assumed that under-reporting of alcohol consumption is equal across population groups. Chapters 6-8 of this thesis have shown that the extent of under-reporting varies by alcohol-related factors, therefore this assumption is incorrect.

Upward revision of the drinking guidelines based on the current evidence that consumption is under-reported would be an irresponsible move likely to damage population health. It is accepted that the majority of under-reporting is not deliberate and is due to mode effects, recall bias and under-estimation of the amount of alcohol in drinks (see Chapter 2). Put simply, individuals are not aware that they under-estimate their consumption. If the guidelines were increased, this would suggest to the public that there was scientific evidence that it was safe for people to drink more alcohol. Raising the guideline would not eliminate the fact that people under-estimate their consumption, and therefore consumption would likely increase if the

change to the drinking guidelines was not accompanied by a step change in individuals' awareness of their consumption and concurrently, their reporting accuracy.

This differential under-reporting means that a 'safe' level of (reported) alcohol consumption cannot apply uniformly across the population. To take a simplified example, if the drinking guideline was currently three units, then using the logic of accounting for under-reporting in the drinking guidelines, it follows that the guideline should be increased to five units (three being 60% of five). However, if there is differential under-reporting, then for every person who reports drinking three units and is actually drinking three, there is effectively another who reports drinking three units but is actually drinking seven. This does not suggest the need for upward revision of the drinking guidelines, but rather interventions to improve awareness of alcohol consumption, the alcohol content of different drinks, and standard serving sizes. This would actually tackle the root cause of the issue; by improving knowledge it is likely that reporting would be more accurate, and alcohol sales coverage would increase. This in turn would improve the reliability of the epidemiological evidence on the relationship between consumption and harm, meaning that any necessary revision to the guidelines could be made in due course.

9.4 Public health implications

This thesis has implications for public health in England that may be applicable elsewhere as well. Chapter 2 has shown that under-reporting is often indicative of under-*estimation* of alcohol consumption; if people are not aware of their alcohol intake then they are disempowered and public health organisations have a role to play in improving awareness. One of the public health implications of this thesis is that some individuals are at greater risk of alcohol-related harm than that which their reported consumption reflects. This was discussed in Chapter 3 (see Figure 3.1) where it was shown that individuals who are under-reporting their alcohol consumption are operating on a different J-curve (the same would also apply to other relationships, such as linear or exponential) for the relationship between alcohol consumption and alcohol-related harm than the general population. If these two theoretical groups were compared, the under-reporters would be experiencing a higher level of alcohol-related harm for a given level of (reported) alcohol consumption than the general population. Therefore identifying under-reporting, and hence under-report*ers* could be used to alleviate this alcohol-related harm. This thesis has shown that under-reporting of alcohol consumption is not uniform across the population and that considerable differentials in under-reporting are likely, which in turn means that using reported consumption to deliver public health interventions and plan health service provision is problematic. Interventions and service planning would be best informed by using data on health outcomes, which are more objective than self-reported consumption data (though not without their own biases and limitations).

This thesis has found that the differentials observed in under-reporting are not linked to specific demographic or social factors. This means that it is not possible to use such factors in order to identify individuals who are particularly prone to under-report their alcohol consumption, which would have made targeted approaches to tackling under-reporting straightforward. As a result of this thesis, under-reporting of alcohol consumption is now better understood and new risk factors for under-reporting have been identified. This thesis has identified alcohol-related factors relating to quantity of alcohol consumption and drinking patterns and habits, which could be used to identify under-reporting. This means that if a study or public health intervention wishes to identify 'under-reporters', in order to tackle under-reporting of alcohol consumption and to reduce levels of alcohol-related harm, some information about alcohol consumption will be required *a priori* before this identification could take place. One example of where a basic form of this sort of information could come from is General Practice registration forms where this is collected as part of a registration assessment for new patients. Alternatively, a whole population approach could be taken. As it is believed that the majority of under-reporting is accidental rather than deliberate, individuals who may be particularly likely to under-report their consumption (in the sorts of questions surveys ask) may benefit from public health interventions and education initiatives to improve awareness about their alcohol consumption.

This thesis reinforces the idea that improvements in survey methodology are required in order to better capture consumption among those sampled. However, there are improvements that can be made to the sampling strategy of surveys as well in order to include more heavy drinkers who may under-report to a greater extent. Groups which are traditionally under-sampled in social surveys – such as students and those living in military-owned accommodation - or which have low response rates to social surveys may have a higher proportion of heavy drinkers than the general population and as a result be likely to under-report or under-estimate their consumption considerably. Therefore there is a public health importance in putting particular emphasis on better understanding consumption in these groups, where consumption is not well understood and potentially liable to extensive under-reporting at present.

Related to the issues surrounding the drinking guidelines discussed in Section 9.3, is the fact that this thesis has been able to draw attention to the importance of reliable and valid measurements of health behaviours in order to establish epidemiological relationships, be they for the purposes of establishing causality or quantifying dose-response. In the absence of reliable data on alcohol consumption, the existing quantification of the relationship between consumption and alcohol-related harms is brought into question. Even if we do not believe this has implications for the drinking guidelines (as individuals will still under-estimate their consumption if the guidelines are raised), this serves to highlight the importance of rigorous and up-to-date survey methodology as crucial in public health and epidemiological research. The

ability of such biased or inaccurate measures of health behaviours – or indeed other risk factors or outcomes – to contribute meaningfully to understanding population health is limited. While the argument that continuing use of such measures are useful to identify trends over time is valid, this can be criticised as being short-sighted. The research presented in this thesis has drawn attention to the limitations of self-reported measures, and while this is by no means the first time this has been done, it is arguably the first time that this topic has received such attention from a non-specialist audience and in doing so initiated some level of awareness among the general public.

9.5 Policy recommendations

It is of public health importance to reduce the missing units and make reported consumption more closely aligned with alcohol sales, and policy is able to play a role in doing so. Therefore this thesis also carries recommendations for public health policy. These comprise recommendations for changes to be made to existing or proposed policies, as well as new ideas which could be introduced. This thesis has found that the population distribution of under-reporting is likely to fall particularly on heavier drinkers, those with less routine drinking patterns, and people who pour larger glasses. Understanding the causes of under-reporting is important as these different causes will require different tailored interventions or policies in order to tackle them. Education about standard drink volumes or strengths would be of little use to people who drink primarily in the public sphere, for example.

One current public health policy is the public health Responsibility Deal Alcohol Network which comprises representatives of several organisations, including the alcohol industry, local authorities and the public health community (**213**). These organisations have signed up to eight pledges which mainly concern public education and marketing, with the aim to 'foster a culture of responsible drinking' (**214**). However, six key health-oriented medical and alcohol organisations declined to sign up to the Deal because the alcohol industry's views were being prioritised and the pledges would not address alcohol-related harm (**215**). There is little evidence that public education and marketing campaigns effective in minimising harm and therefore be beneficial for public health.

Minimum unit pricing of around 45 or 50 pence per unit will particularly affect sales – and hence consumption – of low cost drinks such as strong white cider and some spirits. These drinks are associated with alcohol consumption among heavy drinkers, who this thesis suggests may be particularly likely to under-report their consumption or to under-report to a greater extent than lighter drinkers. Further, it was shown in Chapter 4 that alcohol sales coverage is lower for spirits (around 40%) and beer (around 50%) than it is for wine (around 70%). If minimum unit pricing is implemented, and sales of drinks which are not well-captured by social surveys

experience decline as a result, we might expect to observe an improvement in alcohol sales coverage. This would be an unintended outcome of the minimum unit pricing policy but nonetheless an important one from a public health research perspective.

Chapter 2 found that the majority of under-reporting of alcohol consumption is likely to be accidental and a result of the design and content of surveys, rather than deliberate omission of consumption. This evidence that individuals struggle to estimate their consumption accurately is compounded by the poor knowledge of the amount of alcohol in certain drinks and the drinking guidelines identified in the HSE 2007 (**99**) and also in Chapter 8. When asked what the current Department of Health drinking guidelines were in Chapter 8, individuals commonly refer to weekly drinking guidelines that were replaced with daily guidelines in 1995 (**17**), or the threshold which was previously used for binge drinking. Perhaps this sort of confusion around the drinking guidelines is to be expected, given the changes from weekly to daily guidelines over time, however more could be done to make the drinking guidelines more widely-understood. The current drinking guidelines state that three to four units a day for men, and two to three units a day for women, should not be regularly exceeded (**19**). Although these guidelines specify a range of one unit for both men and women, this is a relatively large range to specify: the upper threshold of the guideline for men is 33% higher than the lower threshold, and the upper threshold for women is 50% higher. Perhaps as part of the review of the drinking guidelines that is on-going (**216**) the possibility of no longer specifying a range for the drinking guidelines could be explored, and also age-specific guidelines could be introduced as has been previously proposed by the Royal College of Psychiatrists (**193**).

In terms of new policies that could be introduced which would tackle under-estimation of alcohol consumption, and in turn under-reporting in social surveys, it is difficult to envisage how drinking patterns or styles could be targeted. Perhaps restrictions or bans on ‘happy hour’ promotions such as ‘buy two large glasses of wine and get the rest of the bottle free’ could reduce under-reporting of alcohol consumption in the on-trade. These types of promotions may cloud estimation accuracy, and could explain why drinking in the on-trade in the diary week was independently associated with under-reporting in Chapter 6. A recent ban on multi-buy offers in the off-trade has reduced off-trade alcohol sales in Scotland (**217**), and this may pave the way for future restrictions in the on-trade.

There is also scope for policy to make changes to serving sizes which would hold promise for reducing under-estimation of alcohol consumption, including reducing the size of wine bottles which was recommended by the deputy editor of the British Medical Journal in 2008 (**218**). Much as many labels on bottles of alcoholic drinks for sale are currently marked with the number of units contained in the bottle, additional markings could be added to denote ‘serving

sizes', much as is seen on packets of rice and some cartons of fresh fruit juice. These markings could form part of the labelling along the bottle and mark, for example, one unit or a 125ml glass (approximately 1.5 units) on bottles of wine, and one or two unit intervals on bottles of spirits. Further innovations could also be made with drinks packaging, such as lids to bottles of spirits that could be used as unit measurers. There is also scope for the sale of glasses that are etched with measures such as 25ml (for spirits) or 125ml (for wine glasses). These measures may reduce under-estimation of off-trade alcohol consumption. Promotion or subsidy of devices that may promote sensible drinking in the off-trade such as spouts fitted to the tops of bottles to pour 25ml or spirits, or the 'Glugstop' which pours 80ml of wine (approximately one unit) (**219**), could also be combined with public health campaigns around the issue of under-estimation of alcohol consumption that could form part of initiatives such as Change 4 Life.

9.6 Future research directions

As a result of conducting the research that comprises this thesis several areas where evidence is scarce or uncertain have been identified. Recommendations for future research are made in this section. Some of the areas where evidence is lacking are closely linked to the research presented in Chapters 5-8, whereas others concern different aspects of under-reporting that have not been addressed in as much detail in this thesis. Firstly recommendations are made for future research which build on the research presented in this thesis. Secondly, future research directions for other studies interested in under-reporting are discussed.

It is questioned whether drink strengths - measured as alcohol-by-volume (ABV) - used in social surveys to convert reported consumption into alcohol units are reliable and based on the types of alcoholic beverages that were actually on sale at the time the survey was conducted. In 2006, the strength of wine was revised from 9% ABV to 12% ABV in both the HSE (see Section 5.5.2.2) and in the GLF (see Section 5.5.1.2) to reflect increasing strength (ABV) over time (**220**). Drink size specific options were then introduced for 'a glass' of wine to the HSE in 2007 and the GLF in 2008. It is suggested that the strength of wine is re-investigated, particularly with reference to the different strengths of red and white wines, as red wines are often 13% or 13.5% ABV in supermarkets today. Additionally, the ABV of beer and cider used in social surveys (typically 4%) to calculate alcohol units should be reviewed to account for the increasing ABVs of these drinks too. Default survey options for wine and beer should reflect the market share of different ABV drinks.

Reviewing the ABV for spirits and other drinks (such as alcopops) is unlikely to have much impact as their ABV has remained unchanged or changed relatively little. However, particular alcoholic drinks which are less common, such as fortified wine drinks (for example 'Cherry B', 11.5% ABV), may sometimes be inaccurately reported if the participant does not know what

type of alcohol the drink is, and be wrongly recorded as alcopops (usually around 4% ABV). The exhaustiveness of survey coding frames could be explored in addition to revisions to ABV of different drinks, forming a comprehensive review of how all alcoholic drinks are recorded in surveys. These changes could lead to considerable improvements in alcohol sales coverage. National statistics on alcohol consumption would be more reliable and more precise estimates of the relationship between consumption and harm could be made.

There is scope for the methodology used in Chapter 5 to align self-reported alcohol consumption with alcohol sales to be further developed in order to more accurately estimate actual consumption based on self-reported data. Once more conclusive evidence to describe the population distribution of under-reporting exists, and the relative importance of each factor is known, this information could be combined and used to create an adjustment factor to use in surveys measuring alcohol consumption to account for under-reporting. For instance, what is the relative contribution of drinking spirits, compared with drinking in a combination of on and off-trade venues? This could take the form of a survey weight to account for under-reporting of alcohol consumption that could be used routinely in further statistical analyses. Using an under-reporting weight could also be used to help overcome the biases inherent in epidemiological studies which aim to estimate the relationship between alcohol consumption and alcohol-related harm discussed in Section 9.3. This would mean that a more accurate reflection of the actual relationship between consumption and harm is seen, rather than the relationship between *reported* consumption and harm that is currently observed.

Chapter 6 and Chapter 7 have highlighted areas that future studies could explore in more detail. One of the reasons that the drinking diary used in the Health Survey for England 2011 was not able to make substantial improvements to alcohol sales coverage may have been because of the relatively short duration of the diary measure of drinking used; just seven days. In a future survey, the diary could be conducted for a longer period, such as four weeks, in order to gain a more accurate representation of alcohol consumption and drinking patterns. Such a diary could be completed by the whole survey sample, and compared to survey interview responses (intra-individual comparisons), or participants could be randomised to complete either a week long diary or an extended four week diary, and comparisons made between the two diaries (inter-individual) and the survey interview responses (intra-individual). Using the drinking diary for a longer period may allow for additional risk factors for under-reporting not apparent from Chapter 6 and Chapter 7 to be identified. Other measures of consumption such as the timeline follow back interview which asks participants about consumption in the last 90 days (**221**) could also be explored.

The complementary findings of Chapter 6 and Chapter 7 suggest that a mixed methods approach to exploring under-reporting of alcohol consumption is a valuable one. Mixed methods research may be able to make important contributions to understanding under-reporting particularly in improved measurement of consumption among typically under-sampled populations, or otherwise marginalised groups, or people who are more difficult to contact. Surveys measuring consumption in these groups could be combined with qualitative interviews or focus groups to unpack some of the deeper issues linked to non-response, and the drivers of under-reporting of alcohol consumption, perhaps among those who have experienced alcohol-related harm. Approaches that are traditionally qualitative, such as snowballing, could be applied to quantitative data collection in order to improve understanding of the realities of consumption in 'hard to reach' groups. Such research would need to be conducted by researchers experienced in collecting complex and sensitive information.

Chapter 8 yielded unexpected and intriguing results when investigating perceived amounts of alcohol in a self-defined 'usual glass' of wines and spirits. One important limitation of the study was that the participants were (or at least appeared to be) sober. Of course when drinks are being poured, they are usually being consumed as well, and it is likely that the volume poured as a usual glass and the perception of the amount of alcohol that the 'usual glass' constitutes will vary with the level of intoxication experienced by the participant. Future studies should be conducted among intoxicated individuals using a biological measure such as breath alcohol concentration in order to understand if and how perceptions of the amount of alcohol poured varies with intoxication level. Further, there is also the scope for other methods to explore drink pouring which may be less liable to the researcher bias present in the method used in Chapter 8. Perceived units in a 'usual glass' could be triangulated from the participants' estimation of the number of units in a pre-poured (by the researcher) glass, and the pouring of a 'usual glass' (by the participant). This could be measured by the researcher but would not need to be estimated by the participant. Alternatively, the method which has been used by De Visser and colleagues (**115**) could be used, in which participants are asked to pour their usual glass first, then to attempt to pour one unit of the same drink afterwards. The perceived amount of alcohol in a usual glass can be triangulated in a similar way using this methodology as well.

This thesis was not able to explore each of the aspects of under-reporting identified in Chapter 2 in detail, and as a result is not intended as a comprehensive explanation of, or panacea for, under-reporting. There are several other directions which future research could take. There has been very little research to date that explores some of the aspects of low alcohol sales coverage that are relevant for understanding the extent of under-reporting. Little is known about the extent of counterfeit alcohol, homebrew, and illegally imported alcohol that is consumed in the UK. Consumption among residents of this country while abroad is not included in UK alcohol

sales figures, while consumption by foreign visitors to the UK is. While consumption of UK residents while abroad is likely to outweigh that of foreign visitors to the UK (see Table 2.1), the exact balance is not known. In the absence of more detailed information about such factors, it is difficult to estimate actual population consumption levels and therefore under-reporting with confidence, irrespective of improvements to surveys that measure consumption.

Although Chapter 6 and Chapter 7 have identified 'risk factors' for under-reporting of alcohol consumption among those who are included in the sampling strategy of social surveys, there is relatively little research that describes consumption among those not traditionally sampled. Bellis's team at Liverpool John Moores University are currently surveying under-sampled groups (see Section 9.2), however it is unlikely that a single survey will be able to give a definitive measure of alcohol consumption across all the groups not traditionally sampled. Therefore additional surveys should be conducted among groups such as students living in halls of residence, people living in military or other institutions, and those who are incarcerated. Further, among those who are sampled, the continuum of resistance theory discussed in Section 2.6.2 can be explored further, and consumption in early responders versus late responders should be compared.

It may also be of interest to explore in more detail the relative contribution of selective reporting that is of a deliberate nature in comparison to accidental under-reporting that this thesis predominantly concerns. Previous studies examining selective reporting have found mixed results and have mainly been conducted among participants with particular health conditions (Section 2.6.3). If possible, the ability to make a distinction between consumption that is deliberately and accidentally not reported in surveys would be a useful marker of the likely effectiveness of improvements to survey methodology. If deliberate under-reporting is found to be prevalent, or particularly prevalent in certain groups, the scope for changes to survey design to contribute meaningfully to better understanding of alcohol consumption may be severely limited. In this case, future research should consider the use of more objective measures of consumption that so far have been relatively under-used (Section 2.6.7.1). These include breath alcohol concentration and transdermal alcohol concentration, which yields similar results and can be measured continuously using an anklet (**124-126**). Such measures could be compared with self-reports of consumption, and would be particularly valuable if used in groups that are thought to under-report their consumption to a greater extent in order to quantify their actual consumption more accurately.

These recommendations for future similar studies and directions for future research focused on under-reporting of alcohol consumption each have the potential to make their own unique contributions to the field. Reliable data on the population distribution of under-reporting should

be seen as a particular priority for future studies. This data will enable health professionals to more accurately estimate patients' alcohol consumption based on their reported consumption if they are aware of particular 'risk factors' for under-reporting; making possible the identification of groups at higher risk of alcohol-related disease or mortality than their reported alcohol consumption reflects. This will also permit the development of under-reporting weights for social surveys to make national surveys more representative and population-level statistics more reliable. More accurate estimation of the relationship between alcohol consumption and harm in epidemiological studies will also be facilitated, and areas where targeted alcohol-related public health interventions and policies are required will be illuminated.

9.7 Conclusion

The missing units are a persistent problem and a substantial proportion of alcohol sales. This thesis has shown that the missing units can be attributed to under-reporting of alcohol consumption. Accounting for the missing units affects estimates of self-reported alcohol consumption substantially.

