



Trends in UK deaths associated with abuse of volatile substances, 1971-2008

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Report 23

**Volatile Substance Abuse
(VSA) Mortality Project
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Drug Policy (ICDP)
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Executive summary

This is the twenty-third annual report of the Volatile Substance Abuse (VSA) Mortality Project, and has been produced by the International Centre for Drug Policy (ICDP) based at St. George's, University of London. This report outlines the current trends, examines the nature of the problems, and identifies the factors associated with deaths from abuse of volatile substances occurring in the United Kingdom in 2008.

There were 36 deaths associated with volatile substance abuse in 2008, bringing the cumulative total of VSA deaths in the UK since 1971 to 2,343. Since 1992 there has been a significant fall in deaths which appears to have decreased further in recent years. During the last decade (1999-2008), age at death ranged from 7 to 85 years (mean = 28, SD 13.3), and one-third of deaths occurred in the under-20 years age-group. Eighty percent of deaths were male, and in 2008 deaths from volatile substance abuse accounted for 0.5% of all-cause deaths in males aged 15-19 years.

Standard Mortality Ratios (SMRs) differed significantly across countries and Government Office Regions in England: the highest SMR was in Northern Ireland (193) and the lowest in the North West region of England (70). Gas fuels continue to be associated with the majority of deaths; over 90% in 2008. A steady decrease in suicides associated with the inhalation of a volatile substance was observed during the last ten-year period. However, it is worth noting that this fall appears to have been off-set by a rapid increase in suicides involving the inhalation of helium. As for VSA deaths in general, the majority (56%) of suicides involved males.

Volatile substance abuse remains an important problem in the UK, especially in terms of causing premature death amongst young people. This challenging issue, therefore, needs to be addressed through substance abuse education programmes and other initiatives, as well as examination of appropriate preventative measures and treatment provision, if required.

Key findings for deaths in 2008:

- There were 36 deaths associated with volatile substance abuse in 2008, bringing the total number of VSA deaths in the UK since 1971 to 2,343.
- Since 1992 there has been a significant fall in deaths, from an average of 77 per year in 1992-1999, to an average of 54 per year in 2000-2008.
- Gas fuels continue to be associated with the majority of deaths. In 2008, butane from all sources, including aerosol propellants, accounted for 83% of VSA deaths (30 out of 36 deaths).
- In under-18 year olds there were five VSA deaths in 2008 compared with eight in 2007 and seven in 2006. Of these five deaths, two were associated with butane cigarette lighter refills, the sale of which to under-18s is prohibited by legislation, and three were associated with aerosols.
- VSA deaths overall continue to be more common among males than females. In 2008, there were 34 deaths among males as compared to only two deaths among females, although in under-18 year olds this ratio was 3:2.
- Of the 36 deaths in 2008, four were suicides in males involving the inhalation of a volatile substance. Of these four deaths, three were of adults - one of whom was aged 85.
- In 2008 there were two deaths (three in 2007) associated with the inhalation of nitrous oxide, which had been obtained for non-medical purposes.
- Although, as an inert gas, helium is not a volatile substance, previous reports have provided some basic information on this gas. The number of helium-related deaths has risen since 2001, but at an increasing rate in the last two years, standing at 25 in 2008. During this period the majority (89%) of cases were suicides. The majority of deaths were among males, those aged 20-59 years, and caused by asphyxia (including plastic bag over head).

Introduction

Volatile Substance Abuse (VSA) has been a global issue for several decades according to the World Health Organisation (1993), though the substances are not usually considered to be illegal. In contrast to the situation with respect to illicit drugs, in most countries there is little or no criminal involvement in the supply of products used for VSA. Compounds such as diethyl ether, chloroform and nitrous oxide have been deliberately inhaled for recreational purposes since the early 1800s. Many of the substances which have been abused by inhalation remain in widespread use.

The first modern reports of VSA started to appear in the 1950s (Ramsey *et al*, 1989), involving petrol, glues and solvent-based thinning agents, initially in the United States, and then Western Europe, particularly Scandinavia. Volatile substance use is not automatically linked to gender, race or class, the substance abuse is often a group activity and peer-group influence may be a factor in encouraging the persistence of the practice (Flanagan *et al*, 1997). Abuse of volatile substances is an issue that can affect anyone, anywhere.

For example, research indicates that the main issues underlying volatile substance abuse for indigenous youth in inner Brisbane, Australia, include: unstable living situations, lack of involvement with school, low levels of meaningful activity and boredom, existence of a substance-using peer group, lack of belonging to a culture, and high levels of mental health concerns (Butt, 2004). The results of the 2008 National Survey on Drug Use and Health in the USA show that there was a significant decrease in the average age at first use among recent inhalant initiates aged 12 to 49 from 2007 (17.1 years) to 2008 (15.9 years) (Substance Abuse and Mental Health Services Administration, 2009). Another study conducted among young Native Indians in the USA indicates that the typical user of these substances is an adolescent male with low self-esteem and a family background of alcoholism and physical aggression (Howard *et al*, 1999). In the 2004 Canadian Addiction Survey, the majority of individuals (67%) reported first using inhalants between 12 and 16 years of age; 13% used before the age of 12 and 19% at age 17 or older (Adlaf *et al*, 2005).

In the UK there was a steady increase in VSA deaths from the early 1960s onwards, with

deaths peaking in the early 1990s at over 150 per year (Field-Smith *et al*, 2004),

Data from the Office for National Statistics reveal that the trends in prevalence and death from VSA continue to be serious substance-related issues, certainly for the younger teenage population in the UK (Harris, 2006). According to the National Advisory Committee on Drug (NACD) survey conducted in the Republic of Ireland in 2006/07, the proportion of the adult population who reported using a solvent or volatile inhalant in their lifetime was higher and more common for men than women (National Advisory Committee on Drugs and Drug and Alcohol Information and Research Unit, 2008).

The monitoring of deaths from deliberate inhalation of volatile substances is made difficult by the variety of substances abused, the various modes by which death may occur, and the lack of an appropriate code under the International Classification of Diseases (Anderson, 1990). In addition, international data collection systems on VSA vary from country to country. For example, a systematic information collection programme on inhalant-related deaths in the USA has been maintained by the North Carolina Office of the Chief Medical Examiner (Hall *et al*, 2010), another retrospective study of inhalant deaths collected information from autopsy examinations reported since 1983 by the Office of Forensic Science in South Australia (Wick *et al*, 2007).

Information on all ascertained deaths associated with VSA in the UK was systematically collected by the Division of Community Health Sciences at St. George's University of London from 1983. Research by that team demonstrated that knowledge of, and interest in, the problem had grown, and there had probably been a real increase in the number of deaths (Anderson *et al*, 1985).

Various efforts have been made to prevent solvent abuse and reduce the risk of premature death among abusers. Many of these attempts, however, do not affect the scale of the problems, the pattern of substances abused, or the risk of accidental death among those abusing volatile substances. The most notable exception was the Department of Health's advertising campaign in February 1992 aimed at parents;

this led to a fall from an all-time peak of 152 deaths in 1990 to 67 in 1994.

Last year's report noted that gas fuels continue to be associated with the majority of deaths, both for adults and children. In particular, the single product of butane gas lighter refills is responsible for over one-third of deaths and volatile substance abuse which led to death, usually in the home (Field-Smith *et al*, 2009).

This report is an annual statistical summary of data on trends in deaths associated with the deliberate inhalation of volatile substances. It has been produced by the International Centre for Drug Policy (ICDP) at St. George's, University of London, which took over responsibility for this work from 2009. Data for

deaths occurring in 2008 are analysed in this report, together with updated information for earlier years. Therefore, this report supersedes all previous ones.

There is a necessary delay of more than twelve months between the end of a calendar year and publication of the annual report. This is to allow time for details to become available from HM Coroners and from the Office for National Statistics (ONS), and the General Register Offices for Scotland and Northern Ireland.

This report is intended to inform policy-making and service provision at local and national level. It may also be of interest to health professionals, academics, and other stakeholders.

Definitions

The terms 'glue sniffing' and 'solvent abuse', which were commonly used in connection with the abuse of volatile substances, have for some years been inadequate to describe the problem, hence the adoption of the term 'Volatile Substance Abuse' or 'VSA'. Other terms widely used are 'inhalant abuse' and 'huffing'. VSA has been defined by this project since 1983 as: "the deliberate inhalation of a volatile substance (gas, aerosol propellants, solvents in glue and other solvents) to achieve a change in mental state".

Solvents are a diverse group of substances whose chemical vapours can be inhaled to produce psychoactive or mind-altering effects (National Institute on Drug Abuse. (2007). Descriptions and examples of the most commonly abused substances are given in the Appendix. Inhaled volatiles produce a similar effect to hypnotics/sedatives or ethanol with

euphoria and distortion of consciousness being experienced within seconds from a low dosage (Flanagan and Ives, 1994; Steffee *et al*, 1996). Death may occur from the direct toxic effects of the inhaled substances or from trauma. Fatalities often occur very quickly, and there is usually no opportunity to intervene medically and thus to prevent death. Mortality associated with the abuse of volatile substances is related to many factors, including the chemical nature of the substance itself, the product containing it, the method of inhalation and the prevalence of abuse.

In this report, in the context of volatile substance abuse, the term 'substance' is used to denote the generic category within which 'products' are grouped. Thus, for example, the aerosol 'substance' includes 'products' such as deodorants, air fresheners, and fly sprays.

Methods and procedures

The historic dataset includes cases where there is no direct toxicological proof, but circumstantial evidence of varying grades suggesting that these deaths were associated with volatile substance abuse. The data also include suicides where a volatile substance was deliberately inhaled. All such cases are coded accordingly so that they can be reviewed if necessary. When further cases or additional data for previous years come to notice they are added to the dataset. For example, this report

contains one additional case for both of the years 2004 and 2007. Deaths can also be removed from the dataset if subsequent information puts them outside the case criteria. In 2008, there were 38 deaths ascertained initially, but two were later excluded from analysis after receipt of autopsy and toxicological reports and discussions with relevant pathologists and forensic toxicologists.

The project employs both active and passive case-ascertainment approaches. The active approach involves: the use of press-clipping services, Google and other Internet searches of regional and national newspapers, as well as other media sources, to identify cases. Regular visits are made to the Medical Toxicology Laboratory at Guy's and St Thomas' Hospital Trust, and the Forensic Toxicology Service at St George's, University of London, and a number of coroners' offices to check their records for possible cases. For the passive approach, information on deaths associated with VSA in England and Wales is provided by HM Coroners. For Scotland, information is supplied by the Crown Office and the General Register Office for Scotland. Details of Northern Ireland deaths are provided by the State Pathologist's Department, the Coroners Service for Northern Ireland, and the Northern Ireland Statistics & Research Agency on behalf of the General Register Office for Northern Ireland. The Deputy Viscount in Jersey, HM Greffier in Guernsey, and the High Bailiff in the Isle of Man supply information for their areas. Data on 'all-cause' mortality and population estimates are supplied by the Office for National Statistics, the General Register Office for Scotland and the Northern Ireland Statistics & Research Agency.

To enable comparison with various national and international datasets all causes of death have been coded according to the International Classification of Diseases version 10. This is an international standard for the classification of diseases and health-related problems published by the World Health Organisation. The current on-line (2007) version is employed by this Project (World Health Organization, 2007).

The method of data collection used by this project has been stable and systematic since 1983. The process of confirming cause of death is undertaken by reference to the case definition criteria; each case is critically

checked against information provided by the Coroner or Procurator Fiscal, including toxicological information, autopsy reports, incident reports or witness statements, and other documents.

Information from these sources is entered into coding sheets by two separate team members and any discrepancies reconciled, before being entered into the database. Death associated with VSA in 2008 and deaths occurring in any previous years have been added to the historic dataset. All data held, whether electronic or paper, is stored securely and treated as confidential. Access is restricted to project staff; only aggregated and anonymous data are released to third parties and only with the prior written consent of the relevant data-provider.

For some analyses all deaths have been used. For examining time trends, the period of stable data collection has been used (1983-2008), whilst for others the most recent ten-year period has been employed.

This report has been produced following analysis of all available information in a cumulatively updated database. Data-cleaning for a separate research project indicated that some relevant cases had been omitted and other non-relevant cases included in the historic database. As a result, a few of the numbers for some earlier years may be different to those previously published.

All tables have been designed using uni- and bi-variate tabulation formats, and related graphs/charts have also been drawn up using these tables. Statistical analysis was undertaken using SPSS™ for Windows version 17 (based on the previous EPI Info and Stata® programs) and Stata® for Windows version 9. The presentation of complex statistical techniques has been kept to a minimum to facilitate ease of reading.

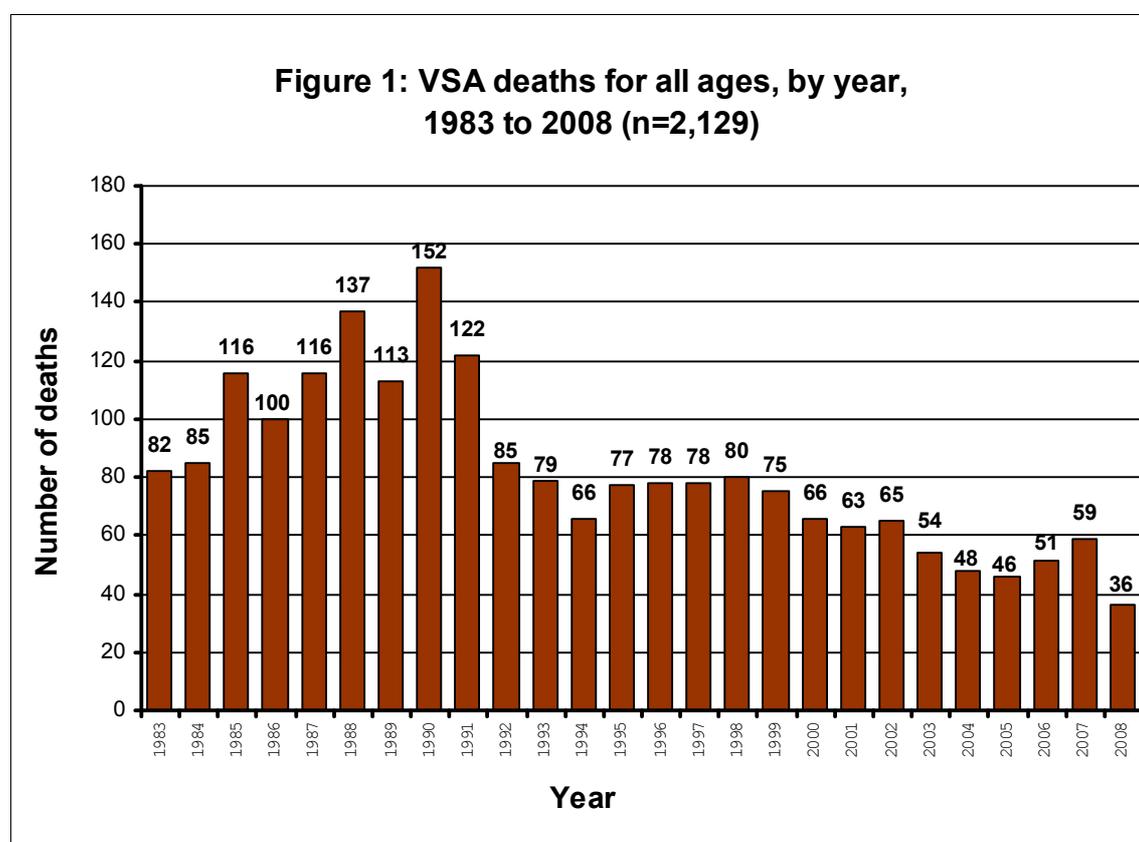
Trends in total VSA deaths

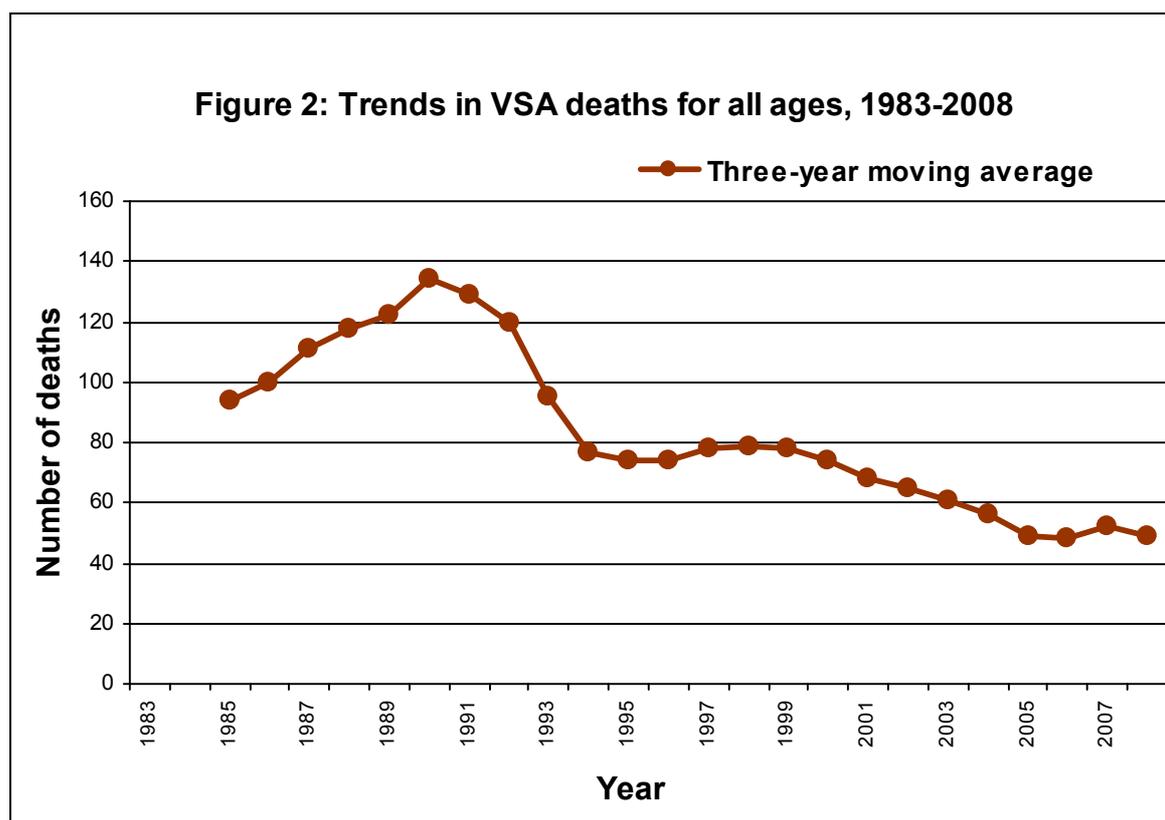
The total number of deaths between 1971 and 2008 was 2,343; during 2008 there were 36 deaths. Figure 1 gives the total number of deaths from 1983, when the methods of data collection became stable and systematic, to 2008. The Figure shows that there was a steady increase between 1985 and 1991 followed by a more gradual decline.

A commonly-used technique is 'smoothing' which, when properly applied, reveals more clearly the underlying trend. The 'moving average' method is one of these techniques, which can smooth a data-series and make it easier to spot trends. It is routinely employed with time-series data to smooth out short-term fluctuations and highlight longer-term trends. In Figure 2, the three-year moving average method was used to examine the underlying trend in VSA deaths for all ages between 1983 and 2008.

An increasing upward trend in deaths is discernible during the 1980s, followed by a sharper decline in the early 1990s. This was followed by a period of stability, with a more gradual fall from the late 1990s. The decline since the peak around 1990 reflects the impact of the publicity campaign by the Department of Health in 1992. There are no noteworthy variations between 1997 and 1999 as well as in later periods, when the average number ranges from about 50 to 75 deaths per year.

There has been a continuing programme of health education, along with personal and social education in schools, addressing the issue of volatile substance abuse. Guidance has been published on how to approach this within the National Curriculum (Department for Education and Skills, 2004; Stradling *et al*, 2009).





Death by age

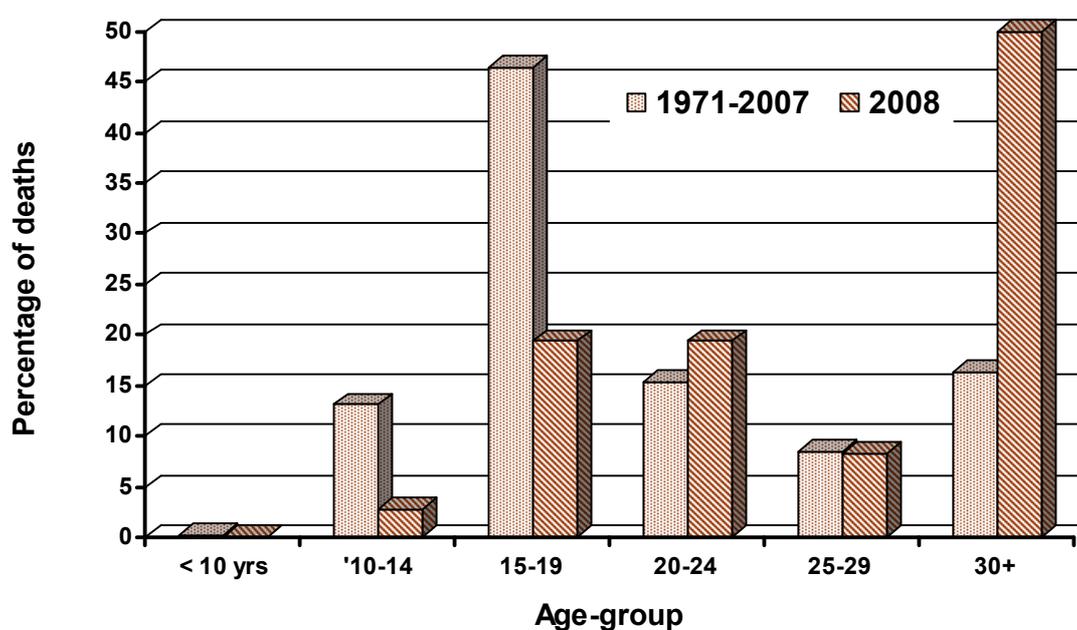
Table 1 presents the age-distribution of VSA deaths in 1971-98 and during the last 10 years. In 2008 the youngest person to die was aged 12 years and the oldest was aged 85 years. This Table also shows that the fall in deaths since 1971 was predominantly among adolescents (<15 years) with a gradual decline among older teenagers (15-19 years). Just under half (46.6%) of VSA deaths occurred in the under-20 years age-group during the early part of this decade, falling to 20% in recent times. The proportion of deaths accounted for by adults (20 years and over) remained stable until about 2005. Since that time, this proportion has increased significantly.