The mixed methods research in this thesis has identified 'risk factors' for under-reporting that could explain the missing units which relate to alcohol consumption and drinking pattern. The original contribution that this thesis provides is identifying the aspects of drinking pattern or style that are important for under-reporting, in addition to the importance of alcohol consumption level (which was more established).

These risk factors could be the target of future public health interventions and health or alcohol policy that could help to improve accuracy of estimation of consumption and help to reduce the missing units. If future research can reduce or fully explain the missing units then this will enable more objective estimates of the relationship between alcohol consumption and harm.

9.8 Lay summary of thesis

This thesis has investigated why alcohol consumption that is reported by participants in national surveys amounts to far less than the amount of alcohol that is sold in the UK: this is termed the 'missing units'. For 2010, the missing units were equivalent to 44% of alcohol sales. This has been fairly consistent since the 1990s despite substantial changes in the composition of alcohol sales in terms of drink type and drinking venue.

The literature review found that the missing units are not simply due to consumption among groups not invited to participate in surveys, those who do not respond to invitations to participate in surveys, or other uses of alcohol such as in cooking. This means that the missing

units are due to under-reporting of alcohol consumption. Under-reporting occurs for several reasons, including but not limited to: a) the wording and detail of survey questions, and the way they are administered influencing what participants say, b) survey participants may not be willing to disclose consumption, c) survey participants can't accurately remember consumption, and d) survey participants aren't aware of the amount of alcohol in different drinks.

This thesis has shown that if everyone under-reported their alcohol consumption equally (i.e. everyone had only reported 56% of their consumption), then among drinkers, over 40% of men and 30% of women would actually be drinking more than the weekly drinking guidelines (21 units for men, 14 for women). 75% men and 80% women who drank in the last week would have drunk more than the daily limits (4 units for men, 3 for women) on their heaviest drinking day, with around half of drinkers drinking more than twice this level. However, it is unlikely that everyone under-reports equally, which means that it is likely that the missing units are concentrated in certain groups.

The majority of the research presented in this thesis focuses on identifying groups that may be particularly prone to under-reporting their alcohol intake. A comparison of a week-long drinking diary and typical survey interview questions about drinking found that participants were more likely to report drinking more in the diary if they were heavier drinkers, drank more frequently, drank a combination of drink types, and drank exclusively in licensed premises (pubs, restaurants, etc). A series of further interviews conducted with the survey participants found that having a non-routine drinking pattern and tracking drinking using certain approaches (e.g. tracking drinking by how intoxicated they felt) were linked to being surprised at the level of alcohol consumed when completing a drinking diary. Separate from the surveys used in the rest of the thesis, a questionnaire and pouring task found a 'usual glass' of wines and spirits to be around 1.9 units of alcohol. On average, participants did not under-estimate the amount of alcohol they had poured, but those who poured larger glasses were more likely to under-estimate how much they had poured.

The alcohol-related risk factors for under-reporting of alcohol consumption identified in this thesis could be the subject of public health interventions and future health policy. This may help to reduce alcohol consumption on a population level and also alcohol-related harm.

References

1. Boniface S, Fuller E. Chapter 7: drinking diary. In: Mindell J, Craig R, editors. *Health Survey for England 2011 Volume 1: Health, social care, and lifestyles*. Leeds: NHS Information Centre for Health and Social Care; 2012.

2. Ng Fat L, Fuller E. Chapter 6: drinking patterns. In: Mindell J, Craig R, editors. *Health Survey for England - 2011, Health, social care, and lifestyles*. Leeds: NHS Information Centre for Health and Social Care; 2012.

3. NHS Information Centre. *Chapter 4: Drinking-related costs, ill health and mortality. Statistics on Alcohol: 2012*. 2012 [cited 26.07.2013]; Available from: https://catalogue.ic.nhs.uk/publications/public-health/alcohol/alco-eng-2012/alco-eng-2012-rep.pdf

4. HM Government: Home Office. *The Government's Alcohol Strategy.* 2012 [cited 26.07.2013]; Available from: http://www.homeoffice.gov.uk/publications/alcohol-drugs/alcohol/alcohol-strategy?view=Binary

5. North West Public Health Observatory. *Local Alcohol Profiles for England*. 2012 [cited 26.07.2013]; Available from: http://www.lape.org.uk/index.html

6. Cabinet Office Strategy Unit. *Figure 2.1: Alcohol Consumption in the UK: 1900-2000 per capita consumption of 100 per cent alcohol*. Alcohol Harm Reduction Strategy for England 2004 [cited 26.07.2013]; Available from: http://webarchive.nationalarchives.gov.uk/+/http://www.cabinetoffice.gov.uk/~/media/assets/www.cabinetoffice.gov.uk/strategy/caboffce%20alcoholhar%20pdf.ashx

7. British Beer and Pub Association. *Statistical Handbook 2010*. London: British Beer and Pub Association; 2010.

8. Davies SC. *Annual Report of the Chief Medical Officer. Volume 1, 2011: On the state of the public's health*. London: Department of Health; 2012.

9. Nutt D. *Drugs: without the hot air*. Cambridge: UIT; 2012.

10. Office for National Statistics. Social and Vital Statistics Division. General Lifestyle Survey 2010 SN7000: Special Licence Access [computer file]. 2nd edition. Colchester, Essex: UK Data Archive; 2012.

11. HM Revenue and Customs. Table 2.3. Alcohol clearances per adult (1986/87-2010/11). *Alcohol factsheet: March 2012*. London: HM Revenue and Customs; 2012.

12. Martin CS, Nirenberg TD. Alcohol content variation in the assessment of alcohol consumption. *Addictive Behaviors* 1991;**16**(6): 555-60.

13. Turner C. How much alcohol is in a 'standard drink'? An analysis of 125 studies. *British Journal of Addiction* 1990 Sep;**85**(9): 1171-5.

14. Furtwængler NAFF, de Visser RO. Lack of international consensus in low-risk drinking guidelines. *Drug and Alcohol Review* 2013;**32**(1): 11-8.

15. Royal College of Physicians. *A great and growing evil: the medical consequences of alcohol abuse*. London: Tavistock; 1987.

16. Institute of Alcohol Studies. *IAS Fact sheet: what is problem drinking?* 2002 [cited 10.01.2013]; Available from: http://www.ias.org.uk/resources/factsheets/problemdrinking.pdf

17. Department of Health. *Sensible drinking: Report of an inter-departmental working group*. London: Department of Health; 1995.

18. Department of Health. *Alcohol Advice*. 2011 22nd March 2011 [cited 20.09.2011]; Available from: http://www.dh.gov.uk/en/Publichealth/Alcoholmisuse/DH_125368

19. Department of Health. *Alcohol Advice*. 2012 14th February 2012 [cited 07.02.2013]; Available from: http://www.dh.gov.uk/en/Publichealth/Alcoholmisuse/DH_125368

20. Anderson P, Cremona A, Paton A, Turner C, Wallace P. The risk of alcohol. *Addiction* 1993 Nov;**88**(11): 1493-508.

21. Twigg L, Moon G. The spatial and temporal development of binge drinking in England 2001-2009: An observational study. *Social Science & Medicine* 2013;**91**: 162-7.

22. Jayne M, Valentine G, Holloway SL. Geographies of alcohol, drinking and drunkenness: a review of progress. *Progress in Human Geography* 2008;**32**(2): 247-63.

23. Jayne M, Valentine G, Holloway SL. The place of drink: Geographical contributions to alcohol studies. *Drugs-Education Prevention and Policy* 2008 Jun;**15**(3): 219-32.

24. Valentine G, Holloway SL, Jayne M, Knell C. *Drinking Places: where people drink and why*. 2008 [cited 26.07.2013]; Available from: http://www.jrf.org.uk/sites/files/jrf/2113-where-people-drink.pdf

25. Roberts M, Eldridge A. Chapter 5: Binge-drinking Britain? *Planning the night-time city*. Oxon: Routledge; 2009. p. 82-108.

26. Jayne M, Valentine G, Holloway SL. Fluid Boundaries—British Binge Drinking and European Civility: Alcohol and the Production and Consumption of Public Space. *Space and Polity* 2008;**12**(1): 81-100.

27. Holloway SL, Jayne M, Valentine G. 'Sainsbury's is my local': English alcohol policy, domestic drinking practices and the meaning of home. *Transactions of the Institute of British Geographers* 2008;**33**(4): 532-47.

28. The Guardian. *Scale of harmful middle class drinking revealed*. 16.10.2007 [cited 01.12.2010]; Available from: http://www.guardian.co.uk/society/2007/oct/16/drugsandalcohol.health

29. The Times. *Home tipplers drink doubles by mistake*. 2004 [cited 01.12.2010]; Available from: http://www.timesonline.co.uk/tol/news/uk/scotland/article484546.ece

30. BBC News. *Wealthy areas head alcohol table*. 16.10.2007 [cited 22.05.2013]; Available from: http://news.bbc.co.uk/1/hi/health/7045830.stm

31. Hughes. Alcohol, nightlife and violence: the relative contributions of drinking before and during nights out to negative health and criminal justice outcomes. *Addiction* 2008;**103**(1): 60-5.

32. Change 4 Life. *Don't let drink sneak up on you!* 2013 [cited 13.02.2013]; Available from: http://www.nhs.uk/Change4Life/Pages/sneaky-drinks.aspx

33. Pernanen K. Validity of survey data on alcohol use. In: Gibbins RJ, *et. al.*, editors. *Research Advances in Alcohol and Drug Problems*. New York, USA & London, England: John Wiley and Sons, Inc.; 1974. p. 355-74.

34. Smith PF, Remington PL, Williamson DF, Anda RF. A comparison of alcohol sales data with survey data on self-reported alcohol use in 21 states. *American Journal of Public Health* 1990 1990/03/01;**80**(3): 309-12.

35. Hoyer G, Nilssen O, Brenn T, Schirmer H. The Svalbard study 1988-89: A unique setting for validation of self-reported alcohol consumption. *Addiction* 1995;**90**(4): 539-44.

36. Kühlhorn E., Leifman H. Alcohol surveys with high and low coverage rate: a comparative analysis of survey strategies in the alcohol field. *Journal of Studies on Alcohol* 1993;**54**(5): 542-54.

37. Knibbe RA, Bloomfield K. Alcohol consumption estimates in surveys in Europe: Comparability and sensitivity for gender differences. *Substance Abuse* 2001;**22**(1): 23-38.

38. Stockwell T, Zhao J, Chikritzhs T, Greenfield TK. What did you drink yesterday? Public health relevance of a recent recall method used in the 2004 Australian National Drug Strategy Household Survey. *Addiction* 2008 Jun;**103**(6): 919-28.

39. Leifman H. The six-country survey of the European Comparative Alcohol Study: comparing patterns and assessing validity. *Contemporary Drug Problems* 2002;**29**: 477-500.

40. Kerr WC, Greenfield TK. Distribution of Alcohol Consumption and Expenditures and the Impact of Improved Measurement on Coverage of Alcohol Sales in the 2000 National Alcohol Survey. *Alcoholism: clinical and experimental research* 2007;**31**(10): 1714-22.

41. Nelson DE, Naimi TS, Brewer RD, Roeber J. US state alcohol sales compared to survey data, 1993–2006. *Addiction* 2010;**105**(9): 1589-96.

42. Casswell S, Huckle T, Pledger M. Survey Data Need Not Underestimate Alcohol Consumption. *Alcoholism: clinical and experimental research* 2002;**26**(10): 1561-7.

43. Rehm J. Measuring quantity, frequency, and volume of drinking. *Alcoholism: clinical and experimental research* 1998;**22**(2 SUPPL.): 4s-14s.

44. Casswell S, Meier P, MacKintosh AM, et al. The International Alcohol Control (IAC) Study—Evaluating the Impact of Alcohol Policies. *Alcoholism: clinical and experimental research* 2012;**36**(8): 1462-7.

45. Morleo M, Cook PA, Bellis MA. *Improving accuracy in recording alcohol consumption: a survey in Greater Manchester*. 2011 [cited 15.03.2013]; Available from: http://www.cph.org.uk/showPublication.aspx?pubid=726

46. Bellis MA, Hughes K, Cook PA, Morleo M. *Off measure: how we underestimate the amount we drink*. 2009 [cited 26.07.2013]; Available from: http://www.alcoholconcern.org.uk/assets/files/Publications/Off%20Measure%20-%20FINAL.pdf

47. Thorpe R, Robinson M, McCartney G, Beeston C. *Monitoring and Evaluating Scotland's Alcohol Strategy (MESAS): A review of the validity and reliability of alcohol retail sales data for*

the purpose of MESAS. 2012 [cited 26.07.2013]; Available from: http://www.healthscotland.com/uploads/documents/18793-MESAS%20-%20Validityofalcoholretailsalesdata%20_Rev052012BMKD.pdf

48. Meier PS, Meng Y, Holmes J, et al. Adjusting for unrecorded consumption in survey and per capita sales data: Quantification of impact on gender- and age-specific alcohol-attributable fractions for oral and pharyngeal cancers in Great Britain. *Alcohol and Alcoholism* 2013;**48**(2): 241-9.

49. Bridges S, & Sutton, R. Chapter 3: Drinking alcohol. In: Fuller E, editor. *Smoking, drinking and drug use among young people in England in 2010*. Leeds: NHS Information Centre for Health and Social Care; 2011.

50. Norstrom T. Estimating changes in unrecorded alcohol consumption in Norway using indicators of harm. *Addiction* 1998;**93**(10): 1531-8.

51. Trolldal B. Alcohol sales figues in 15 European countries: corrected for consumption abroad and tax-free purchases. *Nordisk Alkohol & Nartkotikatidskrift (English Supplement)* 2001;**18**: 71-80.

52. Leifman H. Estimations of unrecorded alcohol consumption levels and trends in 14 European countries. *Nordisk Alkohol & Nartkotikatidskrift (English Supplement)* 2001;**18**: 54-69.

53. HM Revenue and Customs. *Renewal of the 'Tackling Alcohol Fraud' Strategy*. 2010 [cited 28.11.2012]; Available from: http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_PROD1_030554&propertyType=document#downloadopt

54. HM Parliament: Public Accounts Committee News. *Committee reports on HM Revenue and Customs renewed alcohol strategy*. 29.08.2012 [cited 26.07.2013]; Available from: http://www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/news/renewed-alcohol-strategy/

55. Thames Reach. *Homelessness facts and figures*. 2012 [cited 01.02.2013]; Available from: http://www.thamesreach.org.uk/news-and-views/homelessness-facts-and-figures/

56. Hough J, Rice B. *Voices of experience: How people who drink on the streets can make positive changes in their lives. Full report*. 2011 [cited 26.07.2013]; Available from: http://www.broadwaylondon.org/ResearchInformation/Research/main_content/Voices_of_Experience_Academic_report.pdf

57. Wine and Spirits Trade Association. *Policy: Fraud Prevention Unit*. 2011 [cited 22.05.2013]; Available from: http://www.wsta.co.uk/fraud-prevention-unit.html

58. Gmel G. Measuring Alcohol Consumption. *Contemporary Drug Problems* 2004;**31**: 467-540.

59. Office for National Statistics. *Travel trends 2011*. 2011 [cited 26.07.2013]; Available from: http://www.ons.gov.uk/ons/dcp171776_274235.pdf

60. Trip Advisor. Press Release: Tripadvisor Health on Holiday Index. It's Official: British Holidaymakers Named Biggest Drinkers In Europe (obtained through Tripadvisor press office). 2011.

61. Goddard E. National Statistics Methodology Series No. 24: Obtaining information about drinking through surveys of the general population. Newport: Office for National Statistics; 2001.

62. Crawford A. Bias in a survey of drinking habits. *Alcohol & Alcoholism* 1987;**22**(2): 167-79.

63. DEFRA. *Household Food and Drink Waste linked to Food and Drink Purchases*. 2010 [cited 10.01.2013]; Available from: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-food-foodwastepurchases-100727.pdf

64. Jansen H, Lahaut V, Garretsen H, van de Mheen D. Measuring the Year Consumption of Alcohol: The Development of a Questionnaire. *Substance Use & Misuse* 2008;**43**(7): 880-94.

65. Johnson TP. Failures in Substance Use Surveys. *Substance Use & Misuse* 2012;**47**(13-14): 1675-82.

66. Wilson P. Improving the methodology of drinking surveys. *Statistician* 1981;**30**(3): 159-67.

67. Lin I, Schaeffer NC. Using Survey Participants to Estimate the Impact of Nonparticipation. *Public Opinion Quarterly* 1995 June 20, 1995;**59**(2): 236-58.

68. Kypri K, Stephenson S, Langley J. Assessment of Nonresponse Bias in an Internet Survey of Alcohol Use. *Alcoholism: clinical and experimental research* 2004;**28**(4): 630-4.

69. Lemmens PHHM, Tan ES, Knibbe RA. Bias due to Non-response in a Dutch Survey on Alcohol Consumption. *British Journal of Addiction* 1988;**83**(9): 1069-77.

70. Lahaut V, Jansen H, van de Mheen D, Garretsen H. Non-response bias in a sample survey on alcohol consumption. *Alcohol and Alcoholism* 2002 May 1, 2002;**37**(3): 256-60.

71. Caetano R, Ramisetty-Mikler S, McGrath C. Characteristics of non-respondents in a US national longitudinal survey on drinking and intimate partner violence. *Addiction* 2003;**98**(6): 791-7.

72. Zhao J, Stockwell TIM, Macdonald S. Non–response bias in alcohol and drug population surveys. *Drug and Alcohol Review* 2009;**28**(6): 648-57.

73. Gray L, McCartney G, White IR, et al. Use of record-linkage to handle non-response and improve alcohol consumption estimates in health survey data: a study protocol. *BMJ Open* 2013 January 1, 2013;**3**(3).

74. Midanik L. The validity of self-reported alcohol consumption and alcohol problems: a literature review. *British Journal of Addiction* 1982 Dec;**77**(4): 357-82.

75. Hormes JM, Gerhardstein KR, Griffin PT. Under-reporting of alcohol and substance use versus other psychiatric symptoms in individuals living with HIV. *AIDS Care* 2011;**24**(4): 420-3.

76. Ernhart CB, Morrow-Tlucak M, Sokol RJ, Martier S. Underreporting of alcohol use in pregnancy. *Alcoholism: clinical and experimental research* 1988;**12**(4): 506-11.

77. Jacobson SW, Chiodo LM, Sokol RJ, Jacobson JL. Validity of maternal report of prenatal alcohol, cocaine, and smoking in relation to neurobehavioral outcome. *Pediatrics* 2002;**109**(5): 815-25.

78. Duffy JC, Waterton JJ. Under-reporting of alcohol consumption in sample surveys: the effect of computer interviewing in fieldwork. *British Journal of Addiction* 1984 Sep;**79**(3): 303-8.

79. Kraus L, Augustin R. Measuring alcohol consumption and alcohol-related problems: comparison of responses from self-administered questionnaires and telephone interviews. *Addiction* 2001 Mar;**96**(3): 459-71.

80. Tipping S, Hope S, Pickering K, Mindell J, Erens B. An analysis of mode effects using data from the Health Survey for England 2006 and the Boost Survey for London. Leeds: NHS Information Centre for Health and Social Care; 2008.

81. Greenfield TK, Kerr W. Alcohol measurement methodology in epidemiology: recent advances and opportunities. *Addiction* 2008;**103**(7): 1082-99.

82. Poikolainen K, Karkkainen P. Nature of questionnaire options affects estimates of alcohol intake. *Journal of Studies on Alcohol* 1985;**46**(3): 219-22.

83. Ivis FJ, Bondy SJ, Adlaf EM. The effect of question structure on self-reports of heavy drinking: closed-ended versus open-ended questions. *Journal of Studies on Alcohol* 1997;**58**(6): 622-4.