Changes in the age-distribution are illustrated in several ways, e.g. those aged 15-19 years

have been declining, whereas those aged 30 years or more have seen a sharp increase and those aged 25-29 years have remained stable. However, the proportion of teenagers and youths are more likely than those in other age-groups in the general population to die from abuse of volatile substances. Figure 3 shows a larger proportion of deaths among teenagers (10-14 years) and youths (15-19 years) as compared to their counterparts in both historic data (1971-2007) and in 2008. This Figure also shows a shift in the distribution of deaths towards higher age-groups, when 2008 is compared with historic data. This shift is highly statistically significant ($p < 0.001$ in the Mann-Whitney U test where all deaths were included).

Table 1: Age-distribution (%) of VSA deaths, 1971-98 and each year to 2008

Age Group (years)	Year											All 1971-08
	1971-98	99	00	01	02	03	04	05	06	07	08	
7	0.1	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.1
9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
10	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
11	0.3	1.3	0.0	0.0	1.5	0.0	0.0	2.2	0.0	0.0	0.0	0.4
12	1.3	1.3	4.5	0.0	3.1	1.9	2.1	0.0	0.0	0.0	2.8	1.4
13	3.4	1.3	0.0	3.2	7.7	0.0	4.2	0.0	0.0	0.0	0.0	3.0
14	9.4	4.0	3.0	7.9	6.2	3.7	0.0	6.5	2.0	0.0	0.0	8.0
15	14.0	5.3	9.1	7.9	9.2	1.9	10.4	4.3	5.9	0.0	0.0	12.0
16	13.9	5.3	4.5	14.3	6.2	3.7	6.3	0.0	2.0	6.8	8.3	12.0
17	10.6	14.7	4.5	6.3	3.1	5.6	4.2	4.3	3.9	6.8	2.8	9.5
18	8.2	9.3	6.1	9.5	6.2	0.0	4.2	2.2	5.9	3.4	5.6	7.6
19	5.4	0.0	9.1	6.3	4.6	5.6	6.3	2.2	2.0	1.7	2.8	5.1
20-24	15.7	13.3	16.7	12.7	15.4	24.1	10.4	17.4	7.8	13.6	19.4	15.5
25-29	7.9	13.3	9.1	6.3	6.2	14.8	2.1	19.6	11.8	13.6	8.3	8.5
30-39	5.1	16.0	21.2	14.3	16.9	27.8	31.3	23.9	35.3	35.6	27.8	9.6
40-49	2.0	9.3	4.5	6.3	6.2	5.6	8.3	4.3	11.8	10.2	11.1	3.4
50-59	1.6	1.3	6.1	3.2	6.2	3.7	8.3	8.7	5.9	3.4	5.6	2.4
60-69	0.7	1.3	0.0	1.6	1.5	0.0	2.1	4.3	3.9	1.7	0.0	0.9
70+	0.1	2.7	1.5	0.0	0.0	0.0	0.0	0.0	2.0	3.4	5.6	0.4
Total	1780	75	66	63	65	54	48	46	51	59	36	2343

Figure 3: Age-distribution of VSA deaths, 1971-2007 & 2008

Death in young people (10-19 years)

Figures 4 and 5 show the mortality rates per million populations for each year from 1999 to 2008, respectively for the 10-14 years and 15-19 years age-groups by gender. These rates were calculated by taking into account any possible changes over time in the general population. In both age-groups the mortality rates for females are generally lower than those for males. A few exceptions were observed in the 10-14 years age-group.

Table 2 presents a comparison of deaths from VSA, from drug misuse (defined as deaths where the underlying causes is poisoning, drug abuse or dependence and where any of the substance controlled under the Misuse of Drugs Act 1971 are involved), from transport accidents and from all causes among the 10-14 and 15-19 years age-groups in the UK for 2008. Mortality data for all causes, transport accidents and drug misuse are for deaths registered in 2008, whereas those for VSA are those occurring in the calendar year.

In 2008 there was only one death in the 10-14 years age-group, but at the 15-19 years age-group VSA deaths accounted for 0.5% of deaths

from all causes. In the same year, transport accidents (which are by far the most frequent cause of death), accounted for 13.7% of all deaths at age 10-14 years and 29.4% of all deaths at age 15-19 years. Deaths associated with drug misuse accounted for 1.6% of all deaths in the 10-14 years age-group and 4.7% of all deaths in the 15-19 years age-group.

Looking more closely at individual age data for England and Wales for 2000 to 2008, the ratio of VSA to drug misuse deaths appears to cross over between the ages of 14 and 15 years. In the 10-14 year age-group there were 34 VSA deaths over the nine-year period compared with 15 deaths related to drug misuse. In the same period, at age 15 years there were 28 VSA deaths and 34 deaths related to drug misuse. At age 16 years there were 29 VSA deaths and 64 deaths related to drug misuse. It should be noted that all drug misuse death numbers are collated by registration year and that in England and Wales, VSA deaths coded to ICD 10: F18 where an illicit drug is mentioned on the death record are also included in the drug-related deaths.

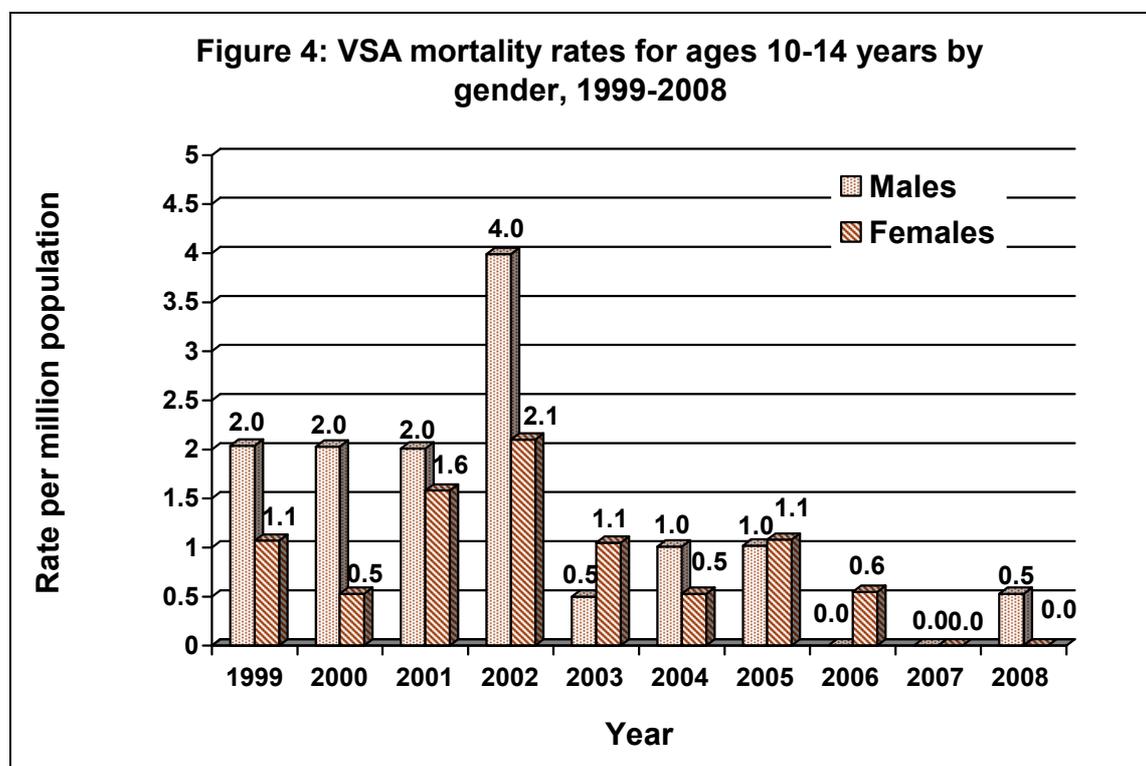


Figure 5: VSA mortality rates for ages 15-19 years by gender, 1999-2008

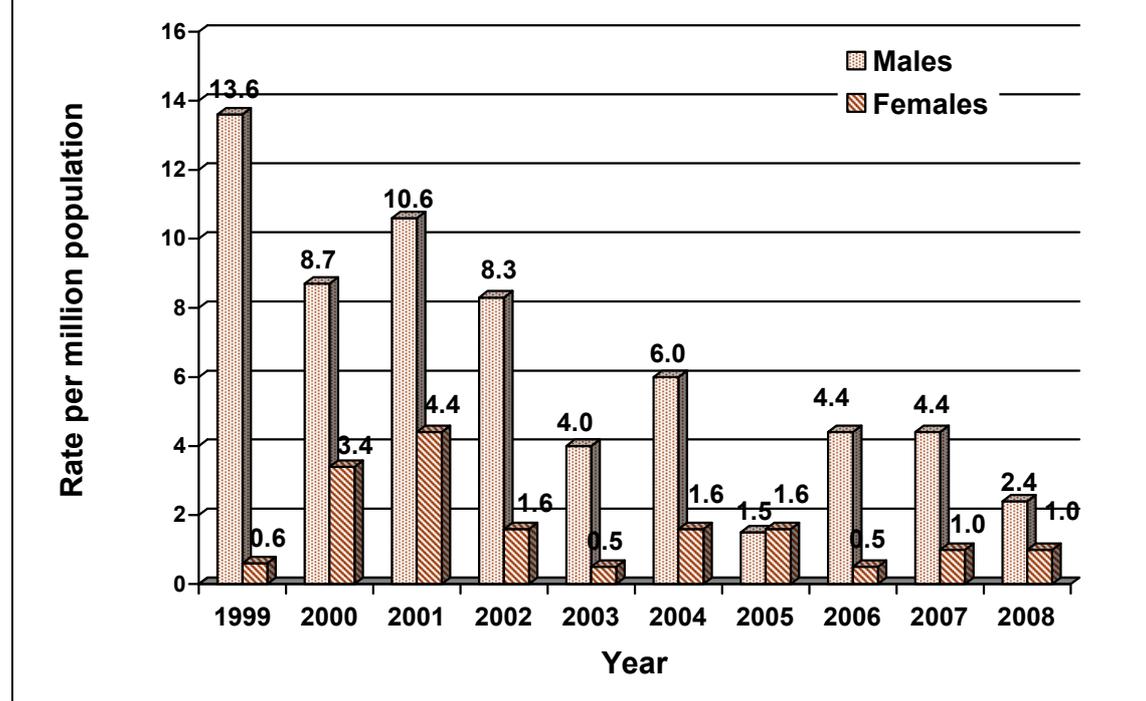


Table 2: Number of deaths in the UK for the 10-14 and 15-19 years age-groups, by cause of death, 2008

Cause of death	Age (years)			
	10-14		15-19	
	No.	% of all causes	No.	% of all causes
All causes*				
Male	218	57.5	955	69.0
Female	161	42.5	430	31.1
Total	379	100.0	1385	100.0
Transport accidents*				
Male	34	15.6	307	32.2
Female	18	11.2	100	23.3
Total	52	13.7	407	29.4
Drug misuse**§				
Total	6	1.6	65	4.7
Volatile Substance Abuse				
Male	1	0.5	5	0.5
Female	0	0.0	2	0.5
Total	1	0.3	7	0.5

* Deaths registered in 2008. § Data on drug misuse by gender were not available.

Sources of data for death from all causes, transport accidents and drug misuse:

England and Wales: Office for National Statistics
 Scotland: General Register Office for Scotland
 Northern Ireland: Northern Ireland Statistics and Research Agency for GRONI

Death by gender

Table 3 shows the gender-distribution of deaths associated with volatile substances. In 2008 only two female deaths were recorded (6%) while male deaths numbered 34 (94%). Over the past ten years males have accounted for an average of 85% of deaths across all age-groups. There have been slight year-to-year fluctuations in this proportion.

Figures 6 and 7 shows the percentage of deaths among males and females aged under 18 years and in persons aged 18 years and over respectively, for 1971-1998 and each year to 2008. In 2008 there were five deaths (two female) in the under-18 year age-group (Figure 6); there were 31 deaths (all male) in the 18 years and over age-group (Figure 7).

To compare the difference in proportions of males and females in the two age-groups, a statistical test was employed (Chi-square test) which shows marked gender differences ($X^2=17.1$, 1df, $p<0.001$) in both those aged under-18 and aged 18 and above. Again, over time there have also been significant differences in gender for both those aged

under 18 years and for those aged 18 years and over. This shows a significantly lower proportion of females to males were observed over time in both age-groups.

Figure 5 shows a higher percentage of deaths for males compared to a lower percentage for female. A survey of secondary schoolchildren aged 11-15 years in England in 2008 was carried out for the National Centre for Social Research and the National Foundation for Educational Research. This found that 4.8% of male pupils in this age-range used volatile substances in the 12 months prior to the survey compared to 5.2% of female pupils (Fuller, 2009). The European School Survey Project on Alcohol and other Drugs (ESPAD) 2007 found that there was no gender difference in lifetime inhalant use among 16-year olds in the majority of countries surveyed, although a gender difference was evident for the UK (Hibell *et al*, 2009). Although there is greater use of volatile substances by girls, the number of deaths is higher amongst boys. This indicates that boys are at higher risk of dying from VSA.

Table 3: Gender-distribution of VSA deaths, 1971-1998 & each year to 2008

Year	Gender					
	Male		Female		All persons	
	No.	%	No.	%	No.	%
1971-98	1547	86.9	233	13.1	1780	100.0
1999	67	89.3	8	10.7	75	100.0
2000	54	81.8	12	18.2	66	100.0
2001	49	77.8	14	22.2	63	100.0
2002	49	75.4	16	24.6	65	100.0
2003	39	72.2	15	27.8	54	100.0
2004	39	81.3	9	18.8	48	100.0
2005	35	76.1	11	23.9	46	100.0
2006	38	74.5	13	25.5	51	100.0
2007	49	83.1	10	16.9	59	100.0
2008	34	94.4	2	5.6	36	100.0
Total	2000	85.4	343	14.6	2343	100.0

Figure 6: Gender-distribution of VSA deaths by age (<18 years), 1971-98 and each year to 2008

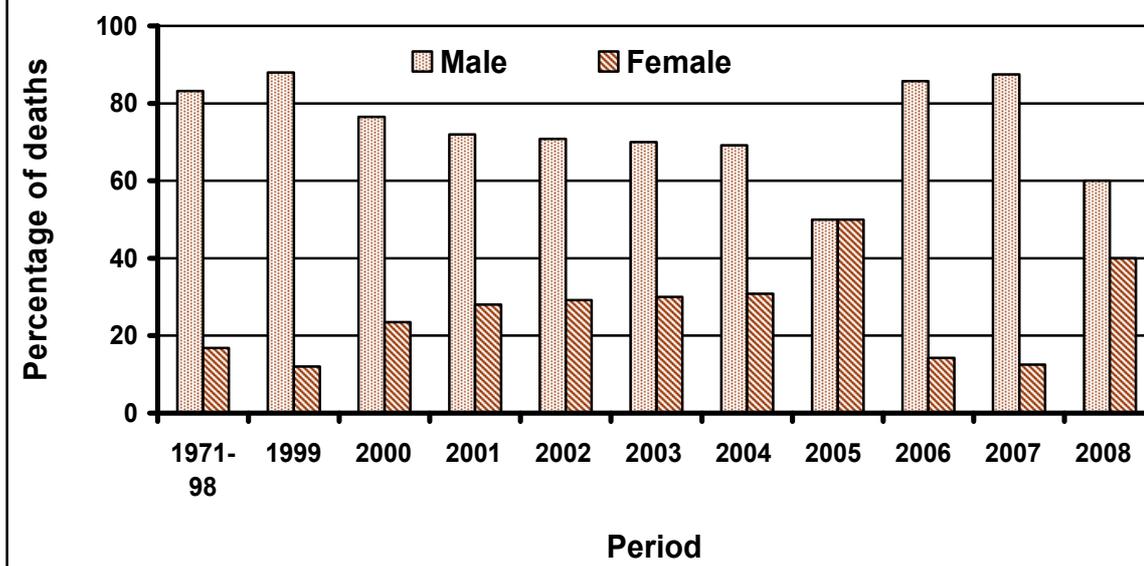
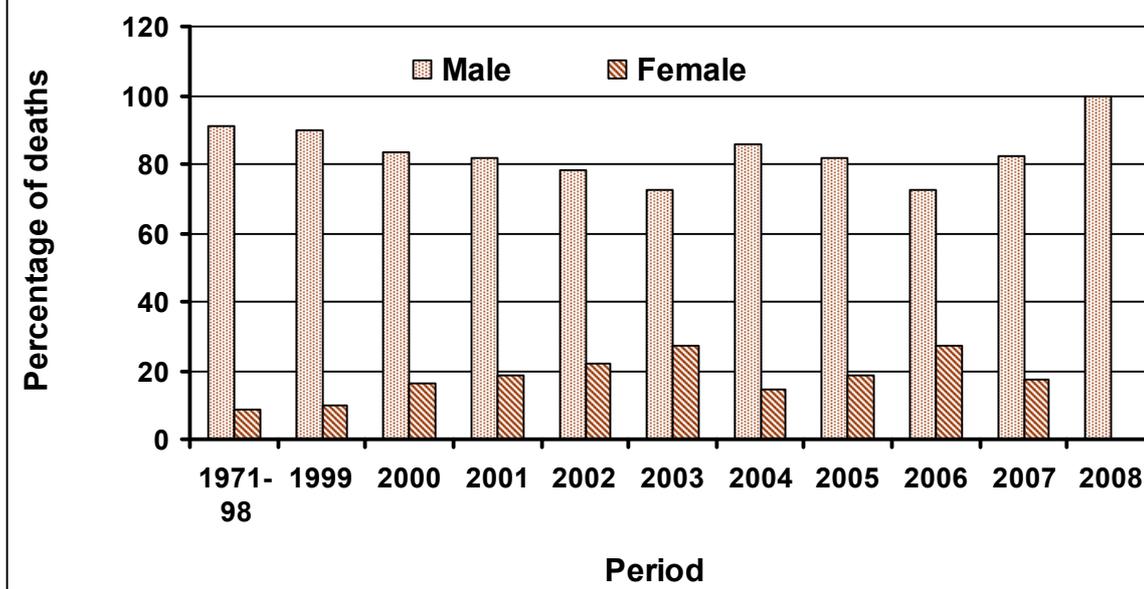


Figure 7: Gender-distribution of VSA deaths by age (18+ years), 1971-98 and each year to 2008



Regional variation

Table 4 shows the numbers of deaths by country and by Government Office Region in England. In 2008, there were 29 deaths in England, two in both Wales and Northern Ireland, and three deaths in Scotland. There were no deaths in the Channel Islands or Isle of Man.

Table 5 and Figure 9 give the Standardised Mortality Ratios (SMRs) for each Region and country averaged across the period 1999-2008. SMRs are used to compare geographical areas taking account of any differences in the age- and gender-distribution of the population. The whole of the UK has an average SMR of 100. Countries and regions where the SMR is

higher than 100 have more deaths than expected and those where the SMR is less than 100 have lower deaths than expected.

SMRs differ significantly across countries and Government Office Regions ($P < 0.001$ with 11 df.). For the period 1999-2008 Northern Ireland had the highest SMR (193) and North West England had the lowest SMR (70). In general, there were more deaths than expected in Northern Ireland, Scotland, Wales, North East, Yorkshire and Humber, and the East and West Midlands. London, South East and South West exhibited lower death rates than expected.

Table 4: Number of VSA deaths by Government Office Region (England) and Country, 1971-98 and each year to 2008

Region or Country	Year											Total
	71-98	99	00	01	02	03	04	05	06	07	08	
England:												
North East	112	7	3	3	6	4	1	2	2	3	1	144
North West	236	6	10	4	4	5	6	1	3	2	4	281
Yorkshire/Humber	167	5	5	10	7	4	6	4	4	5	3	220
East Midlands	115	6	5	9	5	3	7	6	4	6	2	168
West Midlands	156	7	7	5	10	5	3	3	5	7	5	213
East	113	4	7	5	2	4	4	4	5	5	2	155
London	216	7	4	6	2	8	6	8	4	5	5	271
South East	179	4	7	4	10	8	5	7	5	8	4	241
South West	102	8	4	3	5	1	3	1	2	3	3	135
Total England	1396	54	52	49	51	42	41	36	34	44	29	1828
WALES	70	7	1	1	5	1	4	1	5	2	2	99
SCOTLAND	242	8	9	9	8	6	1	4	9	10	3	309
N. IRELAND	64	6	2	4	1	5	2	5	3	3	2	97
CHANNEL ISLANDS	6	0	1	0	0	0	0	0	0	0	0	7
ISLE OF MAN	2	0	1	0	0	0	0	0	0	0	0	3
Total UK and Island	1780	75	66	63	65	54	48	46	51	59	36	2343

Table 5: Standardised Mortality Ratios for Govt. Office Region (England) and Country, adjusted for age and gender, 1999-2008

Region or Country	Deaths		SMR	95% confidence interval
	Observed	Expected		
ENGLAND				
North East	32	23.8	135	92 to 190
North West	45	64.0	70	51 to 94
Yorkshire/Humber	53	47.6	111	83 to 146
East Midlands	53	39.9	133	100 to 177
West Midlands	57	50.0	114	86 to 148
East	42	50.0	84	60 to 113
London	55	77.1	71	54 to 93
South East	62	75.0	83	63 to 106
South West	33	44.8	74	51 to 144
Total England	432	472.1	92	
WALES	29	26.7	109	73 to 156
SCOTLAND	67	47.1	142	110 to 181
N. IRELAND	33	17.1	193	133 to 271
Total UK*	561	561	100	

Crude Mortality Rates per million population per year	Male = 1.55	Female = 0.36	All persons = 0.94
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* Channel Isles and Isle of Man are not included