84. Dawson DA. Measuring alcohol consumption: limitations and prospects for improvement. *Addiction* 1998 Jul;**93**(7): 965-8.

85. Feunekes GI, van 't Veer P, van Staveren WA, Kok FJ. Alcohol intake assessment: the sober facts. *American Journal of Epidemiology* 1999;**150**(1): 105-12.

86. Poikolainen K, Kärkkäinen P. Diary gives more accurate information about alcohol consumption than questionnaire. *Drug and Alcohol Dependence* 1983;**11**(2): 209-16.

87. Rehm J, Greenfield TK, Walsh G, Xie X, Robson L, Single E. Assessment methods for alcohol consumption, prevalence of high risk drinking and harm: a sensitivity analysis. *International Journal of Epidemiology* 1999 April 1, 1999;**28**(2): 219-24.

88. Koppes LLJ, Twisk JWR, Snel J, Kemper HCG. Concurrent validity of alcohol consumption measurement in a 'healthy' population; quantity-frequency questionnaire v. dietary history interview. *British Journal of Nutrition* 2002 Oct;**88**(4): 427-34.

89. Townshend JM, Duka T. Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures. *Alcohol & Alcoholism* 2002;**37**(2): 187-92.

90. Stockwell T, Donath S, Cooper-Stanbury M, Chikritzhs T, Catalano P, Mateo C. Under-reporting of alcohol consumption in household surveys: a comparison of quantity-frequency, graduated-frequency and recent recall. *Addiction* 2004 Aug;**99**(8): 1024-33.

91. Heeb J-L, Gmel G. Measuring alcohol consumption: A comparison of graduated frequency, quantity frequency, and weekly recall diary methods in a general population survey. *Addictive Behaviors* 2005;**30**(3): 403-13.

92. Stahre M, Naimi T, Brewer R, Holt J. Measuring average alcohol consumption: the impact of including binge drinks in quantity-frequency calculations. *Addiction* 2006;**101**(12): 1711-8.

93. Williams GD, Aitken SS, Malin H. Reliability of Self-Reported Alcohol Consumption in a General Population Survey. *Journal of Studies on Alcohol and Drugs* 1985;**46**(3): 223-7.

94. Grant KA, Arciniega LT, Tonigan JS, Miller WR, Meyers RJ. Are reconstructed self-reports of drinking reliable? *Addiction* 1997 May;**92**(5): 601-6.

95. Perrine MWB, Schroder KEE. How many drinks did you have on September 11, 2001? *Journal of Studies on Alcohol* 2005;**66**(4): 536-44.

96. Chu AY, Meoni LA, Wang NY, Liang K-Y, Ford DE, Klag MJ. Reliability of alcohol recall after 15 years and 23 years of follow-up in the Johns Hopkins Precursors Study. *Journal of Studies on Alcohol & Drugs* 2010;**71**(1): 143-9.

97. Searles JS, Helzer JE, Rose GL, Badger GJ. Concurrent and retrospective reports of alcohol consumption across 30, 90 and 366 days: interactive voice response compared with the timeline follow back. *Journal of Studies on Alcohol* 2002;**63**(3): 352-62.

98. Owen K. *Senior research officer for Drinkaware reporting on 'Established adult drinking patterns' (IPSOS MORI Drinkaware KPI study 2009/10)*. Drinkaware research seminar; 2011 May 2011; London; 2011.

99. Fuller E. Chapter 7. Adult alcohol consumption. In: Craig R, Shelton N, editors. *Health Survey for England 2007: Volume 1 Healthy lifestyles: knowledge, attitudes and behaviour* Leeds: NHS Information Centre for Health and Social Care; 2008.

100. NHS Information Centre for Health and Social Care. Health Survey for England 2007 [computer file]. Colchester, Essex: UK Data Archive; 2009.

101. Stockwell T, Blaze-Temple D, Walker C. The effect of 'standard drink' labelling on the ability of drinkers to pour a 'standard drink'. *Australian Journal of Public Health* 1991 Mar;**15**(1): 56-63.

102. Carruthers SJ, Binns CW. The standard drink and alcohol consumption. *Drug & Alcohol Review* 1992;**11**(4): 363-70.

103. Lemmens PH. The alcohol content of self-report and 'standard' drinks. *Addiction* 1994 May;**89**(5): 593-601.

104. Banwell C. How many standard drinks are there in a glass of wine? *Drug and Alcohol Review* 1999;**18**(1): 99-101.

105. Gual A, Martos AR, Lligoña A, Llopis JJ. Does the concept of a standard drink apply to viticultural societies? *Alcohol and Alcoholism* 1999 March 1, 1999;**34**(2): 153-60.

106. Kaskutas LA, Graves K. Pre-pregnancy drinking: how drink size affects risk assessment. *Addiction* 2001;**96**(8): 1199-209.

107. White AM, Kraus CL, McCracken LA, Swartzwelder HS. Do college students drink more than they think? Use of a free-pour paradigm to determine how college students define standard drinks. *Alcoholism-Clinical and Experimental Research* 2003;**27**(11): 1750-6.

108. Gill JS, Donaghy M. Variation in the alcohol content of a 'drink' of wine and spirit poured by a sample of the Scottish population. *Health Education Research* 2004 October 1, 2004;**19**(5): 485-91.

109. Kerr WC, Greenfield TK, Tujague J, Brown SE. A drink is a drink? Variation in the amount of alcohol contained in beer, wine and spirits drinks in a US methodological sample. *Alcoholism: Clinical & Experimental Research* 2005 Nov;**29**(11): 2015-21.

110. White. College Students Lack Knowledge of Standard Drink Volumes: Implications for Definitions of Risky Drinking Based on Survey Data. *Alcoholism: clinical and experimental research* 2005;**29**(4): 631-8.

111. Gill JS, Donaghy M, Guise J, Warner P. Descriptors and accounts of alcohol consumption: methodological issues piloted with female undergraduate drinkers in Scotland. *Health Education Research* 2007;**22**(1): 27-36.

112. Kerr WC, Patterson D, Koenen MA, Greenfield TK. Alcohol Content Variation of Bar and Restaurant Drinks in Northern California. *Alcoholism: clinical and experimental research* 2008;**32**(9): 1623-9.

113. Nayak MB, Kerr W, Greenfield TK, Pillai A. Not All Drinks Are Created Equal: Implications for Alcohol Assessment in India. *Alcohol and Alcoholism* 2008 November 1, 2008;**43**(6): 713-8.

114. Wilkinson C, Allsop S, Chikritzhs T. Alcohol pouring practices among 65- to 74-year-olds in Western Australia. *Drug & Alcohol Review* 2011;**30**(2): 200-6.

115. De Visser RO, Birch JD. My cup runneth over: Young people's lack of knowledge of low-risk drinking guidelines. *Drug and Alcohol Review* 2012;**31**(2): 206-12.

116. Kaskutas LA, Graves K. An alternative to standard drinks as a measure of alcohol consumption. *Journal of Substance Abuse* 2000;**12**(1-2): 67-78.

117. Attwood AS, Scott-Samuel NE, Stothart G, Munafò MR. Glass Shape Influences Consumption Rate for Alcoholic Beverages. *PLoS ONE* 2012;**7**(8): e43007.

118. Raghubir P, Krishna A. Vital dimensions in volume perception: Can the eye fool the stomach? *Journal of Marketing Research* 1999;**36**(3): 313-26.

119. Wansink B, Van Ittersum K. Bottoms up! The influence of elongation on pouring and consumption volume. *Journal of Consumer Research* 2003;**30**(3): 455-63.

120. Wansink B, van Ittersum K. Shape of glass and amount of alcohol poured: comparative study of effect of practice and concentration. *BMJ* 2005;**331**(7531): 1512-4.

121. Kehoe T, Gmel G, Shield KD, Gmel G, Rehm J. Determining the best population-level alcohol consumption model and its impact on estimates of alcohol-attributable harms. *Population Health Metrics* 2012;**10**(6).

122. Rehm J, Kehoe T, Gmel G, Stinson F, Grant B, Gmel G. Statistical modeling of volume of alcohol exposure for epidemiological studies of population health: the US example. *Population Health Metrics* 2010;**8**(3).

123. Shield KD, Gmel G, Kehoe-Chan T, Dawson DA, Grant BF, Rehm J. Mortality and Potential Years of Life Lost Attributable to Alcohol Consumption by Race and Sex in the United States in 2005. *PLoS ONE* 2013;**8**(1): e51923.

124. Dougherty DM, Charles NE, Acheson A, John S, Furr RM, Hill-Kapturczak N. Comparing the detection of transdermal and breath alcohol concentrations during periods of alcohol consumption ranging from moderate drinking to binge drinking. *Experimental and Clinical Psychopharmacology* 2012;**20**(5): 373-81.

125. Leffingwell TR, Cooney NJ, Murphy JG, et al. Continuous Objective Monitoring of Alcohol Use: Twenty-First Century Measurement Using Transdermal Sensors. *Alcoholism: Clinical & Experimental Research* 2012;**37**(1): 16-22.

126. Barnett NP, Tideya J, Murphy JG, Swift R, Colbya SM. Contingency management for alcohol use reduction: A pilot study using a transdermal alcohol sensor. *Drug and Alcohol Dependence* 2011;**118**(2-3): 391-9.

127. Kloeden CN, Moore VM, McLean AJ. Estimated and measured blood alcohol levels in the night-time driving population. *Drug and Alcohol Review* 1994;**13**(3): 239-45.

128. Sommers MS, Dyehouse JM, Howe SR, Wekselman K, Fleming M. "Nurse, I only had a couple of beers": validity of self-reported drinking before serious vehicular injury. *American Journal of Critical Care* 2002;**11**(2): 106-14.

129. Sommers MS, Dyehouse JM, Howe SR, Lemmink J, Volz T, Manharth M. Validity of self-reported alcohol consumption in nondependent drinkers with unintentional injuries. *Alcoholism: Clinical & Experimental Research* 2000;**24**(9): 1406-13.

130. Kraus CL, Salazar NC, Mitchell JR, et al. Inconsistencies between actual and estimated blood alcohol concentrations in a field study of college students: do students really know how much they drink? *Alcoholism: Clinical & Experimental Research* 2005;**29**(9): 1672-6.

131. Kroke A, Klipstein-Grobusch K, Hoffmann K, Terbeck I, Boeing H, Helander A. Comparison of self-reported alcohol intake with the urinary excretion of 5-hydroxytryptophol:5-hydroxyindole-3-acetic acid, a biomarker of recent alcohol intake. *British Journal of Nutrition* 2001 May;**85**(5): 621-7.

132. Grant SP, LaBrie JW, Hummer JF, Lac A. Underestimations of blood alcohol concentration predict event-specific negative consequences. *Substance Use & Misuse* 2011;**46**(10): 1309-17.

133. Bellis MA, Hughes K, Quigg Z, Morleo M, Jarman I, Lisboa P. Cross-sectional measures and modelled estimates of blood alcohol levels in UK nightlife and their relationships with drinking behaviours and observed signs of inebriation. *Substance Abuse Treatment, Prevention, & Policy* 2010;**5**: 5.

134. Uchalik DC. A comparison of questionnaire and self-monitored reports of alcohol intake in a nonalcoholic population. *Addictive Behaviors* 1979;**4**(4): 409-13.

135. Poikolainen K. Underestimation of Recalled Alcohol Intake in Relation to Actual Consumption. *British Journal of Addiction* 1985;**80**(2): 215-6.

136. Northcote J, Livingston M. Accuracy of self-reported drinking: observational verification of 'last occasion' drink estimates of young adults. *Alcohol & Alcoholism* 2011;**46**(6): 709-13.

137. Marmot MG, Shipley MJ, Rose G, Thomas B. Alcohol and mortality: a U-shaped curve. *The Lancet* 1981;**317**(8220): 580-3.

138. Poikolainen K. Alcohol and mortality: A review. *Journal of Clinical Epidemiology* 1995;**48**(4): 455-65.

139. Brien SE, Ronksley PE, Turner BJ, Mukamal KJ, Ghali WA. Effect of alcohol consumption on biological markers associated with risk of coronary heart disease: systematic review and meta-analysis of interventional studies. *BMJ* 2011;**342**: d636.

140. Ronksley PE, Brien SE, Turner BJ, Mukamal KJ, Ghali WA. Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. *BMJ* 2011;**342**: d671.

141. Barefoot JC, Grønbæk M, Feaganes JR, McPherson RS, Williams RB, Siegler IC. Alcoholic beverage preference, diet, and health habits in the UNC Alumni Heart Study. *The American Journal of Clinical Nutrition* 2002 August 1, 2002;**76**(2): 466-72.

142. Chikritzhs T, Fillmore K, Stockwell T. A healthy dose of scepticism: Four good reasons to think again about protective effects of alcohol on coronary heart disease. *Drug and Alcohol Review* 2009;**28**: 441-4.

143. Ng Fat L, Shelton N. Associations between self-reported illness and non-drinking in young adults. *Addiction* 2012;**107**(9): 1612-20.

144. Stockwell T, Greer A, Fillmore K, Chikritzhs T, Zeisser C. How good is the science? *BMJ* 2012;**344**(e2276).

145. Fillmore KM, Stockwell T, Chikritzhs T, Bostrom A, Kerr W. Moderate Alcohol Use and Reduced Mortality Risk: Systematic Error in Prospective Studies and New Hypotheses. *Annals of Epidemiology* 2007;**17**(5, Supplement): S16-S23.

146. Harrison L, Gardiner E. Do the rich really die young? Alcohol-related mortality and social class in Great Britain, 1988-94. *Addiction* 1999;**94**(12): 1871-80.

147. Crombie IK, Precious E. Changes in the Social Class Gradient of Cirrhosis Mortality in England and Wales across the 20th Century. *Alcohol and Alcoholism* 2011 January 1, 2011;**46**(1): 80-2.

148. Wannamethee G, Shaper AG. Alcohol and sudden cardiac death. *British Heart Journal* 1992 Nov;**68**(5): 443-8.

149. Mäkelä P, Valkonen T, Martelin T. Contribution of deaths related to alcohol use to socioeconomic variation in mortality: register based follow up study. *BMJ* 1997 July 26, 1997;**315**(7102): 211-6.

150. Mäkelä P, Keskimäki I, Koskinen S. What underlies the high alcohol related mortality of the disadvantaged: high morbidity or poor survival? *Journal of Epidemiology and Community Health* 2003 December 1, 2003;**57**(12): 981-6.

151. Makela P. Alcohol-related mortality as a function of socio-economic status. *Addiction* 1999;**94**(6): 867-86.

152. Romelsjo A, Lundberg M. The changes in the social class distribution of moderate and high alcohol consumption and of alcohol-related disabilities over time in Stockholm County and in Sweden. *Addiction* 1996;**91**(9): 1307-24.

153. Erskine S, Maheswaran R, Pearson T, Gleeson D. Socioeconomic deprivation, urban-rural location and alcohol-related mortality in England and Wales. *BMC Public Health* 2010;**10**(99).

154. Lithell H, Aberg H, Selinus I, Hedstrand H. Alcohol intemperance and sudden death. *British Medical Journal Clinical Research Ed* 1987 Jun 6;**294**(6585): 1456-8.

155. Kauhanen J, Kaplan GA, Goldberg DE, Salonen JT. Beer binging and mortality: results from the Kuopio ischaemic heart disease risk factor study, a prospective population based study. *BMJ* 1997 Oct 4;**315**(7112): 846-51.

156. Kauhanen J, Kaplan GA, Goldberg DD, Cohen RD, Lakka TA, Salonen JT. Frequent hangovers and cardiovascular mortality in middle-aged men. *Epidemiology* 1997 May;**8**(3): 310-4.

157. Malyutina S, Bobak M, Kurilovitch S, et al. Relation between heavy and binge drinking and all-cause and cardiovascular mortality in Novosibirsk, Russia: a prospective cohort study. *The Lancet* 2002;**360**(9344): 1448-54.

158. Murray RP, Connett JE, Tyas SL, et al. Alcohol Volume, Drinking Pattern, and Cardiovascular Disease Morbidity and Mortality: Is There a U-shaped Function? *American Journal of Epidemiology* 2002 February 1, 2002;**155**(3): 242-8.

159. Murray RP, Connett JE, Mäkelä P, Rehm J. Difficulty in demonstrating a risk from drinking pattern in fourteen years of coronary heart disease morbidity and mortality: The Lung Health Study. *Addictive Behaviors* 2005;**30**(5): 875-87.

160. Morch LS, Johansen D, Lokkegaard E, Hundrup YA, Gronbaek M. Drinking pattern and mortality in Danish nurses. *Eur J Clin Nutr* 2007;**62**(6): 817-22.

161. van de Wiel A, de Lange DW. Cardiovascular risk is more related to drinking pattern than to the type of alcoholic drinks. *Netherlands Journal of Medicine* 2008 Dec;**66**(11): 467-73.

162. Sull JW, Yi S-W, Nam CM, Ohrr H. Binge drinking and mortality from all causes and cerebrovascular diseases in korean men and women: a Kangwha cohort study. *Stroke* 2009 Sep;**40**(9): 2953-8.

163. Sull JW, Yi SW, Nam CM, Choi K, Ohrr H. Binge drinking and hypertension on cardiovascular disease mortality in Korean men and women: a Kangwha cohort study. *Stroke* 2010 Oct;**41**(10): 2157-62.

164. Gruchow HW, Hoffmann RG, Anderson AJ, Barboriak JJ. Effects of drinking patterns on the relationship between alcohol and coronary occlusion. *Atherosclerosis* 1982;**43**(2-3): 393-404.

165. Tolstrup JS, Jensen MK, Tjønneland A, Overvad K, Grønbæk M. Drinking pattern and mortality in middle-aged men and women. *Addiction* 2004;**99**(3): 323-30.

166. Trevisan M, Schisterman E, Mennotti A, Farchi G, Conti S. Drinking Pattern and Mortality:: The Italian Risk Factor and Life Expectancy Pooling Project. *Annals of Epidemiology* 2001;**11**(5): 312-9.

167. Stranges S, Wu T, Dorn JM, et al. Relationship of alcohol drinking pattern to risk of hypertension: a population-based study. *Hypertension* 2004 Dec;**44**(6): 813-9.

168. Office for National Statistics. Appendix B: Sample design and response. In: Dunstan S, editor. *General Lifestyle Survey: Technical Appendices 2010*. Newport: Office for National Statistics; 2012.

169. Baumberg B. How Will Alcohol Sales in the UK Be Affected If Drinkers Follow Government Guidelines? *Alcohol and Alcoholism* 2009;**44**(5): 523-8.

170. HM Revenue and Customs. *Alcohol Factsheet: March 2012*. 2012 [cited 26.07.2013]; Available from: https://www.uktradeinfo.com/Statistics/Statistical%20Factsheets/AlcoholFactsheet0312.xls

171. Craig R, Hirani V. *Chapter 1. Introduction. Health Survey for England 2009: Volume 1. Health and lifestyles*. Leeds: NHS Information Centre for Health and Social Care; 2010.

172. Craig R, Hirani V, editors. *Chapter 1. Introduction. Health Survey for England 2010: Volume 1. Respiratory health*. Leeds: NHS Information Centre for Health and Social Care; 2011.

173. ESDS Government. *General Lifestyle Survey (formerly the General Household Survey)*. 2013 [cited 06.02.2013]; Available from: http://www.esds.ac.uk/government/ghs/

174. Robinson S, Bugler C. *General Lifestyle Survey 2008: Smoking and drinking among adults, 2008* London: Office for National Statistics; 2010.

175. Ali R, Bugler C, Curtis D, et al. *General Lifestyle Survey 2008: Sample Design and Response (Appendix B)*. Newport: Office for National Statistics; 2010.