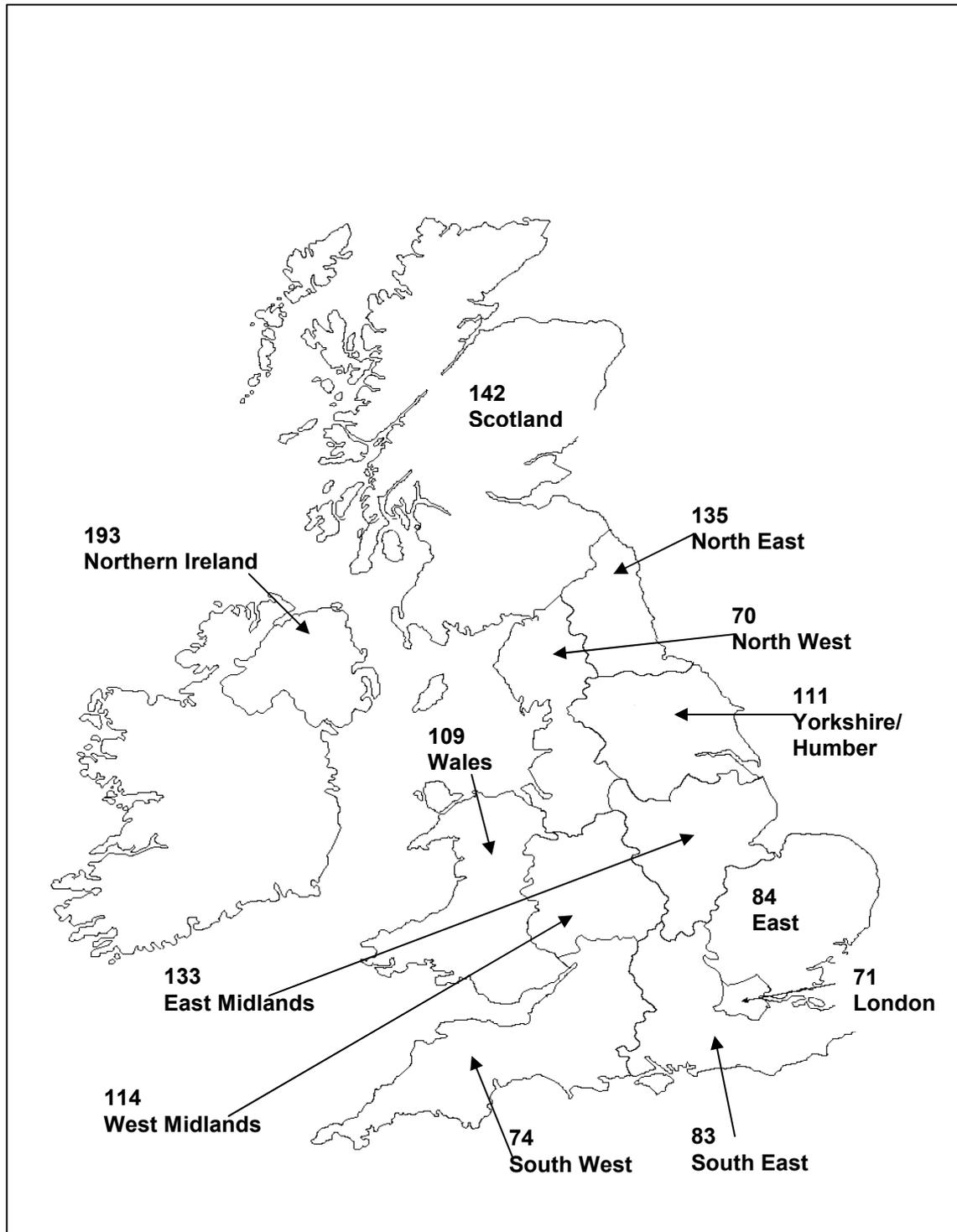
Sources of population data (Average of censuses updated mid-year estimates for 2003 and 2004)

England and Wales: Office for National Statistics

Scotland: General Register Office for Scotland

Northern Ireland: Northern Ireland Statistics and Research Agency for GRONI

Figure 8: Standardised Mortality Ratios for Govt. Office Region (England) and Country, adjusted for age and gender, 1999-2008



Substances abused

The main substances abused by all age-groups between 1999 and 2008 are shown in Table 6. Butane intended for fuel use and butane used as a propellant in aerosols are classified separately. The highest proportion of deaths is associated with only one volatile substance - butane. In 12 (2%) deaths over this 10-year period, two volatile substances in combination were known to be involved. Table 6 and Figure 9 show the number of times each substance was associated with death.

Over the time-period 1971 to 2008 there was a notable change in the proportions of specific substances abused. In 2008 the total number of cases associated with gas fuels was 26, lower than in any of the previous nine years (even

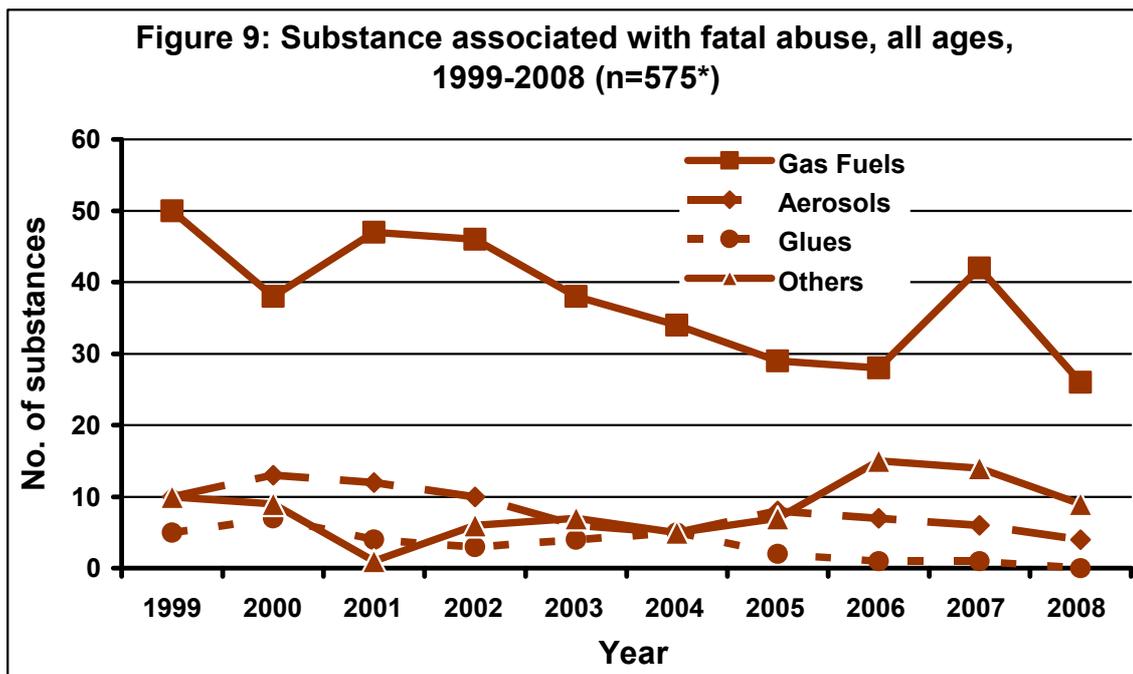
taking into account a fall in the absolute number of such deaths between 2007 (41 deaths) and 2008 (23 fatalities). The declines in aerosol-related deaths in recent years and declines in glue-related deaths over time are more pronounced.

Figure 10 gives the same information for those aged less than 18 years for the number of times each substance was associated with death. Changes in the proportion of substances abused in this age-group are also notable, with marked fluctuations observed in different periods between 1999 and 2008. In 2008 deaths associated with gas fuels sharply declined as compared to 2007; whereas deaths associated with aerosols moved in the opposite direction.

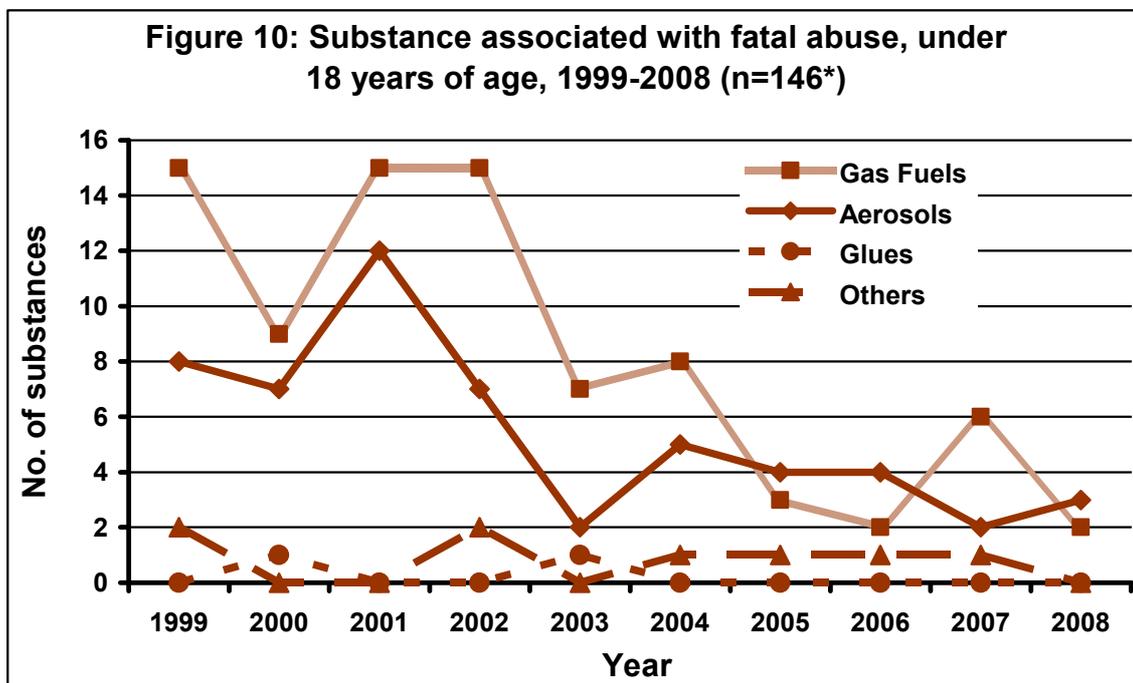
Table 6: Substance abused, all ages, each year 1999 to 2008 (n=2454*)

Substance	Year											Total
	1971 - 98	99	00	01	02	03	04	05	06	07	08	
Gas fuels	795	50	38	47	46	38	34	29	28	42	26	1173
%	42.3	66.7	56.7	72.3	70.8	69.1	69.4	63.0	54.9	66.7	66.7	47.8
Aerosols	346	10	13	12	10	6	5	8	7	6	4	428
%	18.4	13.3	19.4	18.5	15.4	10.9	10.2	17.4	13.7	9.5	10.3	17.4
Glues	318	5	7	4	3	4	5	2	1	1	0	350
%	16.9	6.7	10.4	6.2	4.6	7.3	10.2	4.3	2.0	1.6	0.0	14.3
Other	351	9	8	1	6	7	5	7	15	12	8	438
%	18.7	12.0	11.9	1.5	9.2	12.7	10.2	15.2	29.4	19.0	20.5	17.5
Fire Extinguishers	57	1	0	0	0	0	0	0	0	0	0	58
%	3.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Not known	12	0	1	0	0	0	0	0	0	1	1	15
%	0.6	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.6	0.6
All substances	1879	75	67	65	65	55	49	46	51	63	39	2454

* Number of substances is greater than the number of deaths as all substances associated with a death are included.



* All substances associated with a death are included.



* All substances associated with a death are included.

Products abused

Table 7 shows products abused by substance for 2008. This also gives the type of products implicated in death, showing them as percentages of substances used, rather than as percentages of the total number of deaths. There were no multiple product fatalities in 2008. However, in previous years there were some instances of more than one product being involved and thus deaths can appear more than once in the table. Butane gas lighter fuel was associated with 25% of all substances fatally abused in 2008. In addition, unspecified butane (including butane gas can), some of which is likely to have been lighter fuel, accounted for another 23% of all substances in the same year.