176. Ali R, Bugler C, Curtis D, et al. General Lifestyle Survey 2008: Summary of main topics included in GHS/GLF questionnaires: 1971 to 2008 (Appendix F). Newport: Office for National Statistics; 2010.

177. Ali R, Bugler C, Curtis D, et al. *General Lifestyle Survey 2008: Weighting (Appendix D)*. Newport: Office for National Statistics; 2010.

178. ESDS Government. *Health Survey for England*. 2012 [cited 05.02.2013]; Available from: http://www.esds.ac.uk/government/hse/

179. Craig R, Mindell J, Hirani V, editors. *Health Survey for England 2008: Volume 2. Methods and documentation*. Leeds: NHS Information Centre for Health and Social Care; 2010.

180. Fuller E. Chapter 12. Adult alcohol consumption. In: Craig R, Mindell J, Hirani V, editors. *Health Survey for England 2008 Volume 1: Physical activity and fitness*. Leeds: NHS Information Centre for Health and Social Care; 2009.

181. Rehm J, Irving H, Ye Y, Kerr WC, Bond J, Greenfield TK. Are Lifetime Abstainers the Best Control Group in Alcohol Epidemiology? On the Stability and Validity of Reported Lifetime Abstention. *American Journal of Epidemiology* 2008 October 15, 2008;**168**(8): 866-71.

182. Goldman E, Najman JM. Lifetime Abstainers, Current Abstainers and Imbibers: A Methodological Note. *British Journal of Addiction* 1984;**79**(4): 309-14.

183. Corti B, Blaze-Temple D, Howat P, Binns C, Radalj T. Alcohol consumption patterns of women in Perth, Western Australia. *Drug & Alcohol Review* 1990;**9**(1): 23-31.

184. Romelsjo A, Leifman H, Nystrom S. A comparative study of two methods for the measurement of alcohol consumption in the general population. *International Journal of Epidemiology* 1995;**24**(5): 929-36.

185. Craig R, Mindell J, editors. *Health Survey for England 2011. Volume 2. Methods and Documentation*. Leeds: NHS Information Centre for Health and Social Care; 2012.

186. Fuller E. *HSE 2011: comparisons of alcohol estimates based on CAPI and diary data. Note to NHS Information Centre*: NatCen Social Research; 2012 (obtained from author).

187. Craig R, Mindell J, editors. *Health Survey for England 2011: Volume 2. Methods and documentation*: NHS Information Centre; 2012.

188. Jayne M, Valentine G, Holloway SL. Emotional, embodied and affective geographies of alcohol, drinking and drunkenness. *Transactions of the Institute of British Geographers* 2010;**35**(4): 540-54.

189. Thompson C. *Experiences of the food environment and the role of the 'routine' in producing food practices: an ethnography of Sandwell residents. PhD thesis.* Geography 2012 [cited 26.07.2013]; Available from: http://qmro.qmul.ac.uk/jspui/handle/123456789/3178

190. Latham A. Research, performance, and doing human geography: some reflections on the diary-photograph, diary-interview method. *Environment and Planning A* 2003;**35**(11): 1993-2017.

191. Latham A. Diaries as a research method. In: Clifford N, French S, Valentine G, editors. *Key Methods in Geography Second edition*. London: Sage; 2010. p. 189-201.

192. Crang M. Analysing qualitative materials. In: Flowerdew R, Martin D, editors. *Methods in human geography Second edition*. Essex: Pearson; 2005. p. 218-32.

193. Royal College of Psychiatrists. *Our invisible addicts. First Report of the Older Persons' Substance Misuse Working Group of the Royal College of Psychiatrists*. 2011 [cited 26.07.2013]; Available from: http://www.rcpsych.ac.uk/files/pdfversion/cr165.pdf

194. BBC. *Panorama: Old, Drunk and Disorderly. Broadcast on BBC One on 16 Sep 2012 at 20:30.* 2012 [cited 26.07.2013]; Available from: http://www.bbc.co.uk/programmes/b01mrmfd

195. Miller DA. *Theory of Shopping* Cambridge: Polity; 1998.

196. White AM, Kraus CL, Flom JD, et al. College Students Lack Knowledge of Standard Drink Volumes: Implications for Definitions of Risky Drinking Based on Survey Data. *Alcoholism: clinical and experimental research* 2005;**29**(4): 631-8.

197. Health Survey for England 2008 Questionnaire - Booklet for Adults (up to age 64) *Health Survey for England 2008 - Program Documentation: Household Questionnaire* 2008.

198. Health Survey for England 2007 Questionnaire - Booklet for Adults (up to age 64) *Health Survey for England 2007 - Program Documentation: Household Questionnaire* 2007.

199. Boniface S, Shelton N. How is alcohol consumption affected if we account for under-reporting? A hypothetical scenario. *European Journal of Public Health* 2013 26.02.2013 DOI: 10.1093/eurpub/ckt016.

200. BBC News. *Level of excess drinking of alcohol 'is underestimated'*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.bbc.co.uk/news/health-21586566

201. Daily Mail. *Are you in drink denial? Half of adults down too much alcohol yet barely a quarter ADMIT doing so*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.dailymail.co.uk/health/article-2285071/Are-drink-denial-Half-adults-alcohol-barely-quarter-admit-doing-so.html?ito=feeds-newsxml

202. Huffington Post. *UK Drinking Study: Britons Underestimate Their Alcohol Consumption By 40 Percent (Video)*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.huffingtonpost.com/2013/02/27/britain-drinking-study_n_2775985.html

203. The Guardian. *Many more Britons drinking harmfully than thought, survey suggests*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.guardian.co.uk/society/2013/feb/27/britons-drinking-dangerously-alcohol-consumption

204. The Independent. *A nation of 'secret boozers': English people underestimate how much alcohol they drink*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.independent.co.uk/life-style/health-and-families/health-news/a-nation-of-secret-boozers-english-people-underestimate-how-much-alcohol-they-drink-8512382.html

205. The Telegraph. *Drinkers 'consuming almost double official estimates'*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.telegraph.co.uk/health/healthnews/9895916/Drinkers-consuming-almost-double-official-estimates.html

206. The Times. *Drinkers admit to only half their consumption*. 27.02.2013 [cited 18.04.2013]; Available from: http://www.thetimes.co.uk/tto/science/psychology/article3700563.ece?CMP=OTH-gnws-standard-2013_02_26

207. NHS Choices Behind the Headlines. *Binge drinking rates could be higher than thought*. 27.02.2013 [cited 25.07.2013]; Available from: http://www.nhs.uk/news/2013/02February/Pages/Binge-drinking-rates-could-be-higher-than-thought.aspx

208. Alcohol Research UK. *Alcohol and British Society*. 2013 [cited 18.04.2013]; Available from: http://alcoholresearchuk.org/2012/12/12/alcohol-and-british-society-conference/

209. The Telegraph. *NHS iPhone app to alert drinkers when they go over their limits 'encouraging bingeing'*. 26.12.2009 [cited 19.04.2013]; Available from: http://www.telegraph.co.uk/health/healthnews/6860568/NHS-iPhone-app-to-alert-drinkers-when-they-go-over-their-limits-encouraging-bingeing.html

210. NHS Choices. *Drinks tracker for iPhone*. 2013 [cited 19.04.2013]; Available from: http://www.nhs.uk/Tools/Pages/iphonedrinks.aspx

211. Duffy JC. *Alcohol and Illness: the Epidemiological Viewpoint*. Edinburgh: Edinburgh University Press; 1992.

212. The Independent. *Pro-alcohol academics paid by drinks lobby*. 05.12.1994 [cited 22.04.2013]; Available from: http://www.independent.co.uk/news/proalcohol-academics-paid-by-drinks-lobby-1386957.html

213. Department of Health. *Public Health Responsibility Deal: Alcohol Network*. 2011 [cited 30.04.2013]; Available from: https://responsibilitydeal.dh.gov.uk/category/alcohol-network/

214. Department of Health. *Public Health Responsibility Deal: Alcohol Pledges*. 2011 [cited 30.04.2013]; Available from: https://responsibilitydeal.dh.gov.uk/alcohol-pledges/

215. Royal College of Physicians. *Key health organisations do not sign responsibility deal*. 2011 [cited 30.04.2013]; Available from: http://www.rcplondon.ac.uk/press-releases/key-health-organisations-do-not-sign-responsibility-deal

216. Gov.uk Inside Government. *Government response to Science and Technology Committee Report on alcohol guidelines published*. 2012 [cited 01.05.2013]; Available from: https://www.gov.uk/government/news/government-response-to-science-and-technology-committee-report-on-alcohol-guidelines-published

217. Monitoring and Evaluating Scotland's Alcohol Strategy. *The impact of the Alcohol Act on off-trade alcohol sales in Scotland*. 21.05.2013 [cited 25.07.2013; Available from: http://www.healthscotland.com/uploads/documents/21101-Alcohol%20Act%20Report%20May%202013.pdf

218. Groves T. Half bottle or half cut? *BMJ* 2008 2008-02-28 00:00:00;**336**(7642): 507.

219. Glugstop: the one unit measurer. *The world's first one unit wine measurer*. 2011 [cited 25.07.2013; Available from: http://www.glugstop.co.uk/

220. Goddard E. *National Statistics Methodological Series No. 37: Estimating alcohol consumption from survey data: updated method of converting volumes to units*. Newport: Office for National Statistics; 2007.

221. Sobell LC, Sobell MB. Timeline Follow-Back. In: Litten RZ, Allen JP, editors. *Measuring Alcohol Consumption: psychosocial and biochemical methods*. New York: Springer Science + Business Media; 1992. p. 41-72.

Appendices

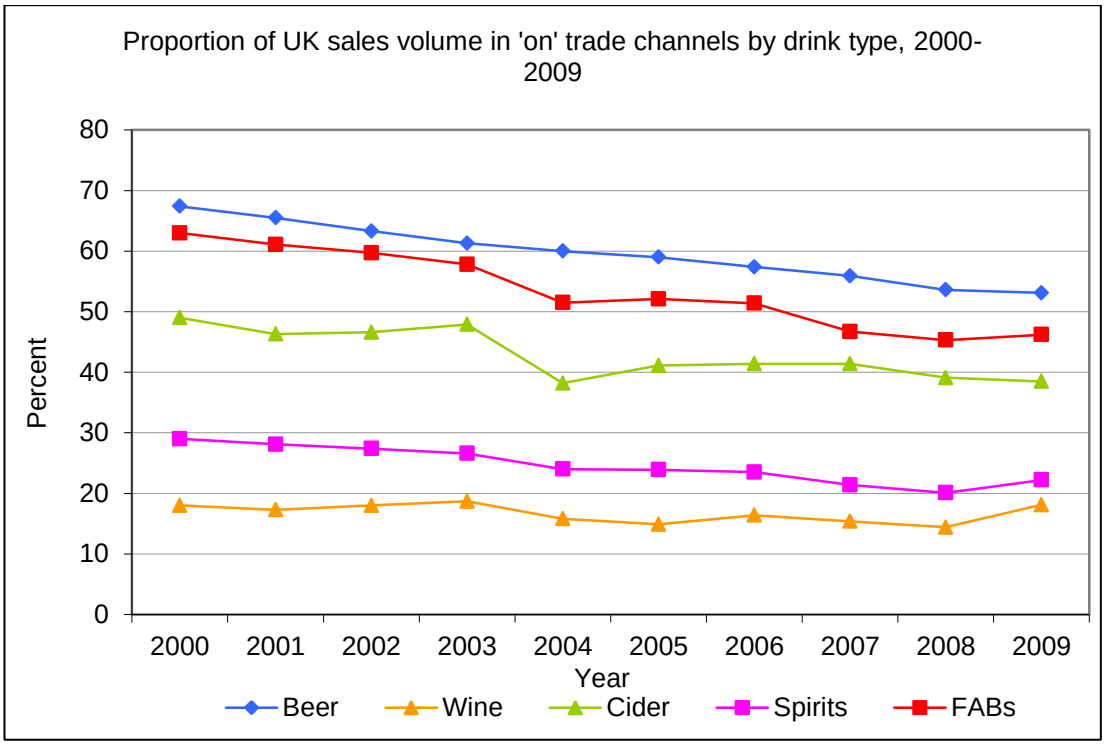
Appendix C. Worldwide variation in drinking guidelines from ICAP

Country	Standard Drink	Men	Women
Australia	10g	no more than 2 standard drinks on any day reduces the lifetime risk of harm; no more than 4 standard drinks on a single occasion reduces the risk of alcohol-related injury arising from that occasion	
Austria	10g	24g pure ethanol per day	16g pure ethanol per day
Canada	13.6g	not to exceed 2 units per day (27.2g/day); not to exceed 14 units per week (190g/week)	not to exceed 2 units/day (27.2g/day); not to exceed 9 units per week (121.5g/week)
Czech Republic	N/A	less than 24g per day	less than 16g per day
Denmark	12g	not to exceed 21 alcohol units (252g) a week	not to exceed 14 units (168g) a week
Finland	11g	not to exceed 15 units (165g) a week	not to exceed 10 units/week (110g) a week
France	10g	not to exceed 30g/day	not to exceed 30g/day
Germany		not to exceed 24g/day	not to exceed 12g/day
Hong Kong	1 unit = glass of wine/pint of beer	not to exceed 3-4 units/day, not to exceed 21units/week	not to exceed 2-3 units/day, not to exceed 14 units/week
Iceland	N/A	Pregnant women are advised to abstain from alcohol during pregnancy and breastfeeding.	
Indonesia	N/A	National Dietary Guidelines state: "Avoid drinking alcoholic beverages."	
Ireland	10g	21 units/week (210g/week)	14 units/week (140g/week)
Israel	N/A	Recommended: Pregnant women should not drink; students should not drink more than one unit of alcohol per drinking session; avoid alcohol if taking medication.	
Italy	12g	less than 40g per day	less than 40g per day
Japan	19.75g	1-2 units/day (19.75-39.5g/day)	
Luxembourg	N/A	The health authorities promote moderate alcohol consumption (without specifying limits) and urge consumers to refrain from drinking alcohol when driving.	
Netherlands	9.9g	not to exceed 4 units/day (39.6g/day)	not to exceed 2 units/day (19.8g/day)
New Zealand	10g	not to exceed 3 units/day (30g/day), not to exceed 21units/ week (210g/week)	not to exceed 2 units/day (20g/day), not to exceed 14 units/week (140g/week)
Norway	N/A	Situational abstinence is recommended, such as when driving, during pregnancy, at work, or in the company of children and young people.	
Philippines	N/A	*National Dietary Guidelines* state: "For a healthy lifestyle and good nutrition, exercise regularly, do not smoke, and avoid drinking alcoholic beverages."	
Poland	10g	2 units/day (20g/day) up to 5 times/week (not to exceed 100g/week)	1 unit/day (10g/day) up to 5 times/week (not to exceed 50g/week)
Portugal	14g (unofficial)	2-3 units/day (28-42g/day)	1-2 units/day (14-28g/day)
Romania	N/A	not to exceed 32.5g beer/day or 20.7g wine/day	not to exceed 32.5g beer/day or 20.7g wine/day
Singapore	N/A	*National Dietary Guidelines* state: "Limit alcohol intake to no more than 2 standard drinks a day" (about 30g alcohol).	
Slovenia	N/A	not to exceed 20g/day and not to exceed	not to exceed 10g/day

		50g/drinking occasion	and not to exceed 30g/drinking occasion
South Africa	N/A	not to exceed 21 units/week (252g/week)	not to exceed 14 units/week (168g/week)
Spain	10g	not to exceed 3 units/day (30g/day)	not to exceed 3 units/day (30g/day)
Sweden	N/A	not to exceed 20g/day	not to exceed 20g/day
Switzerland	10-12g	not to exceed 2 units/day (not to exceed 24g/day)	not to exceed 2 units/day (not to exceed 24g/day)
Thailand	N/A	*National Dietary Guidelines* state: "Avoid or reduce the consumption of alcoholic beverages."	
United Arab Emirates	N/A	No official drinking guidelines exist.	
United Kingdom	8g	should not regularly drink more than 3-4 units/day (24-32g/day)	should not regularly drink more than 2-3 units/day (16-24g/day)
United States	14g	1-2 units/day (14-28g/day), not to exceed 14 units/week (196g/week)	1 unit/day (14g/day), not to exceed 7units/week (98g/week)

Appendix D. **On-trade alcohol sales composition over time (BBPA)**

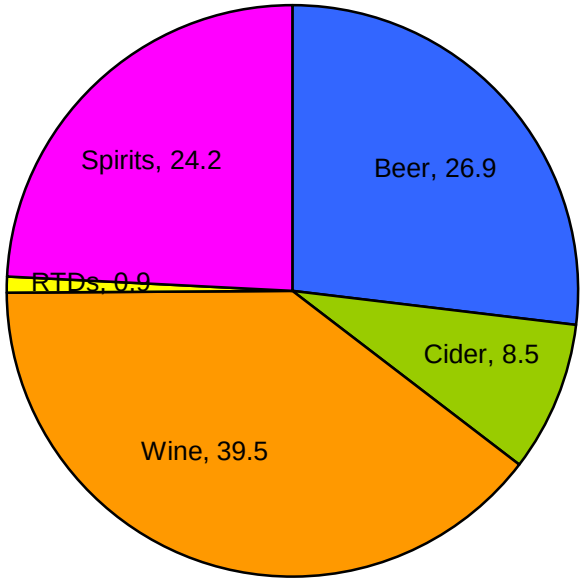
The decline in the on-trade corresponds to the rise in sales in the off-trade:



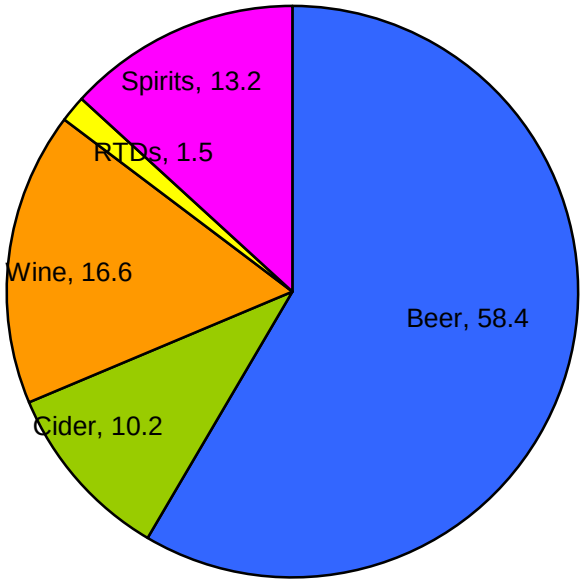
Data from the BBPA Statistical Handbook 2010.

Appendix E. Alcohol sales volume composition, 2009

UK off trade alcohol sales volume composition, 2009



UK on trade alcohol sales volume composition, 2009



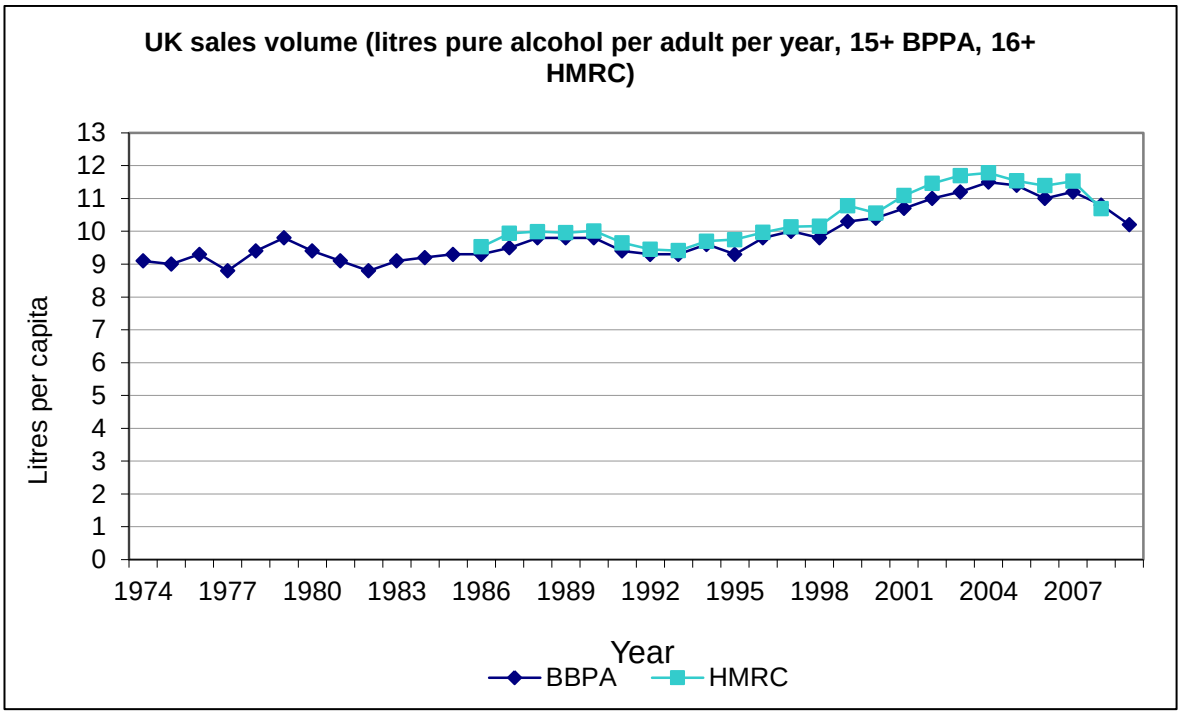
Data from the BBPA Statistical Handbook 2010.

Appendix F. Measures of alcohol consumption available for England

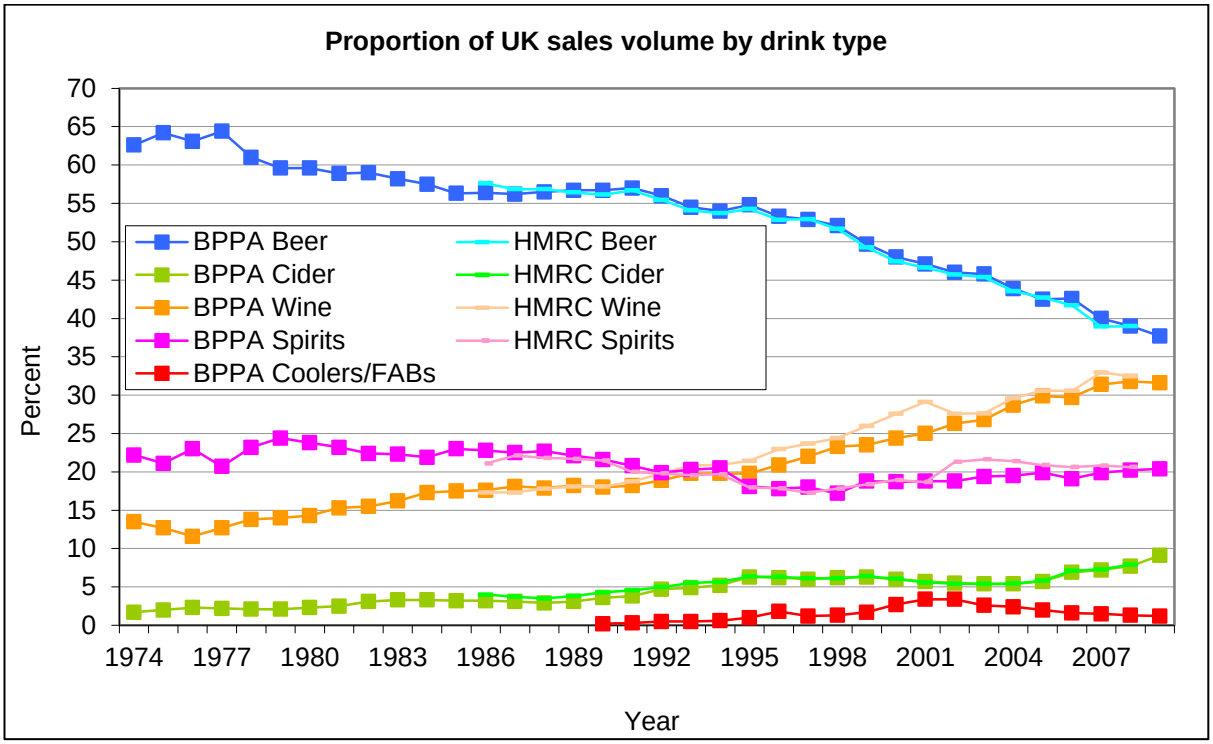
Data	Source	Region	Years available	What is measured
Reported consumption	General Lifestyle Survey	Great Britain	1978-2011	Weekly consumption in units, based on average consumption in previous 12 months. NB. The methodology used to calculate the units in a glass of wine was revised in 2006. From 2008, data on wine glass size were collected also.
	Health Survey for England	England	1998-2011	Heaviest drinking day in the last week. Proportion drinking above recommended limits/binge drinking on heaviest drinking day in the last week. NB. The methodology used to calculate the units in a glass of wine, strong beer/lager, and alcopops was updated in 2006.
	Health Survey for England	England	2011 only	Weekly consumption in units, based on average consumption in previous 12 months. Weekly alcohol consumption based on a seven-day drinking diary.
Duty receipts	HM Revenue and Customs	UK (data by country are not freely available)	1980/81-2010/11	Duty receipts in £ millions (at 2011 prices)
Sales volume	HM Revenue and Customs	UK (data by country are not freely available)	1986/7-2010/11	Pure alcohol clearances using average strengths for wine, beer and cider. Either in million hectolitres, or litres per adult (16+) Available by drink type
	British Beer and Pub Association	Great Britain	1974-2011	Litres pure alcohol per adult (15+) Available by drink type, on vs. off trade, region
Sales value	British Beer and Pub Association	Great Britain	1965-2011	In £ millions, or £ per capita (15+)
Sales value relative to household expenditure	British Beer and Pub Association	Great Britain	1965-2011	As % of household expenditure Available by drink type

Appendix G. **HMRC & BBPA alcohol sales comparison**

Reported consumption from social surveys provides useful information on social and demographic characteristics. Alcoholic drinks become liable for duty when they are released for consumption in the UK, allowing duty receipts to be calculated by HMRC. Sales volume calculated by the British Beer and Pub Association (BBPA) uses the HMRC data, along with data from National Statistics and the BBPA. There is a high degree of agreement between the two figures for overall alcohol sales:



There is also a high degree of agreement by drink type:



This suggests it is acceptable to use HMRC/BBPA interchangeably. As data from the BBPA are more detailed and available for a longer time period these are preferable in exploring secular trends in alcohol sales by drink type and on vs. off-trade.

Sources:

- BBPA Statistical Handbook, 2010
- HMRC Alcohol Factsheet, March 2012.

Appendix H. **Estimated consumption among non-responders if there was no under-reporting**

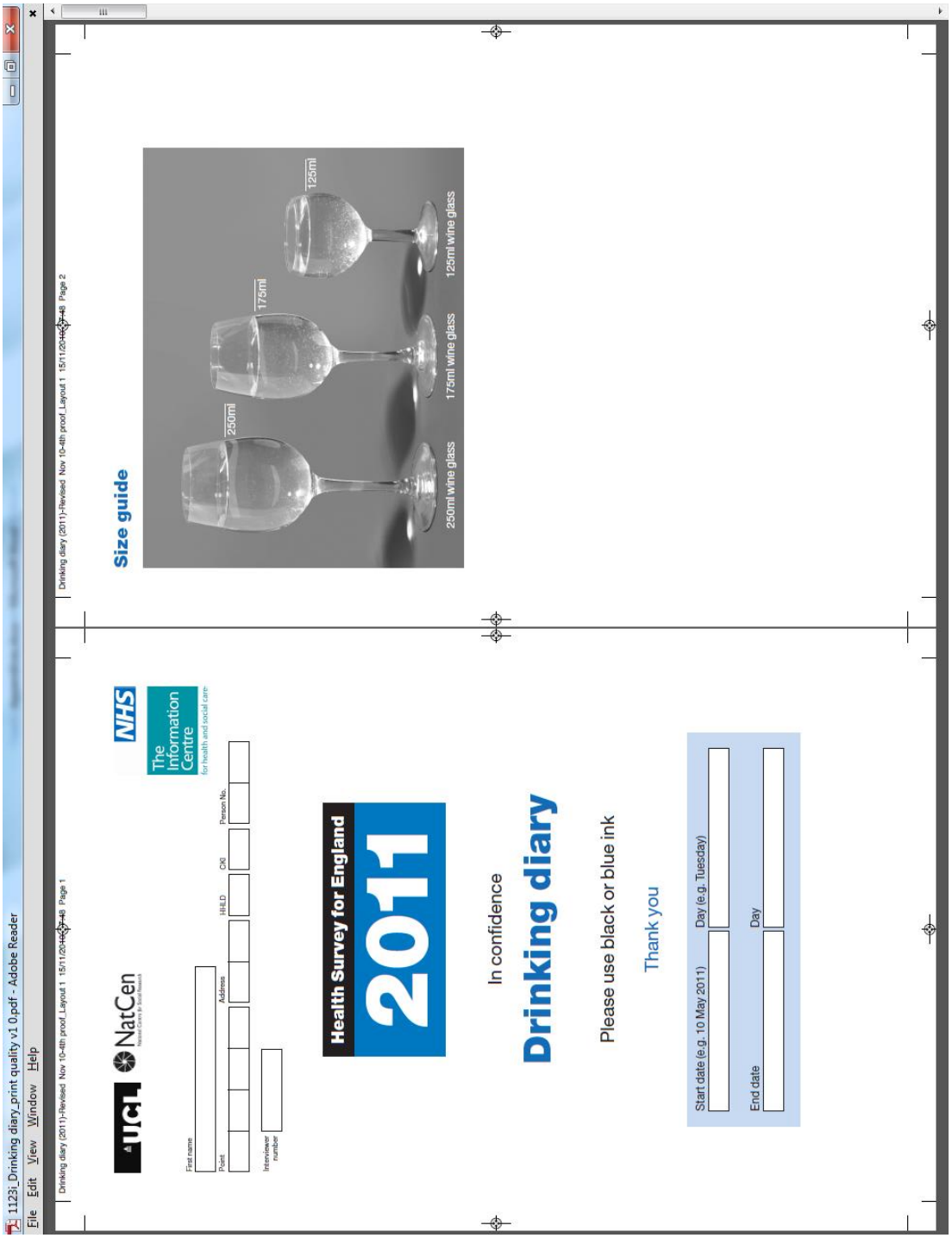
GLF response rate from technical appendix B:	72.0%	
Non-response:	28.0%	
Unweighted weekly alcohol (units):	11.4	
Sales equivalent:	20.4	
Missing units:	9	
Coverage among responders (unweighted):	55.9%	
Missing (%):	44.1%	
Sales for 2010/11 (HMRC Factsheet March 2012):	5.36	million hectolitres
Volume of sales among 'responders' (55.9%):	*3.00*	*million hectolitres*
Volume of sales among 'non-responders' (44.1%):	*2.36*	*million hectolitres*
UK population in 2010 (16+, pop^{n} spring trends):	50,653,848	
72%* pop^{n}*, or 'Responders'	*36,470,771*	
28%* pop^{n} , or *'Non-responders'	*14,183,077*	

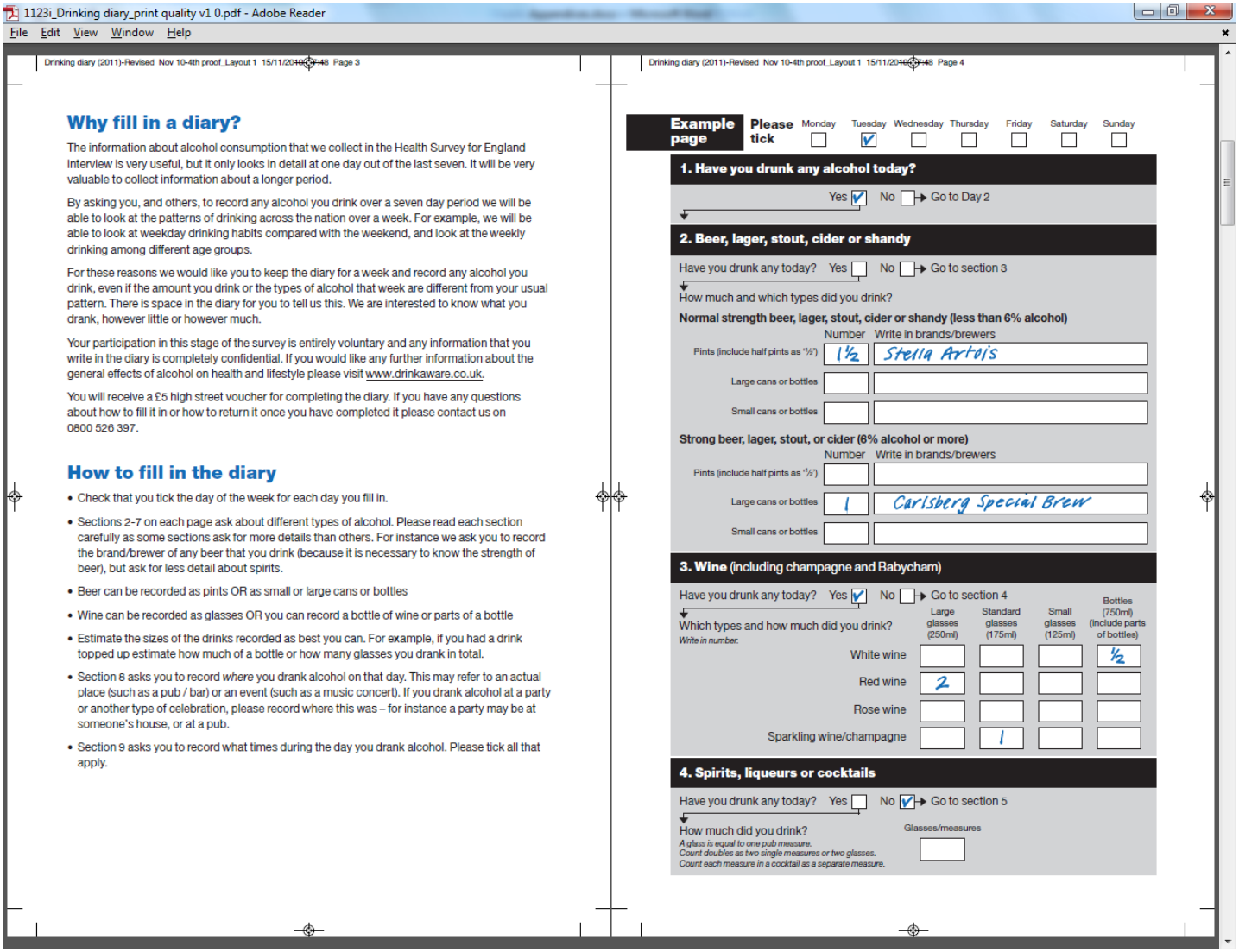
	n	Volume (million hectolitres)	Volume (litres)	Litres per capita (16+)	Weekly units per capita
Total UK population in 2010 (16+):	50,653,848	5.36	535464000	10.57	20.33
Non-responders:	*14,183,077*	2.36	236139624	16.65	32.02

*Notes: 1 hectolitre = 99.99 litres. Convert litres to weekly units = ((litres)*100)/52*

Appendix I. **HSE 2011 drinking diary**

Source: Fuller, E. Personal communication.





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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2010 7:48 Page 3

Why fill in a diary?

The information about alcohol consumption that we collect in the Health Survey for England interview is very useful, but it only looks in detail at one day out of the last seven. It will be very valuable to collect information about a longer period.

By asking you, and others, to record any alcohol you drink over a seven day period we will be able to look at the patterns of drinking across the nation over a week. For example, we will be able to look at weekday drinking habits compared with the weekend, and look at the weekly drinking among different age groups.

For these reasons we would like you to keep the diary for a week and record any alcohol you drink, even if the amount you drink or the types of alcohol that week are different from your usual pattern. There is space in the diary for you to tell us this. We are interested to know what you drank, however little or however much.

Your participation in this stage of the survey is entirely voluntary and any information that you write in the diary is completely confidential. If you would like any further information about the general effects of alcohol on health and lifestyle please visit www.drinkaware.co.uk.

You will receive a £5 high street voucher for completing the diary. If you have any questions about how to fill it in or how to return it once you have completed it please contact us on 0800 526 397.

How to fill in the diary

- Check that you tick the day of the week for each day you fill in.
- Sections 2-7 on each page ask about different types of alcohol. Please read each section carefully as some sections ask for more details than others. For instance we ask you to record the brand/brewer of any beer that you drink (because it is necessary to know the strength of beer), but ask for less detail about spirits.
- Beer can be recorded as pints OR as small or large cans or bottles
- Wine can be recorded as glasses OR you can record a bottle of wine or parts of a bottle
- Estimate the sizes of the drinks recorded as best you can. For example, if you had a drink topped up estimate how much of a bottle or how many glasses you drank in total.
- Section 8 asks you to record *where* you drank alcohol on that day. This may refer to an actual place (such as a pub / bar) or an event (such as a music concert). If you drank alcohol at a party or another type of celebration, please record where this was – for instance a party may be at someone's house, or at a pub.
- Section 9 asks you to record what times during the day you drank alcohol. Please tick all that apply.

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2010 7:48 Page 4

Example page **Please tick** Monday ☐ Tuesday ☑ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐

1. Have you drunk any alcohol today?

Yes ☑ No ☐ → Go to Day 2

2. Beer, lager, stout, cider or shandy

Have you drunk any today? Yes ☐ No ☐ → Go to section 3

How much and which types did you drink?

Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)

	Number	Write in brands/brewers
Pints (include half pints as ½)	1½	Stella Artois
Large cans or bottles		
Small cans or bottles		

Strong beer, lager, stout, or cider (6% alcohol or more)

	Number	Write in brands/brewers
Pints (include half pints as ½)		
Large cans or bottles	1	Carlsberg Special Brew
Small cans or bottles		

3. Wine (including champagne and Babycham)

Have you drunk any today? Yes ☑ No ☐ → Go to section 4

Which types and how much did you drink?
Write in number.

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (include parts of bottles)
White wine				½
Red wine	2			
Rose wine				
Sparkling wine/champagne		1		

4. Spirits, liqueurs or cocktails

Have you drunk any today? Yes ☐ No ☑ → Go to section 5

How much did you drink?
A glass is equal to one pub measure.
Count doubles as two single measures or two glasses.
Count each measure in a cocktail as a separate measure.

Glasses/measures

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 08:48 Page 6

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 08:48 Page 5

Day 1 Please tick Monday Tuesday Wednesday Thursday Friday Saturday Sunday

1. Have you drunk any alcohol today?
Yes ☐ No ☐ → Go to Day 2

2. Beer, lager, stout, cider or shandy
Have you drunk any today? Yes ☐ No ☐ → Go to section 3
How much and which types did you drink?
Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)
Number — Write in brands/brewers
Pints (include half pints as ½)
Large cans or bottles
Small cans or bottles
Strong beer, lager, stout, or cider (6% alcohol or more)
Number — Write in brands/brewers
Pints (include half pints as ½)
Large cans or bottles
Small cans or bottles

3. Wine (including champagne and Babycham)
Have you drunk any today? Yes ☐ No ☐ → Go to section 4
Which types and how much did you drink?
Write in number.