In 2008 there were two deaths (four in 2007) associated with the inhalation of anaesthetic agents. Both cases involved nitrous oxide, supplied for non-medical use as cylinders or as caplets designed to be employed with cream-whipping devices, and were the result of asphyxiation where the nitrous oxide had been inhaled using a plastic bag over the head. The supply, other than by a registered pharmacist, of nitrous oxide for inhalation is an offence under Section 52 of the Medicines Act 1968. In addition two deaths were associated with the inhalation of chloroform and three deaths involved the inhalation of alkyl nitrites ('poppers'). The supply of chloroform and one form of alkyl nitrite, isobutyl nitrite, is now controlled by legislation, The Dangerous Substances and Preparations (Safety) Regulations 2006, which came into full effect in August 2007. In 2008 there was one death involving the use of paint thinner but none involving the use of products like insect spray or petrol (while there was one for each category in 2007).

Table 8 gives similar information for the period 1971 to 2008. This shows the wide variety of products that has been abused within the broad substance categories. Since 1971, butane gas lighter fuel has been associated with a little higher than 80% of fatal abuses of gas fuel, and

38% of all substances fatally abused. Deodorants and anti-perspirants have been associated with 46% of fatal abuses of aerosols, and 8% of all substances, and contact adhesives with 54% of fatal abuses of glue, also 8% of all substances. Since 1995 there have been no deaths from text-correction fluid or pain-relief sprays and only one death from a fire extinguisher (involving an old product).

Table 9 shows deaths associated with butane cigarette lighter refills in the time-period 1971-1998 and for each year from 1999 to 2008 by gender for those aged under-18 years of age. Amongst those in this age-group, there were two deaths in 2008, compared with 3 in 2007 and 2 in both 2006 and 2005. Legislation which banned the sale of these items to under-18 year olds came into effect in October 1999 [The Cigarette Lighter Refill (Safety) Regulations 1999]. In this age-group the number of deaths associated with lighter fuel fell from an average of 18 per year between 1991 and 1999 to 7 per year between 2000 and 2008. The difference between these two periods is statistically significant ($X^2=21.6$, 1df, $p<0.001$). About two-thirds (61%) of the fall in deaths occurred after the coming into force of these regulatory provisions. These changes provide evidence to suggest that the change in legislation had some beneficial impact. However, detailed analysis will be needed to evaluate the impact of changes in legislation over time.

The coming into force of a European Union Directive (2005/95/EC) which restricted the use of toluene and trichlorobenzene in products harmful to man and the environment on 15 December 2006, together with the introduction of the first phase of provisions on 1 January 2007 of the Volatile Organic Compounds (VOCs) in Paints, Varnishes and Vehicle Refinishing Products Regulations 2005 may have contributed to the low level in recent years of deaths involving the deliberate inhalation of products containing these substances.

Table 7: Substance abused, by product, 2008 (n=36*)

Substance and product	No.	% of substance group	% of all substances
GAS FUELS			
Lighter fuel	9	42.8	25.0
Calor gas/domestic gas	3	14.3	8.3
Propane	1	4.8	2.8
Butane gas can	1	4.8	2.8
Butane unspecified	7	33.3	19.4
TOTAL OF GAS FUELS	21	100.0	58.3
AEROSOLS			
Deodorant	5	100.0	13.9
TOTAL OF AEROSOLS	5	100.0	13.9
OTHER			
Chloroform	2	25.0	5.6
Alkyl nitrites	3	37.5	8.3
Paint thinners	1	12.5	2.7
Nitrous oxide (anaesthetic)	2	25.0	5.6
Total of Other	8	100.0	22.2
Substance not known	2	100.0	5.6
All Substances	36	-	100.0

* No multiple substances associated with a death

Table 8: Substance abused, by product, 1971-2008 (n=2,446)

Substance and product	No.	% of substance group	% of all substances
Lighter fuel	940	80.4	38.4
Calor gas/domestic Gas	113	9.7	4.6
Propane	37	3.2	1.5
Acetylene	3	0.3	0.1
Butane gas can	45	3.8	1.8
Butane Unspecified	31	2.7	1.3
TOTAL OF GAS FUELS	1169	100.0	47.8
Deodorant	200	46.3	8.2
Pain relief spray	63	14.6	2.6
Air freshener	51	11.8	2.1
Hair spray	33	7.6	1.3
Cleaning fluid	17	3.9	0.7
Fly spray	8	1.9	0.3
Paint spray	8	1.9	0.3
Aerosol glue	2	0.5	0.1
Other aerosols	50	11.6	2.0
TOTAL OF AEROSOLS	432	100.0	17.7
Contact adhesive	186	53.8	7.6
Puncture repair glue	11	3.2	0.4
Model glue	3	0.9	0.1
Other glues	146	42.2	6.0
TOTAL OF GLUES	346	100.0	14.1
Typewriter correction fluid	112	26.4	4.6
Chloroform	40	9.4	1.6
Unspecified trichloroethylene	38	8.9	1.6
Petrol	38	8.9	1.6
Paint thinners	15	3.5	0.6
Domestic cleaner-unspecified	19	4.5	0.8
Industrial solvent	18	4.2	0.7
Carbon tetrachloride	12	2.8	0.5
Nitromors paint stripper	6	1.4	0.2
Alkyl nitrites	21	4.9	0.9
Refrigerant gases	5	1.2	0.2
Ether	5	1.2	0.2
Benzene	1	0.2	0.0
Nitrous oxide (anaesthetic)	47	11.1	1.9
Misc other	48	11.3	2.0
TOTAL OF OTHERS	425	100.0	17.4
Fire Extinguishers	58	100.0	2.4
Substance not known	16	100.0	0.7
TOTAL OF ALL SUBSTANCES	2446	100.0	100.0

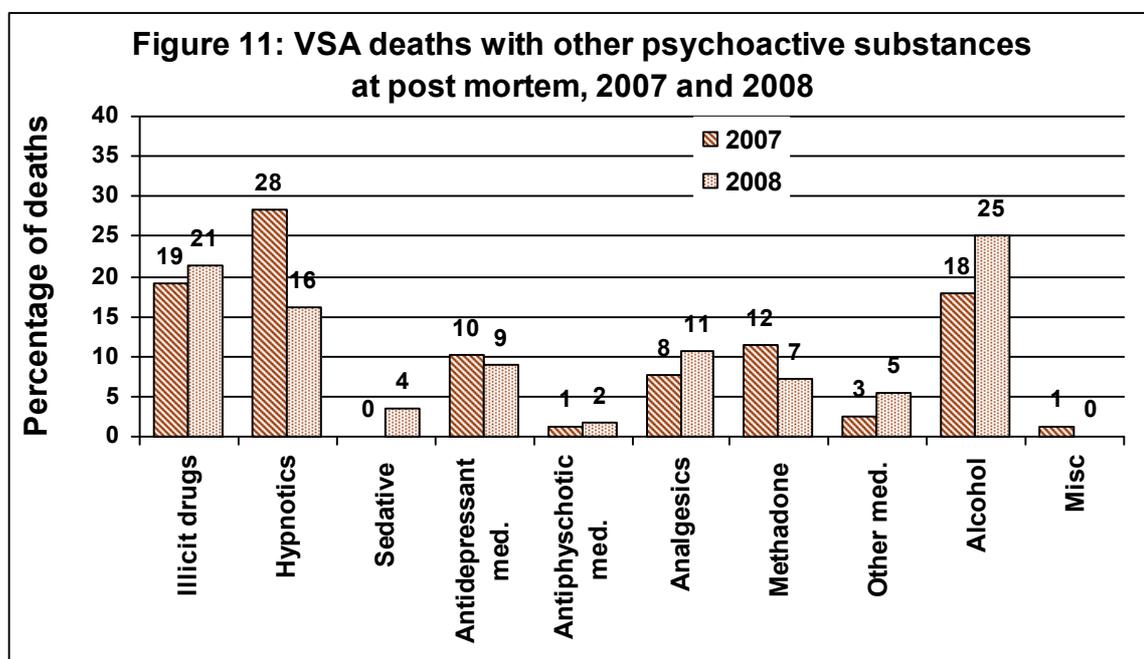
Table 9: Deaths associated with cigarette lighter refills, 1971-1998 and each year to 2008

Gender	Year											Total
	71-98	99	00	01	02	03	04	05	06	07	08	
Male	318	15	7	12	13	4	6	1	2	2	2	382
Female	59	0	1	3	2	2	2	1	0	1	0	71
All persons	377	15	8	15	15	6	8	2	2	3	2	453
VSA deaths (All)	949	25	17	25	24	10	13	8	7	8	5	1091
% all VSA deaths	39.7	60.0	47.1	60.0	62.5	60.0	61.5	25.0	28.6	37.5	40.0	41.5

Other psychoactive substances associated with VSA deaths

Figure 11 shows that other psychoactive substances, including alcohol, were also present in the post mortem toxicology of VSA fatalities. This does not mean that they necessarily caused, or contributed to, death. Drugs were mentioned in 25 (69%) cases in 2008 and 34 (58%) cases in 2007. In 2008, alcohol (as a sole additional substance) was recorded in 25% of cases, followed by illicit drugs (21%) and hypnotic drugs (16%). On the other hand, hypnotics/sedatives such as

benzodiazepines as sole additional substances were mentioned in 28% of cases in 2007, followed by illicit drugs (19%) and alcohol (18%). The presence of methadone was also evident in both years: 12% in 2007, and 7% in 2008. These findings underline the continuing emergence of polysubstance abuse. Combining the use of psychoactive substances increases the risk of overdose and death (Ghodse *et al*, 2009).



Method of administration

Methods of administration of volatile substances are given in Tables 10; Table 11 gives this information by product. Over the last ten years, the highest proportion of deaths occurred after substances were discharged directly into the mouth, followed by substances sniffed from plastic bags. The predominant method of abuse of butane lighter refills is believed to be by discharge directly into the

mouth. In the absence of evidence to the contrary, lighter fuel abuse has been coded to this method. The most common method of administration for aerosols has been by spraying through a cloth, and for glues has been by inhalation of the fumes or vapours from plastic bags.

Table 10: Methods of administration of main substances, 1971-1998 and each year to 2008

Method	Period											Total
	1971-98	99	00	01	02	03	04	05	06	07	08	
Directly into mouth	488	30	31	40	34	34	25	18	27	31	20	778
Sniffed from container	128	4	4	1	7	6	5	4	2	3	2	166
Sniffed from cloth or sleeve	182	3	5	7	8	4	2	3	4	2	5	225
Sniffed from plastic bag	284	9	3	3	3	1	2	0	1	0	2	308
Plastic bag over head	197	8	10	3	7	5	10	12	13	15	2	282
Mask or padding over face	44	3	2	2	1	1	3	5	3	7	3	74
Other	23	1	0	0	0	0	0	0	0	0	1	25
Not known	434	17	11	7	5	3	1	4	1	1	1	485
Total	1780	75	66	63	65	54	48	46	51	59	36	2343

Table 11: Methods of administration of main substances, by product, 1971-1998 and each year to 2008 (n=2343)