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (or 75cl cans of bottles)
White wine				
Red wine				
Rose wine				
Sparkling wine/champagne				

4. Spirits, liqueurs or cocktails
Have you drunk any today? Yes ☐ No ☐ → Go to section 5
How much did you drink?
A glass is equal to one pub measure.
Count doubles as two measures or two glasses.
Count each measure in a cocktail as a separate measure.
Glasses/measures

5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet
Have you drunk any today? Yes ☐ No ☑ → Go to section 6
How much did you drink? Small glasses
Count doubles as two singles.

6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice
Have you drunk any today? Yes ☑ No ☐ → Go to section 7
How much did you drink? Small cans or bottles: 1 | Large cans or bottles

7. Other kinds of alcoholic drink
Have you drunk any today? Yes ☐ No ☑ → Go to section 8
Which types and how much did you drink?
You can write in half pints or parts of a bottle, e.g. '1½'.
Count doubles as two single glasses.

	Glasses	Pints	Large cans or bottles	Small cans or bottles

8. Where did you drink today?
Tick all that apply
At home ☐
At another person's home ☐
In a pub or bar ☑
In a social club ☐
At a nightclub/disco ☐
In a restaurant ☐
At an outdoor public space, e.g. a park or the beach ☐
A bar at a public place, e.g. sporting event, concert or bowling alley ☐
Another place *(please write in)* ☐

9. What times of day did you drink?
Tick all that apply
Before 12 noon ☐
12 noon to 3pm ☐
3pm to 6pm ☐
6pm to 9pm ☑
9pm to midnight ☑
After midnight ☐

10. Is there anything else you would like to tell us about today's drinking?
Please write in

Turn over for **Day 1**

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:48 Page 6

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:48 Page 7

Day 2

Please tick — Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐

1. Have you drunk any alcohol today?

Yes ☐ No ☐ → Go to Day 3

2. Beer, lager, stout, cider or shandy

Have you drunk any today? Yes ☐ No ☐ → Go to section 3

How much and which types did you drink?

Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)

	Number	Write in brands/brewers
Pints (include half pints as ½)		
Large cans or bottles		
Small cans or bottles		

Strong beer, lager, stout, or cider (6% alcohol or more)

	Number	Write in brands/brewers
Pints (include half pints as ½)		
Large cans or bottles		
Small cans or bottles		

3. Wine (including champagne and Babycham)

Have you drunk any today? Yes ☐ No ☐ → Go to section 4

Which types and how much did you drink?
Write in number.

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (include parts of bottles)
White wine				
Red wine				
Rose wine				
Sparkling wine/champagne				

4. Spirits, liqueurs or cocktails

Have you drunk any today? Yes ☐ No ☐ → Go to section 5

How much did you drink?
A glass is equal to one pub measure.
Count doubles as two single measures or two glasses.
Count each measure in a cocktail as a separate measure.

Glasses/measures

5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet

Have you drunk any today? Yes ☐ No ☐ → Go to section 6

How much did you drink? Small glasses
Count doubles as two singles.

6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice

Have you drunk any today? Yes ☐ No ☐ → Go to section 7

How much did you drink? Small cans or bottles | Large cans or bottles

7. Other kinds of alcoholic drink

Have you drunk any today? Yes ☐ No ☐ → Go to section 8

Which types and how much did you drink?
You can write in half pints or parts of a bottle, e.g. '1½'.
Count doubles as two single glasses.

	Glasses	Pints	Large cans or bottles	Small cans or bottles

8. Where did you drink today?

Tick all that apply

- At home ☐
- At another person's home ☐
- In a pub or bar ☐
- In a social club ☐
- At a nightclub/disco ☐
- In a restaurant ☐
- At an outdoor public space, e.g. a park or the beach ☐
- A bar at a public place, e.g. sporting event, concert or bowling alley ☐
- Another place *(please write in)* ☐

9. What times of day did you drink?

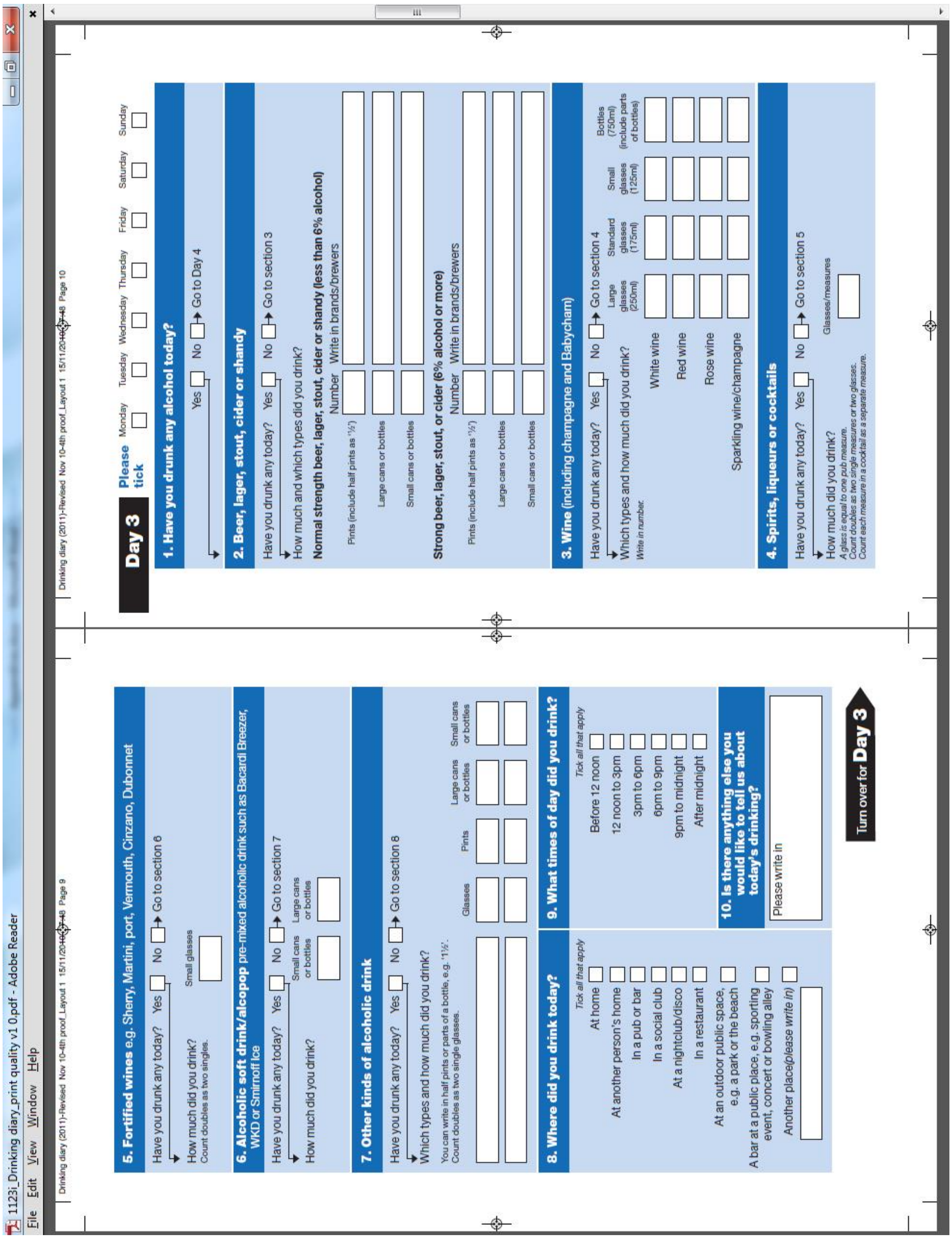
Tick all that apply

- Before 12 noon ☐
- 12 noon to 3pm ☐
- 3pm to 6pm ☐
- 6pm to 9pm ☐
- 9pm to midnight ☐
- After midnight ☐

10. Is there anything else you would like to tell us about today's drinking?

Please write in

Turn over for **Day 2**



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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2010 17:48 Page 9

5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet

Have you drunk any today? Yes ☐ No ☐ → Go to section 6

How much did you drink? Count doubles as two singles. Small glasses ☐

6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice

Have you drunk any today? Yes ☐ No ☐ → Go to section 7

How much did you drink? Small cans or bottles ☐ Large cans or bottles ☐

7. Other kinds of alcoholic drink

Have you drunk any today? Yes ☐ No ☐ → Go to section 8

Which types and how much did you drink?

You can write in half pints or parts of a bottle, e.g. '1½'. Count doubles as two single glasses.

	Glasses	Pints	Large cans or bottles	Small cans or bottles

8. Where did you drink today?

Tick all that apply

- At home ☐
- At another person's home ☐
- In a pub or bar ☐
- In a social club ☐
- At a nightclub/disco ☐
- In a restaurant ☐
- At an outdoor public space, e.g. a park or the beach ☐
- A bar at a public place, e.g. sporting event, concert or bowling alley ☐
- Another place *(please write in)* ☐

9. What times of day did you drink?

Tick all that apply

- Before 12 noon ☐
- 12 noon to 3pm ☐
- 3pm to 6pm ☐
- 6pm to 9pm ☐
- 9pm to midnight ☐
- After midnight ☐

10. Is there anything else you would like to tell us about today's drinking?

Please write in

Turn over for **Day 3**

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2010 17:48 Page 10

Day 3 Please tick Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐

1. Have you drunk any alcohol today?

Yes ☐ No ☐ → Go to Day 4

2. Beer, lager, stout, cider or shandy

Have you drunk any today? Yes ☐ No ☐ → Go to section 3

How much and which types did you drink?

Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

Strong beer, lager, stout, or cider (6% alcohol or more)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

3. Wine (including champagne and Babycham)

Have you drunk any today? Yes ☐ No ☐ → Go to section 4

Which types and how much did you drink? *Write in number.*

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (include parts of bottles)
White wine				
Red wine				
Rose wine				
Sparkling wine/champagne				

4. Spirits, liqueurs or cocktails

Have you drunk any today? Yes ☐ No ☐ → Go to section 5

How much did you drink? Glasses/measures ☐

A glass is equal to one pub measure. Count doubles as two single measures or two glasses. Count each measure in a cocktail as a separate measure.

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:48 Page 11

5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet

Have you drunk any today? Yes ☐ No ☐ → Go to section 6

How much did you drink? Small glasses

Count doubles as two singles.

6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice

Have you drunk any today? Yes ☐ No ☐ → Go to section 7

How much did you drink? Small cans or bottles / Large cans or bottles

7. Other kinds of alcoholic drink

Have you drunk any today? Yes ☐ No ☐ → Go to section 8

Which types and how much did you drink?

You can write in half pints or parts of a bottle, e.g. '1½'.
Count doubles as two single glasses.

	Glasses	Pints	Large cans or bottles	Small cans or bottles

8. Where did you drink today?

Tick all that apply

At home ☐
At another person's home ☐
In a pub or bar ☐
In a social club ☐
At a nightclub/disco ☐
In a restaurant ☐
At an outdoor public space, e.g. a park or the beach ☐
A bar at a public place, e.g. sporting event, concert or bowling alley ☐
Another place *(please write in)* ☐

9. What times of day did you drink?

Tick all that apply

Before 12 noon ☐
12 noon to 3pm ☐
3pm to 6pm ☐
6pm to 9pm ☐
9pm to midnight ☐
After midnight ☐

10. Is there anything else you would like to tell us about today's drinking?

Please write in

Turn over for **Day 4**

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:48 Page 12

Day 4

Please tick: Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐

1. Have you drunk any alcohol today?

Yes ☐ No ☐ → Go to Day 5

2. Beer, lager, stout, cider or shandy

Have you drunk any today? Yes ☐ No ☐ → Go to section 3

How much and which types did you drink?

Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

Strong beer, lager, stout, or cider (6% alcohol or more)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

3. Wine (including champagne and Babycham)

Have you drunk any today? Yes ☐ No ☐ → Go to section 4

Which types and how much did you drink?
Write in number.

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (include parts of bottles)
White wine				
Red wine				
Rose wine				
Sparkling wine/champagne				

4. Spirits, liqueurs or cocktails

Have you drunk any today? Yes ☐ No ☐ → Go to section 5

How much did you drink? Glasses/measures

A glass is equal to one pub measure.
Count doubles as two single measures or two glasses.
Count each measure in a cocktail as a separate measure.

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:48 Page 13

5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet

Have you drunk any today? Yes ☐ No ☐ → Go to section 6

How much did you drink? Count doubles as two singles. Small glasses

6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice

Have you drunk any today? Yes ☐ No ☐ → Go to section 7

How much did you drink? Small cans or bottles Large cans or bottles

7. Other kinds of alcoholic drink

Have you drunk any today? Yes ☐ No ☐ → Go to section 8

Which types and how much did you drink?

You can write in half pints or parts of a bottle, e.g. '1½'. Count doubles as two single glasses.

	Glasses	Pints	Large cans or bottles	Small cans or bottles

8. Where did you drink today? *Tick all that apply*

At home ☐
At another person's home ☐
In a pub or bar ☐
In a social club ☐
At a nightclub/disco ☐
In a restaurant ☐
At an outdoor public space, e.g. a park or the beach ☐
A bar at a public place, e.g. sporting event, concert or bowling alley ☐
Another place *(please write in)* ☐

9. What times of day did you drink? *Tick all that apply*

Before 12 noon ☐
12 noon to 3pm ☐
3pm to 6pm ☐
6pm to 9pm ☐
9pm to midnight ☐
After midnight ☐

10. Is there anything else you would like to tell us about today's drinking?

Please write in

Turn over for **Day 5**

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:48 Page 14

Day 5 Please tick

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	☐	☐	☐	☐	☐	☐	☐

1. Have you drunk any alcohol today?

Yes ☐ No ☐ → Go to Day 6

2. Beer, lager, stout, cider or shandy

Have you drunk any today? Yes ☐ No ☐ → Go to section 3

How much and which types did you drink?

Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

Strong beer, lager, stout, or cider (6% alcohol or more)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

3. Wine (including champagne and Babycham)

Have you drunk any today? Yes ☐ No ☐ → Go to section 4

Which types and how much did you drink? *Write in number.*

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (include parts of bottles)
White wine				
Red wine				
Rose wine				
Sparkling wine/champagne				

4. Spirits, liqueurs or cocktails

Have you drunk any today? Yes ☐ No ☐ → Go to section 5

How much did you drink? Glasses/measures

A glass is equal to one pub measure. Count doubles as two single measures or two glasses. Count each measure in a cocktail as a separate measure.

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 Page 15
Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 Page 16
Day 6
Please tick
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
1. Have you drunk any alcohol today?
Yes
No
Go to Day 7
2. Beer, lager, stout, cider or shandy
Have you drunk any today?
Yes
No
Go to section 3
How much and which types did you drink?
Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)
Number
Write in brands/brewers
Pints (include half pints as "½")
Large cans or bottles
Small cans or bottles
Strong beer, lager, stout, or cider (6% alcohol or more)
Number
Write in brands/brewers
Pints (include half pints as "½")
Large cans or bottles
Small cans or bottles
3. Wine (including champagne and Babycham)
Have you drunk any today?
Yes
No
Go to section 4
Which types and how much did you drink?
Write in number.
Large glasses (250ml)
Standard glasses (175ml)
Small glasses (125ml)
Bottles (750ml) (include parts of bottles)
White wine
Red wine
Rose wine
Sparkling wine/champagne
4. Spirits, liqueurs or cocktails
Have you drunk any today?
Yes
No
Go to section 5
How much did you drink?
A glass is equal to one pub measure.
Count doubles as two single measures or two glasses.
Count each measure in a cocktail as a separate measure.
Glasses/measures
5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet
Have you drunk any today?
Yes
No
Go to section 6
How much did you drink?
Count doubles as two singles.
Small glasses
6. Alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice
Have you drunk any today?
Yes
No
Go to section 7
How much did you drink?
Small cans or bottles
Large cans or bottles
7. Other kinds of alcoholic drink
Have you drunk any today?
Yes
No
Go to section 8
Which types and how much did you drink?
You can write in half pints or parts of a bottle, e.g. "1½".
Count doubles as two single glasses.
Glasses
Pints
Large cans or bottles
Small cans or bottles
8. Where did you drink today?
Tick all that apply
At home
At another person's home
In a pub or bar
In a social club
At a nightclub/disco
In a restaurant
At an outdoor public space, e.g. a park or the beach
A bar at a public place, e.g. sporting event, concert or bowling alley
Another place(please write in)
9. What times of day did you drink?
Tick all that apply
Before 12 noon
12 noon to 3pm
3pm to 6pm
6pm to 9pm
9pm to midnight
After midnight
10. Is there anything else you would like to tell us about today's drinking?
Please write in
Turn over for Day 6

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:49 Page 17

5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet

Have you drunk any today? Yes ☐ No ☐ → Go to section 6

How much did you drink? Count doubles as two singles. Small glasses

6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice

Have you drunk any today? Yes ☐ No ☐ → Go to section 7

How much did you drink? Small cans or bottles | Large cans or bottles

7. Other kinds of alcoholic drink

Have you drunk any today? Yes ☐ No ☐ → Go to section 8

Which types and how much did you drink?

You can write in half pints or parts of a bottle, e.g. '1½'. Count doubles as two single glasses.

	Glasses	Pints	Large cans or bottles	Small cans or bottles

8. Where did you drink today? *Tick all that apply*

At home ☐
At another person's home ☐
In a pub or bar ☐
In a social club ☐
At a nightclub/disco ☐
In a restaurant ☐
At an outdoor public space, e.g. a park or the beach ☐
A bar at a public place, e.g. sporting event, concert or bowling alley ☐
Another place *(please write in)* ☐

9. What times of day did you drink? *Tick all that apply*

Before 12 noon ☐
12 noon to 3pm ☐
3pm to 6pm ☐
6pm to 9pm ☐
9pm to midnight ☐
After midnight ☐

10. Is there anything else you would like to tell us about today's drinking?

Please write in

Turn over for **Day 7**

Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 17:49 Page 18

Day 7 Please tick: Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐

1. Have you drunk any alcohol today?

Yes ☐ No ☐ → Go to the back page

2. Beer, lager, stout, cider or shandy

Have you drunk any today? Yes ☐ No ☐ → Go to section 3

How much and which types did you drink?

Normal strength beer, lager, stout, cider or shandy (less than 6% alcohol)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

Strong beer, lager, stout, or cider (6% alcohol or more)

	Number	Write in brands/brewers
Pints (include half pints as '½')		
Large cans or bottles		
Small cans or bottles		

3. Wine (including champagne and Babycham)

Have you drunk any today? Yes ☐ No ☐ → Go to section 4

Which types and how much did you drink? *Write in number.*

	Large glasses (250ml)	Standard glasses (175ml)	Small glasses (125ml)	Bottles (750ml) (include parts of bottles)
White wine				
Red wine				
Rose wine				
Sparkling wine/champagne				

4. Spirits, liqueurs or cocktails

Have you drunk any today? Yes ☐ No ☐ → Go to section 5

How much did you drink? Glasses/measures

A glass is equal to one pub measure. Count doubles as two single measures or two glasses. Count each measure in a cocktail as a separate measure.