Substance and method	Period											Total
	1971-98	99	00	01	02	03	04	05	06	07	08	
Gas fuels												
Directly into mouth	423	29	31	40	34	33	25	15	22	30	19	701
Sniffed from container	24	1	2	1	2	0	1	1	0	0	1	23
Sniffed from cloth or sleeves	13	0	0	0	1	0	0	0	0	1	0	15
Sniffed from plastic bag	40	2	1	0	0	0	1	0	0	0	1	45
Plastic bag over head	83	5	3	3	6	4	5	8	5	10	0	132
Mask or padding over face	14	2	0	1	1	0	1	3	1	0	0	23
Other	9	1	0	0	0	0	0	0	0	0	1	11
Not known	175	10	1	1	2	1	1	2	0	0	1	194
Total for gas fuels	781	50	38	46	46	38	34	29	28	41	23	1154
Aerosols												
Directly into mouth	40	1	0	0	0	1	0	3	4	1	1	51
Sniffed from container	10	0	1	0	1	2	0	0	0	0	1	15
Sniffed from cloth or sleeves	71	1	5	7	6	1	2	3	2	1	2	101
Sniffed from plastic bag	62	3	0	2	1	0	1	0	1	0	0	70
Plastic bag over head	33	2	3	0	0	0	1	1	0	3	0	43
Mask or padding over face	10	0	0	0	0	0	0	0	0	0	0	10
Other	2	0	0	0	0	0	0	0	0	0	0	2
Not known	83	3	4	3	2	1	0	1	0	0	0	97
Total for aerosols	311	10	13	12	10	5	4	8	7	5	4	389
Glues												
Directly into mouth	6	0	0	0	0	0	0	0	0	0	0	6
Sniffed from container	13	2	1	0	1	1	2	1	0	0	0	21
Sniffed from cloth or sleeves	3	0	0	0	0	0	0	0	0	0	0	3
Sniffed from plastic bag	146	2	1	1	2	1	0	0	0	0	0	153
Plastic bag over head	44	0	1	0	0	0	3	0	0	0	0	48
Mask or padding over face	6	0	0	0	0	1	0	0	0	0	0	7
Other	1	0	0	0	0	0	0	0	0	0	0	1
Not known	76	1	3	3	0	1	0	1	1	0	0	86
Total for glues	295	5	6	4	3	4	5	2	1	0	0	325
Others												
Directly into mouth	19	0	0	0	0	0	0	0	1	0	0	20
Sniffed from container	81	1	0	0	3	3	2	2	2	3	0	97
Sniffed from cloth or sleeves	95	2	0	0	1	3	0	0	2	0	3	106
Sniffed from plastic bag	36	2	1	0	0	0	0	0	0	0	1	40
Plastic bag over head	37	1	3	0	1	1	1	3	8	2	2	59
Mask or padding over face	14	1	2	1	0	0	2	2	2	7	3	34
Other	11	0	0	0	0	0	0	0	0	0	0	11
Not known	100	3	3	0	1	0	0	0	0	1	0	108
Total for others	393	10	9	1	6	7	5	7	15	13	9	475

Note: Other includes fire extinguisher and substance not known

Mechanism of death

VSA causes death either as a result of a direct toxic mechanism or as a result of other indirect mechanisms including plastic bag asphyxia, inhalation or aspiration of stomach contents, and trauma. Where there is a possibility of an indirect mechanism this is given priority, otherwise the death is recorded as due to 'direct toxic effects'.

Table 12 and Figure 12 show the numbers of deaths due to each mechanism. The majority of

deaths (71% overall and 81% in 2008) are due to direct toxic effects. Between 2004 and 2006 there was an increase in the proportion of deaths associated with asphyxiation, mainly by plastic bag, followed by a decrease. The proportion of trauma deaths, which historically were more common with the abuse of glue, has largely decreased over time, from an average of 7% (1999-2003) to an average of 3% (2004-2008).

Table 12: Principal mechanism of death for all ages, 1999-2008

Mechanism	Year										Total
	99	00	01	02	03	04	05	06	07	08	
Direct toxic effect %	51 68.0	40 60.6	48 76.2	44 67.7	43 79.6	32 66.7	30 65.2	38 74.5	44 74.6	29 80.6	399 70.9
Asphyxia-mainly plastic bag %	6 8.0	8 12.1	2 3.2	6 9.2	2 3.7	9 18.8	8 17.4	11 21.6	10 16.9	5 13.9	67 11.9
Inhalation of vomit %	8 10.7	6 9.1	10 15.9	9 13.8	6 11.1	5 10.4	3 6.5	1 2.0	2 3.4	0 0.0	50 8.9
Trauma %	6 8.0	9 13.6	3 4.8	3 4.6	1 1.9	1 2.1	4 8.7	1 2.0	1 1.7	0 0.0	29 5.2
Other %	0 0.0	1 1.5	0 0.0	0 0.0	0 0.0	1 2.1	1 2.2	0 0.0	1 1.7	1 2.8	5 0.9
Not known %	4 5.3	2 1.5	0 0.0	3 0.0	2 0.0	0 0.0	0 0.0	0 0.0	1 0.0	1 2.8	13 2.3
Total	75	66	63	65	54	48	46	51	59	36	563

Previous history of solvent abuse

In 2008, for 16 of the 36 VSA deaths (44%) there was evidence of a previous history of solvent abuse; for the remaining 56%, there was no evidence of previous volatile substance abuse, or the history was unknown. However,

an absence of evidence should not lead to the assumption that death occurred on the first occasion, as this fact is often difficult to establish.

Place of fatal abuse and death

Figure 13 shows where the fatal abuse leading to death took place. In 2008 the most common place for abuse remained the abuser's home (86%), followed by 8% of abuses in a public place such as a park, shopping centre or the street; place of work. Abuse in other places accounted for 6%. There were no deaths at

the home of a friend.

Figure 14 shows the place of fatal abuse by gender for the period 1999-2008. There was a weak statistically significant difference between males and females in the place of fatal abuse ($X^2=7.3$, 6 df, $p<0.10$).

Figure 12: Principal mechanism of VSA death for all ages, 1999-2008

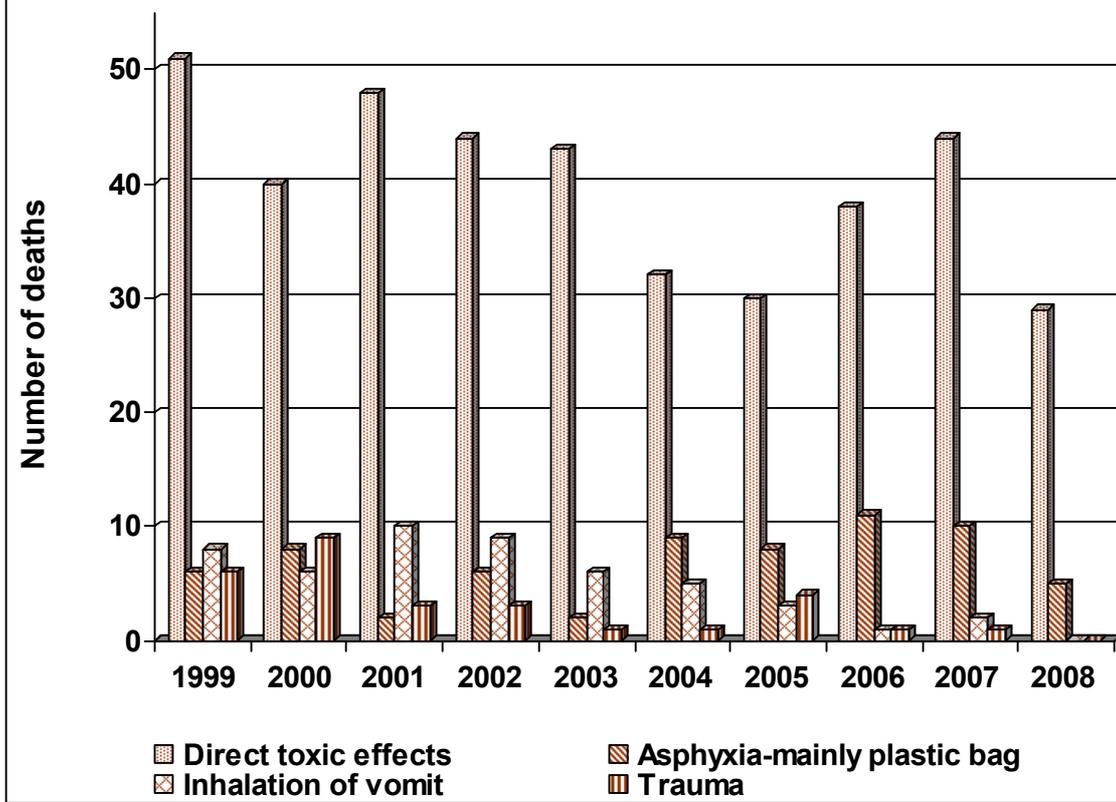
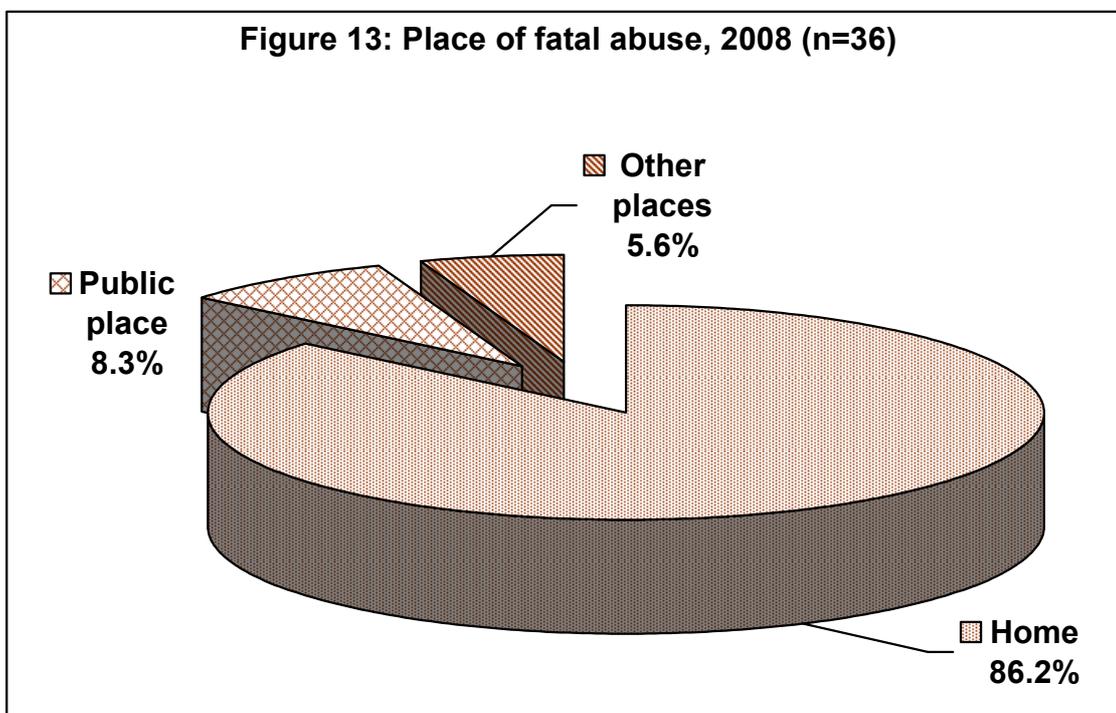
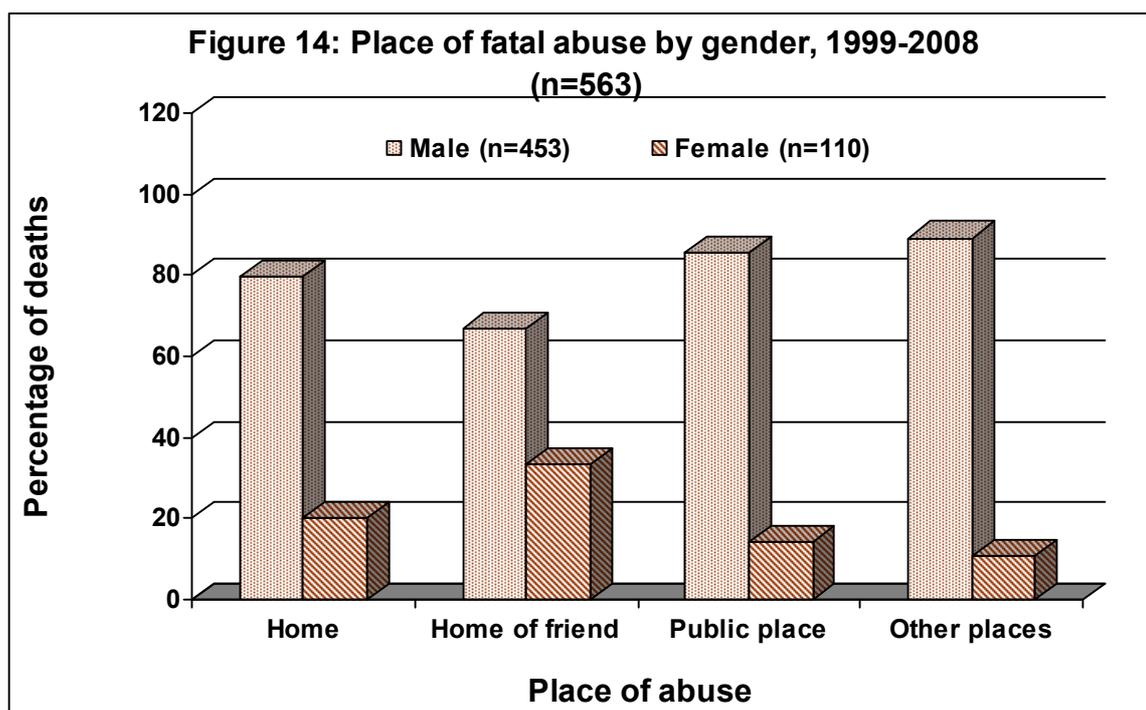