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Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 Page 19
5. Fortified wines e.g. Sherry, Martini, port, Vermouth, Cinzano, Dubonnet
Have you drunk any today? Yes No Go to section 6
How much did you drink? Count doubles as two singles.
Small glasses
6. Alcoholic soft drink/alcopop pre-mixed alcoholic drink such as Bacardi Breezer, WKD or Smirnoff Ice
Have you drunk any today? Yes No Go to section 7
How much did you drink?
Small cans or bottles
Large cans or bottles
7. Other kinds of alcoholic drink
Have you drunk any today? Yes No Go to section 8
Which types and how much did you drink?
You can write in half pints or parts of a bottle, e.g. '1½'. Count doubles as two single glasses.
Glasses
Pints
Large cans or bottles
Small cans or bottles
8. Where did you drink today?
Tick all that apply
At home
At another person's home
In a pub or bar
In a social club
At a nightclub/disco
In a restaurant
At an outdoor public space, e.g. a park or the beach
A bar at a public place, e.g. sporting event, concert or bowling alley
Another place(please write in)
9. What times of day did you drink?
Tick all that apply
Before 12 noon
12 noon to 3pm
3pm to 6pm
6pm to 9pm
9pm to midnight
After midnight
10. Is there anything else you would like to tell us about today's drinking?
Please write in
Go to Back page
Drinking diary (2011)-Revised Nov 10-4th proof_Layout 1 15/11/2011 Page 20
Thinking about the whole week...
Compared with what you usually drink, would you say that this week you drank...
Tick one box
About the same as usual
Less than usual
More than usual
If you drank less or more than usual, why was this?
How many days in the last month have you had an alcoholic drink of any kind?
Please write in number
THANK YOU VERY MUCH FOR COMPLETING THE DIARY

Appendix J. **Data protection form for qualitative study**

Application for inclusion of a research project Form 2

A. APPLICATION DETAILS

A1	**Project Title:** **Ordinary drinking patterns and your experience of drinking diaries**	
	Date of Submission: 09/05/2012	Proposed Start Date: 01/06/2012
	UCL Ethics Project ID Number: 2832/001	Proposed End Date: 30/09/3013

A2	**Principal Researcher** *(Please note that a student – undergraduate, postgraduate or research postgraduate cannot be the Principal Researcher for Ethics purposes).*	
	Full Name: Dr Nicola Jane Shelton	
	Position Held: Senior Lecturer and Head of Health and Social Surveys Research Group	
	Address: UCL Epidemiology and Public Health, 1-19 Torrington Place, London WC1E 6BT	
		Email: n.shelton@ucl.ac.uk
		Telephone: 020 7679 5648

A3	**Data Collector(s) Details** *(if Applicant is not the Principal Researcher e.g. student details)*:	
	Full Name: Sadie Boniface	
	Position Held: MRC PhD student	
	Address: UCL Epidemiology and Public Health PhD room 309, 1-19 Torrington Place, London WC1E 6BT	
		Email: s.boniface@ucl.ac.uk
		Telephone: 020 7679 1704

B. DETAILS OF THE PROJECT

B1 Please provide a brief summary of the project

There is a great deal of evidence to support that alcohol consumption in England is under-estimated by around one-third. This evidence comes from comparing estimates of alcohol consumption in social surveys to unit volumes of alcohol taxed for sale in England.

This project is a qualitative study forming part of a mixed-methods PhD. Respondents in the Health Survey for England (HSE) 2011 who completed a seven-day drinking diary will be contacted through NatCen Social Research. Respondents (n=10) will be visited in their own homes and a semi-structured interview conducted. The interview will focus on respondents' experience of the drinking diary and will aim to establish context and features of routine practices that are linked to this discrepancy between perceived and actual consumption.

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London WC1E 7HB

January 2012

C. DETAILS OF PARTICIPANTS

C1 **Data subjects**
Who will the personal data be collected from?

Respondents who completed a seven-day drinking diary in the Health Survey for England (HSE) 2011 will be written to by NatCen Social Research and invited to take part in the study. Respondents (n=10) will be interviewed in their own homes.

C2 **What data will be collected**
Please provide details of the type of personal data to be collected

Name and address will be known to the data collector in order to co-ordinate the interview.

No personal data will be collected during the interview. The interview will be semi-structured and will focus on the respondent's experience of completing the drinking diary. All transcripts will be anonymised and all audio files and any other files containing personal data will be destroyed.

C3 **Disclosure**
Who will the results of your project be disclosed to?

Anonymised transcripts will appear in the PhD thesis.
Selected quotes may appear in publications and presentations.

D. CONSENT

D1 **Consent**
Please include the information sheet and consent forms you will be using for this project, and or protocol

If you are not including an information sheet and consent form, please explain why:

Consent form CFSB2012 and Participant Information Sheet ISSB2012 supplied.

E. INTERNATIONAL TRANSFER

E1 **International Transfer**

The eighth principle of the Data Protection Act 1998 prohibits the transfer of personal data to countries or territories outside the European Economic Area (which consists of the 27 EU member states, Iceland, Liechtenstein and Norway).

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January 2012

At the time of writing the following countries have also been deemed adequate for the purposes of the 8th principle Argentina, Canada, Guernsey, Isle of Man, Jersey and Switzerland.

If you intend to transfer data to a country not mentioned above, please supply details of adequate safeguards below:

N/A - no intention of transferring data outside the UK.

F. PUBLICATION

Will the results of your research be published in an academic journal or other publication? **YES**

Please note that published results must not contain data by which an individual can be identified.

G. NOTIFICATION

G1 **Notification**
(Please note that notification is a prerequisite for registration)

Have you informed your department's Data Protection Coordinator about your project?
YES

G2 **Notification**
(Please note that notification is a prerequisite for registration)

Have you informed your department's computer representative about your project?
YES

H. ETHICS

H1 Are you applying to the UCL Research Ethics Committee?
YES

Date of Ethics meeting:

N/A, submitting application for chair's approval (applications accepted ad-hoc)

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Legal Services
6th Floor, 1-19 Torrington Place
London WC1E 7HB

January 2012

I. REGISTRATION

I1	**Registration:** *Office use only:*	
	UCL Data Protection Registration Number:	Data issued:

Further information

For more information and guidance on the UCL Research Committee, please visit
http://ethics.grad.ucl.ac.uk/

When all essential documents are ready to archive, contact the UCL Records Office by email at records.office@ucl.ac.uk to arrange ongoing secure storage of your research records unless you have made specific alternative arrangements with your department, or funder.

For information on the UCL Records Management Service, please visit
http://www.ucl.ac.uk/efd/recordsoffice/policy/records-transfer

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Legal Services
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London WC1E 7HB

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Appendix K. **Ethical approval form for qualitative study**

UCL RESEARCH ETHICS COMMITTEE

IMPORTANT: ALL FIELDS MUST BE COMPLETED. THE FORM SHOULD BE COMPLETED IN PLAIN ENGLISH UNDERSTANDABLE TO LAY COMMITTEE MEMBERS.

SEE NOTES IN STATUS BAR FOR ADVICE ON COMPLETING EACH FIELD. YOU SHOULD READ THE ETHICS APPLICATION GUIDELINES AND HAVE THEM AVAILABLE AS YOU COMPLETE THIS FORM.

APPLICATION FORM

SECTION A APPLICATION DETAILS

A1 **Project Title: Ordinary drinking patterns and your experience of drinking diaries**

Date of Submission: 22.05.2012	Proposed Start Date: 15.06.2012
UCL Ethics Project ID Number: 2832/001	Proposed End Date: 31.12.2012

If this is an application for classroom research as distinct from independent study courses, please provide the following additional details:

Course Title: Course Number:

A2 **Principal Researcher**

Please note that a student – undergraduate, postgraduate or research postgraduate cannot be the Principal Researcher for Ethics purposes.

Full Name: Dr Nicola Jane Shelton	Position Held: Senior Lecturer & head of Health & Social Surveys research group
Address: UCL Epidemiology & Public Health 1-19 Torrington Place London WC1E 6BT	Email: n.shelton@ucl.ac.uk
	Telephone: 020 7679 5648
	Fax:

Declaration To be Signed by the Principal Researcher

- I have met with and advised the student on the ethical aspects of this project design *(applicable only if the Principal Researcher is not also the Applicant).*
- I understand that it is a UCL requirement for both students & staff researchers to undergo Criminal Records Checks when working in controlled or regulated activity with children, young people or vulnerable adults. The required Criminal Record Check Disclosure Number(s) is: N/A
  - I have obtained approval from the UCL Data Protection Officer stating that the research project is compliant with the Data Protection Act 1998. My Data Protection Registration Number is: Reference No Z6364106/2012/05/25, section 19, research: health research.
- I am satisfied that the research complies with current professional, departmental and university guidelines including UCL's Risk Assessment Procedures and insurance arrangements.
- I undertake to complete and submit the 'Continuing Review Approval Form' on an annual basis to the UCL Research Ethics Committee.
- I will ensure that changes in approved research protocols are reported promptly and are not initiated without approval by the UCL Research Ethics Committee, except when necessary to eliminate apparent immediate hazards to the participant.
- I will ensure that all adverse or unforeseen problems arising from the research project are reported in a timely fashion to the UCL Research Ethics Committee.
- I will undertake to provide notification when the study is complete and if it fails to start or is abandoned.

Signature: Date:

A3 **Applicant(s) Details** *(If Applicant is not the Principal Researcher e.g. student details):*

Full Name: Miss Sadie Boniface	
Position Held: PhD student	
Address: PhD room 309 UCL Epidemiology and Public Health 1-19 Torrington Place London WC1E 6BT	Email: s.boniface@ucl.ac.uk Telephone: 020 7679 1704 (int. 41704) Fax:
Full Name: Dr James Kneale	
Position Held: Senior Lecturer in Human Geography	
Address: Room 107 Department of Geography 26 Bedford Way London WC1H OAP	Email: j.kneale@ucl.ac.uk Telephone: 020 7679 5535 Fax:

A4 **Sponsor/ Other Organisations Involved and Funding**

a) **Sponsor:** ☒ **UCL** ☐ **Other Institution**
If your project is sponsored by an institution other than UCL please provide details:

b) **Other Organisations:** If your study involves another organisation, please provide details. *Evidence that the relevant authority has given permission should be attached or confirmation provided that this will be available upon request.* NatCen Social Research will send letters to HSE 2011 respondents for a fee.

c) **Funding:** What are the sources of funding for this study and will the study result in financial payment or payment in kind to the department or College? *If study is funded solely by UCL this should be stated, the section should not be left blank.* Sadie Boniface is funded by a Medical Research Council Doctoral Training Grant PhD studentship

A5 **Signature of Head of Department or Chair of the Departmental Ethics Committee**
(This must not be the same signature as the Principal Researcher)

I have discussed this project with the principal researcher who is suitably qualified to carry out this research and I approve it. The project is registered with the UCL Data Protection Officer, a formal signed risk assessment form has been completed, and appropriate insurance arrangements are in place. *Links to details of UCL's policies on data protection, risk assessment, and insurance arrangements can be found at: http://ethics.grad.ucl.ac.uk/procedures.php*

UCL is required by law to ensure that researchers undergo a Criminal Record Check if their research project puts them in a position of trust with children under 18 or vulnerable adults.
Full details of UCL's policy on criminal record checks can be found at http://www.ucl.ac.uk/hr/docs/criminal_record.php

HEAD OF DEPARTMENT TO DELETE BELOW AS APPLICABLE

I am satisfied that checks: **(1) have been satisfactorily completed**
(2) have been initiated
(3) are not required

If checks are not required please clarify why below.

Participants in this study are adults aged 18 and over. This study will not recruit vulnerable adults.

Print Name: Professor Richard Watt

Signature: Date: 22.05.2012

A3 **Applicant(s) Details** *(If Applicant is not the Principal Researcher e.g. student details):*

Full Name: Miss Sadie Boniface	
Position Held: PhD student	
Address: PhD room 309 UCL Epidemiology and Public Health 1-19 Torrington Place London WC1E 6BT	Email: s.boniface@ucl.ac.uk Telephone: 020 7679 1704 (int. 41704) Fax:
Full Name: Dr James Kneale	
Position Held: Senior Lecturer in Human Geography	
Address: Room 107 Department of Geography 26 Bedford Way London WC1H OAP	Email: j.kneale@ucl.ac.uk Telephone: 020 7679 5535 Fax:

A4 **Sponsor/ Other Organisations Involved and Funding**

a) **Sponsor:** ☒ **UCL** ☐ **Other Institution**
If your project is sponsored by an institution other than UCL please provide details:

b) **Other Organisations:** If your study involves another organisation, please provide details. *Evidence that the relevant authority has given permission should be attached or confirmation provided that this will be available upon request.* NatCen Social Research will send letters to HSE 2011 respondents for a fee.

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UCL is required by law to ensure that researchers undergo a Criminal Record Check if their research project puts them in a position of trust with children under 18 or vulnerable adults.
Full details of UCL's policy on criminal record checks can be found at http://www.ucl.ac.uk/hr/docs/criminal_record.php

HEAD OF DEPARTMENT TO DELETE BELOW AS APPLICABLE

I am satisfied that checks: **(1) have been satisfactorily completed**
(2) have been initiated
(3) are not required

If checks are not required please clarify why below.

Participants in this study are adults aged 18 and over. This study will not recruit vulnerable adults.

Print Name: Professor Richard Watt

Signature: Date: 22.05.2012

journals.

B6 **Please outline any ethical issues that might arise from the proposed study and how they are be addressed.** *Please note that all research projects have some ethical considerations so do not leave this section blank.*

Participants may say something in the interview which they may later change their mind about. Participants will be able to contact the researcher and have certain parts of the transcript destroyed, and are also free to withdraw from the study at any time, including after the interview has taken place. This will be made clear in the consent form.

It will be made clear in the information sheet that participants' identities will be masked and that all data will be stored safely and confidentially. Participants will be anonymised through allocation of pseudonyms to themselves, and any names of people or places mentioned. Voice recordings where real names may be used will be deleted once they have been transcribed and pseudonyms allocated.

SECTION C DETAILS OF PARTICIPANTS

C1 **Participants to be studied**

C1a. Number of volunteers:	10
Upper age limit:	none
Lower age limit:	18

C1b. Please justify the age range and sample size:

The HSE includes respondents aged 16 and over. The sample will be randomly selected from survey respondents aged 18 or over so that 16 and 17 year-old children are excluded (CRB check therefore not required).

As this is a qualitative study, the sample size is not the result of a sample size calculation. Ten interviews will allow emergent themes to be identified.

C2 **If you are using data or information held by a third party, please explain how you will obtain this. You should confirm that the information has been obtained in accordance with the UK Data Protection Act 1998.**

N/A

C3 **Will the research include children or vulnerable adults such as individuals with mental health problems or with learning disabilities, the elderly, prisoners or young offenders?** ☐ Yes ☒ No

How will you ensure that participants in these groups are competent to give consent to take part in this study? *If you have relevant correspondence, please attach it.*

4

C4 Will payment or any other incentive, such as gift service or free services, be made to any research participant?

☐ Yes ☒ No

If yes, please specify the level of payment to be made and/or the source of the funds/gift/free service to be used.

Please justify the payment/other incentive you intend to offer.

C5 **Recruitment**

(I) Describe how potential participants will be identified:

NatCen Social Research will identify HSE 2011 respondents who completed the drinking diary living in London drinking on at least four days out of the seven day drinking diary.

(II) Describe how potential participants will be approached:

A letter will be sent to them from NatCen asking them if they wish to participate in the study.

(III) Describe how participants will be recruited:

Once they have agreed to participate in the study by returning a pre-paid reply slip, Sadie Boniface will arrange a mutually convenient time for the interview

Attach recruitment emails/adverts/webpages. A data protection disclaimer should be included in the text of such literature.

C6 Will the participants participate on a fully voluntary basis? ☒ Yes ☐ No

Will UCL students be involved as participants in the research project? ☐ Yes ☒ No

If yes, care must be taken to ensure that they are recruited in such a way that they do not feel any obligation to a teacher or member of staff to participate.

Please state how you will bring to the attention of the participants their right to withdraw from the study without penalty?

This will be made clear in the consent form and participant information sheet.

C7 **CONSENT**

Please describe the process you will use when seeking and obtaining consent.

A consent form will be read and signed prior to the start of the interview. The researcher will answer any questions.

A copy of the participant information sheet and consent form must be attached to this application. For your convenience proformas are provided in C10 below. These should be filled in and modified as necessary.

In cases where it is not proposed to obtain the participants informed consent, please explain why below.

5

C8	**Will any form of deception be used that raises ethical issues? If so, please explain.** No.

C9	**Will you provide a full debriefing at the end of the data collection phase?** ☒ Yes ☐ No If 'No', please explain why below. Once the interview has finished, it will be explained to participants that this study is part of research understanding the discrepancy between self-reported consumption and actual alcohol sales.

C10	**Information Sheets And Consent Forms** **A poorly written Information Sheet(s) and Consent Form(s) that lack clarity and simplicity frequently delay ethics approval of research projects.** The wording and content of the Information Sheet and Consent Form must be appropriate to the age and educational level of the research participants and clearly state in simple non-technical language what the participant is agreeing to. Use the active voice e.g. "we will book" rather than "bookings will be made". Refer to participants as "you" and yourself as "I" or "we". An appropriate translation of the Forms should be provided where the first language of the participants is not English. If you have different participant groups you should provide Information Sheets and Consent Forms as appropriate (e.g. one for children and one for parents/guardians) using the templates below. Where children are of a reading age, a written Information Sheet should be provided. When participants cannot read or the use of forms would be inappropriate, a description of the verbal information to be provided should be given. Please ensure that you trial the forms on an age-appropriate person before you submit your application.

Information Sheet – see attached form ISSB2010

Informed Consent – see attached form CFSB2012

SECTION D DETAILS OF RISKS AND BENEFITS TO THE RESEARCHER AND THE RESEARCHED

6

D1 **Have UCL's Risk Assessment Procedures been followed?** ☒ Yes ☐ No

If No, please explain.

D2 **Does UCL's insurer need to be notified about your project before insurance cover can be provided?** ☐ Yes ☒ No

The insurance for all UCL studies is provided by a commercial insurer. For the majority of studies the cover is automatic. However, for a minority of studies, in certain categories, the insurer requires prior notification of the project before cover can be provided. For example, you will need to complete an insurance registration form for the following types of studies: clinical trials which use drugs or vaccines; trials of medical devices; studies which use radiation, surgery or anesthesia as the intervention; studies which will enroll over 5000 subjects.

If Yes, please provide confirmation that the appropriate insurance cover has been agreed. *Please attach your UCL insurance registration form and any related correspondence.*

D3 **Please state briefly any precautions being taken to protect the health and safety of researchers and others associated with the project (as distinct from the research participants).**

There is a risk in a young female researcher interviewing participants in their own homes alone. The risk will be minimised by the researcher carrying a mobile phone and attack alarm, and informing a colleague of the interview times and approximate location. This risk is anticipated to be very small as the participants have previously been interviewed by NatCan Social Research without issue.

D4 **Will these participants participate in any activities that may be potentially stressful or harmful in connection with this research?** ☐ Yes ☒ No

If Yes, please describe the nature of the risk or stress and how you will minimise and monitor it.

D5 **Will group or individual interviews/questionnaires raise any topics or issues that might be sensitive, embarrassing or upsetting for participants?**

If Yes, please explain how you will deal with this.

Talking about alcohol intake may raise difficult experiences from the respondent's past or present, relating to themselves, a family member, or a friend.

It is mentioned in the consent form that-

a) respondents are free to withdraw from the study at any time, including after the interview has taken place

b) everything said will be treated, if requested, with confidence

7

	At any point during the interview the respondent does not wish to be recorded, the dictaphone will be switched off and if necessary the interview terminated.

D6	**Please describe any expected benefits to the participant.** - Increased awareness of own alcohol intake - Better understanding of Government's drinking guidelines and the amount of alcohol this equates to - Participants will be sent a summary of the research findings

D7	**Specify whether the following procedures are involved:** **Any invasive procedure(s)** ☐ Yes ☒ No **Physical contact** ☐ Yes ☒ No **Any procedure(s) that may cause mental distress** ☐ Yes ☒ No Please state briefly any precautions being taken to protect the health and safety of the research participants.

D8	**Does the research involve the use of drugs?** ☐ Yes ☒ No If Yes, please name the drug/product and its intended use in the research and then refer to Appendix I **Does the project involve the use of genetically modified materials?** ☐ Yes ☒ No If Yes, has approval from the Genetic Modification Safety Committee been obtained for work? ☐ Yes ☐ No If Yes, please quote the Genetic Modification Reference Number:

8

D9	Will any ionising radioactive substances be used on the research participant(s)? ☐ Yes ☒ No If Yes, please refer to Appendix II. Will x-rays be used? ☐ Yes ☐ No If Yes, please refer to Appendix II.

CHECKLIST

Please submit ether 12 copies (1 original + 11 double sided photocopies) of your completed application form for full committee review or 3 copies (1 original + 2 double sided copies) for chair's action, together with the appropriate supporting documentation from the list below to the UCL Research Ethics Committee Administrator. You should also submit your application form electronically to the Administrator at: ethics@ucl.ac.uk

Documents to be Attached to Application Form (if applicable)	Ticked if attached	Tick if not relevant
Section B: Details of the Project		
• Questionnaire(s) / Psychological Tests	☐	☒
• Relevant correspondence relating to involvement of collaborating department/s and agreed participation in the research.	☒	☐
Section C: Details of Participants		
• Parental/guardian consent form for research involving participants under 18	☐	☒
• Participant/s information sheet	☒	☐
• Participant/s consent form/s	☒	☐
• Advertisement	☐	☒
Section D: Details of Risks and Benefits to the Researcher and the Researched		
• Insurance registration form and related correspondence	☐	☒
Appendix I: Research Involving the Use of Drugs		
• Written signed statement from the pharmaceutical/industrial company stating their agreement to abide by the guidelines on compensation of the Association of British Pharmaceutical Industry (ABPI) or other insurance certificate	☐	☒
• Proposed volunteer contract	☐	☒
• Full declaration of financial or direct interest	☐	☒
• Copies of certificates: CTC/CTX/DDX etc…	☐	☒
• Relevant correspondence relating to agreed arrangements for dispensing with the pharmacy	☐	☒

Please note that correspondence regarding the application will normally be sent to the Principal Researcher and copied to other named individuals.

9

Appendix L. Correspondence with NatCen to support ethical approval application for qualitative study

Boniface, Sadie

From: Rachel Craig <Rachel.Craig@natcen.ac.uk>
Sent: 22 May 2012 11:36
To: Boniface, Sadie
Subject: Study 'Ordinary drinking patterns and your experience of drinking diaries'

Dear Sadie

This email is to confirm that NatCen Social Research will be working with you on the study 'Ordinary drinking patterns and your experience of drinking diaries', UCL REC Project ID 2832/001.

NatCen will work with you to identify an appropriate sample of respondents to the Health Survey for England who have agreed to further contact, so that you are able to carry out a small number of individual interviews. NatCen will contact respondents to establish that they are happy for their details to be passed on to you for the research.

Best wishes

Rachel Craig

Rachel Craig
Research Director, Health Survey for England
Direct line: 020 7549 7012
NatCen Social Research

Visit our website. www.natcen.ac.uk
Read our latest blog. natcenblog.blogspot.com
Follow us @NatCen

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35 Northampton Square
London EC1V 0AX
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1

Appendix M. Participant information sheet for qualitative study

ISSB2012 Participant ID: _____

Ordinary drinking patterns and your experience of drinking diaries

UCL

Information for participants

We would like to invite Health Survey for England (HSE) 2011 respondents who completed the seven-day drinking diary to participate in this research project. Participation is entirely voluntary and if you choose not to take part there will not be any disadvantages for you and you will hear no more about this project.

Details of the project:

Please read the following information carefully before you decide to take part; this will tell you why the research is being done and what you will be asked to do if you take part. Please discuss this information with others if you wish or ask us if there is anything that is not clear or if you would like more information. If you do decide to take part you are still free to withdraw at any time and without giving a reason.

This project aims to understand alcohol intake and behaviours. We are interested in your experience of the seven-day drinking diary you completed as part of the HSE 2011, and your routine drinking practices.

If you agree to take part in the research, a researcher will visit you at a place and time that is convenient, and interview you about the drinking diary you completed last year and your routine drinking practices. This should take about an hour. Recorded interviews will be transcribed (written up) and the tape will then be wiped clear.

This project has been approved by the UCL Research Ethics Committee (Project ID Number 2832/001). The information provided will be kept safely and confidentially. All data will be collected and stored in accordance with the Data Protection Act 1998. You will be sent a copy of the study findings when it is written up and will be able to ask me any questions you might have.

If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form.

Contact: Miss Sadie Boniface (postgraduate student)

s.boniface@ucl.ac.uk / **07435 349 170 (until Nov '12) / 020 7679 1704 (thereafter)**

UCL Department of Epidemiology and Public Health (PhD room 309)

1-19 Torrington Place, London WC1E 6BT

(or Dr Nicola Shelton on 020 7679 5648)

Appendix N. **Consent form for qualitative study**

CFSB2012 Participant ID: _____

Ordinary drinking patterns and your experience of drinking diaries

UCL

Consent form

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of project: Ordinary drinking patterns and your experience of drinking diaries
This project has been approved by the UCL Research Ethics Committee (Project ID Number 2832/001).

Thank you for considering taking part in this research. Before you agree to take part, the person organising the research must explain the project to you.

If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decided whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

☐ *I understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately.*

☐ *I consent to the processing of my personal information for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.*

Participant's statement: I _____ agree that the research project named above has been explained to me to my satisfaction and I agree to take part in this study. I have read the notes written above and the Information Sheet, and understand what the study involves.

Signed: Date:

Name:

Address:

Contact number:

Investigator's statement: I _____ confirm that I have carefully explained the nature, demands, and any foreseeable risks (where applicable) of the proposed research to the volunteer.

Appendix O. Feedback from participants and comments on listening to the recordings of the two pilot interviews conducted

INTERVIEW 1

Feedback from participant:

- Interview was good, questions were clear.
- Question 4 needs to be explained to pilot interviewee in advance because they did not do HSE survey interview. Reflexive sharing bit was interesting and could be expanded on.
- Question 8 slightly confusing – have re-phrased this. See what aspects – embodied/social/visual/units – emerge and then probe rather than presenting them to the interviewee.
- Make sure I don't say 'that's good' in response to interviewee answering question
- He didn't feel like I was putting words in his mouth

My comments on listening to the recording:

- He didn't seem to notice I was leaving deliberate silences – can do this even more if I want to
- Could do more to build rapport
- Question 8 was not introduced very well but recovered in 11m33s onwards "so different ways of knowing what you've had to drink. So some people might count how many units (UNITS) they've had, some people might think 'oh I was very drunk that night, I was only a little bit tipsy that night' (EMBODIED) and that might be how they gauge how much they have had to drink, or other people will know based on 'we've shared a bottle of wine', or- (SOCIAL)"
- Less 'erm'-s and 'OK'-s!
- OPEN UP THE QUESTIONS e.g.- "how useful is x compared to y…" rather than "do you think x is better than y"
- Good probing in second half of interview but the first half went too quickly
- Total interview time was 28 minutes including reading info sheet and consent form

INTERVIEW 2

Feedback from participant:

- Helped refining Q8 further; do you have a knack or trick? Thinking of social aspect of Q8 more as contextual cues
- On doing the diary versus f2f interview: *"you can ignore any kind of social relevance to your answers"* 11m in.
- Increased awareness of drinking patterns resulted from diary, would have preferred more information/advice afterwards though esp. as time invested was great.

My comments on listening to the recording:

- Introduce the study more in the real interviews
- Doing work on DRINKING not alcohol
- Ask about time of year, special events
- Perhaps too much assumed knowledge in talking about the HSE interview – provide more information to jog memory
- Don't waffle on Q8 so much
- Small amounts she doesn't think about, if she drinks a lot she remembers drinks and feels 'worry'. Worry is for health reasons.
- Total interview time was almost 34 minutes including reading info sheet and consent form

Appendix P. **Interview schedule for qualitative study**

>> Participant to read information sheet and sign consent form

>> Test equipment and start recording

Introductions and thanks

- I am a PhD student doing work on alcohol consumption and I'm really interested in the drinking diary that was part of last year's HSE
- This is the first time we have done this so I am here to talk to you about your experience
- A few things I would like to say before we start:
    - I have not seen your drinking diary
    - I am not here to change your behaviour or to tell you what to do but if you have any questions I am very happy to answer these as we go, or at the end of the interview

Opening

1. Can you tell me about your experience of doing the drinking diary?
    a. When was it? What time of year? Any special events?
    b. Do you remember it being easy/difficult?
    c. What was the hardest part?
    d. Did you enjoy it?
    e. Have you ever done anything like it before?
2. Do you remember it being a typical week for you?
    a. Did you drink any more, or any less, than usual?
3. Does your drinking follow any particular pattern week-to-week?
    a. Do you drink on the same number of days most weeks?
    b. Do you think you drink the same amount most weeks?
4. How do you think that doing the drinking diary on your own, on paper, was different to talking to an interviewer about your alcohol consumption?
    a. Was it easier to recall what you'd drank when you could do it day-by-day?
    b. Was it easier to do the diary or to have the interviewer ask you questions about drinking?
    c. Did you prefer the privacy of completing it on your own?
5. Do you feel that doing the diary could have influenced your drinking over the course of the week?

   a. For instance, did you drink any more, or any less, than usual because you were doing the diary?
6. Has doing the drinking diary had any lasting impact since?
   a. Have your drinking patterns changed at all?
   b. Are you drinking more or less?

Establish context and routine practices

[Reflexive sharing bit] I am going to share something with you now. I did a drinking diary using a phone app for all of 2010. Afterwards someone asked me questions about my 'average' consumption – and I found a huge difference between what I thought I drank on average and the results of my drinking diary. What I thought I drank was less than 60% of what I had recorded in the diary.

7. Having filled in the diary, do you remember being surprised by what you filled in at all?
   a. By the pattern of your drinking?
   b. By the number of days you drank on?
   c. By the amount of alcohol you drank?
   d. Or, was it just an ordinary week?
   e. If surprised, do you think this could have been because you were counting?
8. [not the diary] Normally, when you drink, do you remember or keep track of how much you have had?
   a. If so, how? Do you have a knack for this? If I asked you about one night last week for instance.
   b. Do you think you normally remember quite well, or not?
   c. Some people might know because they remember a particular event like a birthday party. Or because for instance they shared a bottle of wine at home with their partner, or had two pints after work one evening *(social/contextual cues – who/where/why)*
   d. Some people might remember by how tipsy/drunk they felt *(embodied aspects)*
   e. Some people might remember the number of drinks they had, or how much they spent *(drink recall)*
   f. What about units…? *(do you drink in units?)* Are units useful for knowing how much you've had to drink?
   g. Is there any other way you keep track?
   h. Do you think this is what most people do?
9. Are you aware of the Government's drinking guidelines?
   a. Do you know what these are?
   b. Are these useful/helpful to you?

c. Who (if anyone) do you think they are helpful for?

Closing

10. Is there anything else you would like to tell me about your drinking patterns, or the drinking diary?
11. Do you have any questions you'd like to ask me?

>> Thank participant for their time and contribution and inform them that they will be sent a summary of research findings

Appendix Q. **Participant information sheet for pouring study**

DEPARTMENT OF EPIDEMIOLOGY AND PUBLIC HEALTH

UCL

test your knowledge of alcohol units in my

HOME DRINKING STUDY

...and help me with my PhD research

I'm a first year PhD student in University College London's Department of Epidemiology and Public Health.

If you'd like to know more, please contact me (Sadie Boniface) email s.boniface@ucl.ac.uk or @sadieboniface on Twitter

Appendix R. **Standard table used to convert poured volumes into alcohol units in pouring study**

Units	Wines		Spirits		Units
	ml @ 12% ABV	ml @ 13.5% ABV	ml @ 37.5% ABV	ml @ 40% ABV	
0.25	21	19	7	6	0.25
0.50	42	37	13	13	0.50
0.75	63	56	20	19	0.75
1.00	83	74	26	25	1.00
1.25	104	93	33	31	1.25
1.50	125	111	40	37	1.50
1.75	146	130	47	44	1.75
2.00	167	148	54	50	2.00
2.25	188	167	60	56	2.25
2.50	208	185	67	62	2.50
2.75	229	204	73	69	2.75
3.00	250	222	80	75	3.00
3.25	271	241	87	81	3.25
3.50	292	259	94	87	3.50
3.75	313	278	100	94	3.75

Appendix S. **Sample size calculation for pouring study**

All power calculations were done using a spreadsheet given as part of a course on designing epidemiological studies. The variable used to do the power calculation was the difference between actual and perceived number of units poured into the glass.

Calculation:
=INT((((POWER(NORMSINV(power/100)+ABS(NORMSINV(significance level/2)),2))*standard deviation of sample* standard deviation of sample)/(difference to be detected* difference to be detected))+0.9999)
Original power calculation based on pilot study:
Power 80
Significance 0.01
Difference to be detected 0.25 (ie. ¼ of a unit either way)
SD 0.614014
Sample size required = 70
(in each of men and women so that the two sexes can be looked at separately)
Total sample size required = 140.
Allowing for mistakes in questionnaires and variation in SD, aiming for 200 PARTICIPANTS (100 men, 100 women).

After collecting data from 189 participants (22nd August 2011), the sample size calculation was checked:
Wine SD = 1.44
To detect 0.25 units (other things being equal) would need n=261 (ie. Total n of 522)
However it is possible to detect 0.5 units: power 80, sig 0.05, difference 0.5, SD 1.44, SAMPLE SIZE REQUD = 66 (ie. 132)
Spirits SD = 9.72
With spirits - power 80, sig 0.05, difference 0.5, SD 9.72, SAMPLE SIZE REQUD = 2,967
Or difference 1.0 = sample size = 742
This is due to outliers in the perceived number of units poured for spirits…
SPIRIT PROBLEM OBSERVATION #1
= person who poured 2.7 units, said it was 100. Unit difference = -97.3
If exclude this observation, SD = 2.93
If power 80, sig 0.05, difference 1.0, SD 2.93, SAMPLE SIZE REQUD = 68
If power 80, sig 0.05, difference 0.5, SD 2.93, SAMPLE SIZE REQUD = 270
SPIRIT PROBLEM OBS #2
= person who poured 4.08 units, said it was 30. Unit difference = -25.92
If exclude this observation also, SD = 1.63
If power 80, sig 0.05, difference 1.0, SD 1.63, SAMPLE SIZE REQUIRED = 21

If power 80, sig 0.05, difference 0.5, SD 1.63, SAMPLE SIZE REQUIRED = 68

The difference to detect was revised to 0.5 as this made for a more achievable sample size given the financial and time constraints on the project. This power calculation was repeated again further through the data collection period (on the 7th September 2011, after data had been collected from 227 participants).

So doing sample size calculations again using power 80, sig 0.05, difference 0.5

BOTH SEXES

Drink type	Current n	SD	Required n
Spirits all obs	137	8.657962	2354
Spirits minus outlier #1	136	2.657727	222
Spirits minus outliers #1&2	135	1.542299	75
Wine all obs	194	1.372945	60

MEN only

Drink type	Current n	SD	Required n
Spirits all obs	72	1.548472	76
Wine all obs	89	1.488919	70

WOMEN only

Drink type	Current n	SD	Required n
Spirits all obs	63	12.46719	4880
Spirits minus outlier #1	62	3.52615	391
Spirits minus outliers #1&2	61	1.521714	73
Wine all obs	105	1.243798	49

So, provided a difference of half a unit is a satisfactory difference:

- Sufficient participants for wine to look at men and women separately
- Require approximately four more men and eight more women to pour spirits, if the two outliers (someone guessed 100 units, and someone guessed 30) are excluded from the power calculation.

Data collection continued at previously planned sites in order to achieve this target. The final sample size was 283.

HOME DRINKING QUESTIONNAIRE – PhD research for Sadie Boniface s.boniface@ucl.ac.uk

Gender

Male ☐ Female ☐

Age

16-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65-74 ☐ 75+ ☐

Do you ever **drink alcohol?**

Yes ☐ No ☐

Do you ever **pour drinks for other people?**

Yes ☐ No ☐

Do you drink alcohol **in pubs**, bars, nightclubs, restaurants, hotels, social clubs etc?

Yes ☐ No ☐

Do you drink alcohol **at home**, or in someone else's home?

Yes ☐ No ☐

How often have you had an alcoholic drink in the last 12 months?

☐ Almost every day ☐ At least once a month
☐ At least once a week ☐ Less than once a month

On **how many days** out of the last seven did you have an alcoholic drink?

.....

Have you heard of **units** of alcohol?

Yes ☐ No ☐

How many units do you think there are in the following *(please write in)*:

a small (125ml) glass of **wine**

..... unit(s), or, I don't know ☐

a pint of **normal strength beer**

..... unit(s), or, I don't know ☐

a pub measure of **spirits** (For example whiskey or gin)

..... unit(s), or, I don't know ☐

What do you think is the current recommended **daily** maximum number of units for **men**?

..... unit(s), or, I don't know ☐

What do you think is the current recommended **daily** maximum number of units for **women**?

..... unit(s), or, I don't know ☐

How many units did you drink on your **heaviest drinking day** in the last week? *(please write in)*

.....

What did you drink on that day? *(please write in, eg "½ bottle of red wine & one double vodka coke")*

.....or, I don't know ☐

Which of the following drinks do you **ever** drink? *(please tick all that apply)*

☐ Normal strength beer/lager/cider/shandy (less than 6% alcohol) *e.g. Carling, Strongbow*
☐ Strong beer/lager/cider (more than 6% alcohol) *e.g. Tennants Super, Special Brew, Diamond White*
☐ Spirits (around 40% alcohol) *e.g. gin, whiskey, vodka, rum*
☐ Liqueurs (around 20% alcohol) *e.g. Advocaat, Bailey's, Schnapps*
☐ Sherry or Martini (around 20% alcohol) *e.g. port, vermouth, Cinzano, Dubonnet*
☐ White wine (including Babycham and champagne)
☐ Red wine
☐ Alcopops/pre-mixed alcoholic drinks *e.g. Bacardi Breezer, Smirnoff Ice, WKD*
☐ Low alcohol drinks
☐ Other alcoholic drinks (please specify .....)

Which of the above drinks do you drink **most often**? *(please write in)*

.....

Please give the **first half** of your home postcode *(e.g. HP19, SW11)*

.....

What is your ethnic group?

☐ White ☐ Black or Black British ☐ Mixed
☐ Asian or Asian British ☐ Chinese ☐ Other

What is your highest educational qualification?

☐ NVQ4/NVQ5/Degree or equivalent ☐ NVQ1/CSE other grade equivalent
☐ Higher education below degree ☐ Foreign/other
☐ NVQ3/GCE A Level equivalent ☐ None
☐ NVQ2/GCE O Level equivalent

Are you…

☐ Employed ☐ Retired
☐ Unemployed ☐ In full-time education
☐ Unemployed and receiving benefits e.g. JSA, incapacity benefit

Is your total household income…

☐ Less than £10,655.74 ☐ £16,900.01 - £26,787.88 ☐ £41,864.42 or above
☐ £10,655.74 - £16,900.00 ☐ £26,787.89 - £41,864.41

END OF QUESTIONNAIRE
THANK YOU
Reverse to be completed by researcher

Record of drink poured

Drink type		Glass chosen ID #	Volume poured ml
Wine	White		
	Red		
Spirits	Gin		
	Vodka		
	Dark rum		
	Whiskey		

Notes

How many **units** does participant think they have poured?

.....

.....