Figure 13: Place of fatal abuse, 2008 (n=36)



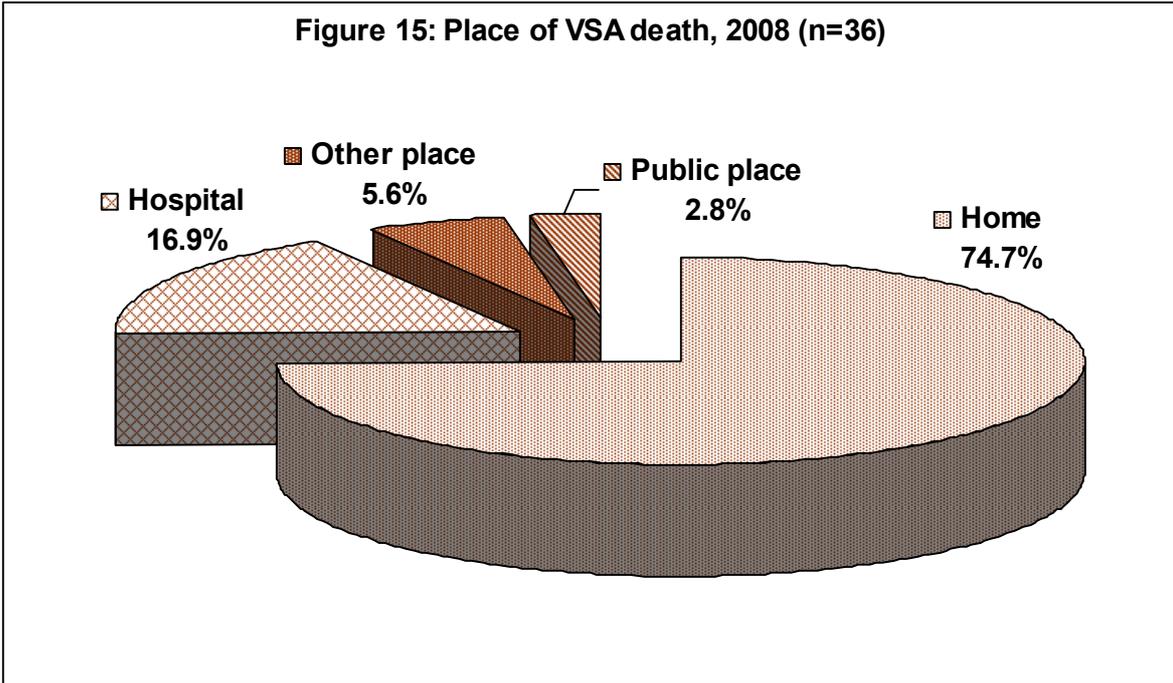


The relationship between age and place of fatal abuse is shown in Table 13. Looking at the last ten years, the most common place of fatal abuse was the person's home or the home of a friend. This proportion for the age less than 18 years dying at home or the home of a friend was 61% and for the 18 years and over was 82%.

Figure 15 shows the place of VSA death in 2008. Three-quarters (75%) of deaths occurred at home and 17% of deaths were recorded as having occurred in hospital, or as 'dead on arrival' at hospital. There was no death in the home of a friend.

Table 13: Place of fatal abuse by age-group, 1999-2008

Age-group (Year)	Place of abuse								Total
	Home		Home of friend		Public place		Other places		
	No.	%	No.	%	No.	%	No.	%	
< 10	1	100.0	0	0.0	0	0.0	0	0.0	1
10-14	18	42.9	3	7.1	20	47.6	1	2.4	42
15-19	87	56.9	15	9.8	42	27.5	9	5.9	153
20-24	63	75.0	6	7.1	12	14.3	3	3.6	84
25-44	176	79.6	8	3.6	27	12.2	10	4.5	221
45+	53	85.5	1	1.6	3	4.8	5	8.1	62
< 18	72	50.7	15	10.6	50	35.2	5	3.5	142
18+	326	77.4	18	4.3	53	12.8	23	5.5	421
All ages	398	70.0	33	5.9	104	18.5	28	5.0	563



Suicide

Information on deaths since 1999 associated with the inhalation of a volatile substance where there was an inquest verdict or Procurator Fiscal finding of suicide is provided in this report. It is sometimes difficult to establish for suicides, particularly where no 'suicide note' is left (or found), what influence the inhalation of a volatile substance had on the actions of the deceased. The use of a volatile substance in combination with a plastic

bag over the head often results in death by asphyxiation, which may be the intended result. However, it has be remembered that plastic bags can also be used to heighten sexual experience and thus death may be the result of an accident arising from impaired judgement due to lack of oxygen and/or the effects of psychoactive (including volatile) substances.

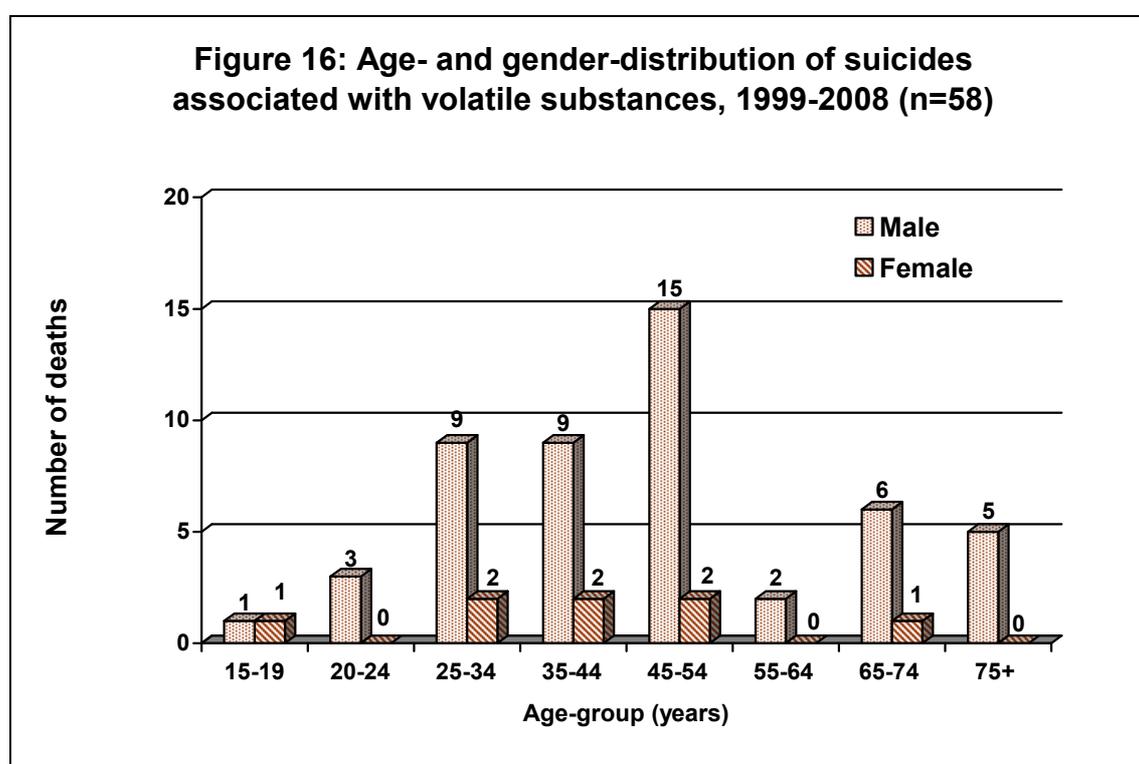
Table 14: Number of suicides associated with a volatile substance, 1999-2008

Year	Suicide		Total		% of VSA deaths	Median age at death
	Male	Female	Suicide	VSA		
1999	6	0	6	75	8.0	56
2000	3	0	3	66	4.5	38
2001	4	0	4	63	6.4	42
2002	4	2	6	65	9.2	48
2003	3	1	4	54	7.4	45
2004	3	0	3	48	6.3	53
2005	6	3	9	46	19.5	36
2006	8	2	10	51	19.6	42
2007	9	0	9	59	15.2	36
2008	4	0	4	36	11.1	44
Total	50	8	58	563	10.3	36

Table 14 gives the frequency and median age at death by year, and Figure 17 shows the age- and gender-distribution of suicides involving VSA. In 2008 there were four suicides associated with the inhalation of a volatile substance. This is lower than the level in 2007, and even lower than in the previous two years. To put these figures in perspective, it is worth mentioning that the total (adults aged 15 years and over) number of suicides (defined using ICD-9 and ICD-10 codes) recorded in the UK from 1999-2008 by the General Register Offices was 58,026 with a male:female ratio of 3:1

(Personal communication to the Project from ONS, 2010).

For suicides associated with the inhalation of a volatile substance, a continuous decrease in the median age was found over time (1999-2008), with an exception in 2004. The median age of suicide was 56 years in 1999, which fell to 41 years in 2006-8. For all suicides involving VSA since 1999, the male-female differences are more pronounced in different age-groups, particularly in those aged 20 and above (see Figure 16).



Deaths associated with helium: an early warning

Whilst inert gases, like helium and nitrogen, do not strictly come under the definition of volatile substances this report series has included reference to helium-related deaths since 1999. The cylinders of helium that can be used for inflating balloons are easily available from party shops, and to purchase over the Internet. It has become evident to the team that, in the last couple of years, there has been a rapid increase in the number of deaths, including suicides, resulting from the deliberate inhalation of helium.

This part of the report presents a brief overview of deaths resulting from the deliberate inhalation of helium gas between 2001 and 2008. Figure 17 gives the number of such deaths during this period; the total number of such deaths in this period was 64, of which 25 occurred in 2008. The majority (89%) of the deaths were suicides, with the remaining 8 cases (11%) being regarded as of undetermined intent, e.g. open verdict.

Figure 17: Distribution of deaths associated with inhalation of helium, 2001-2008

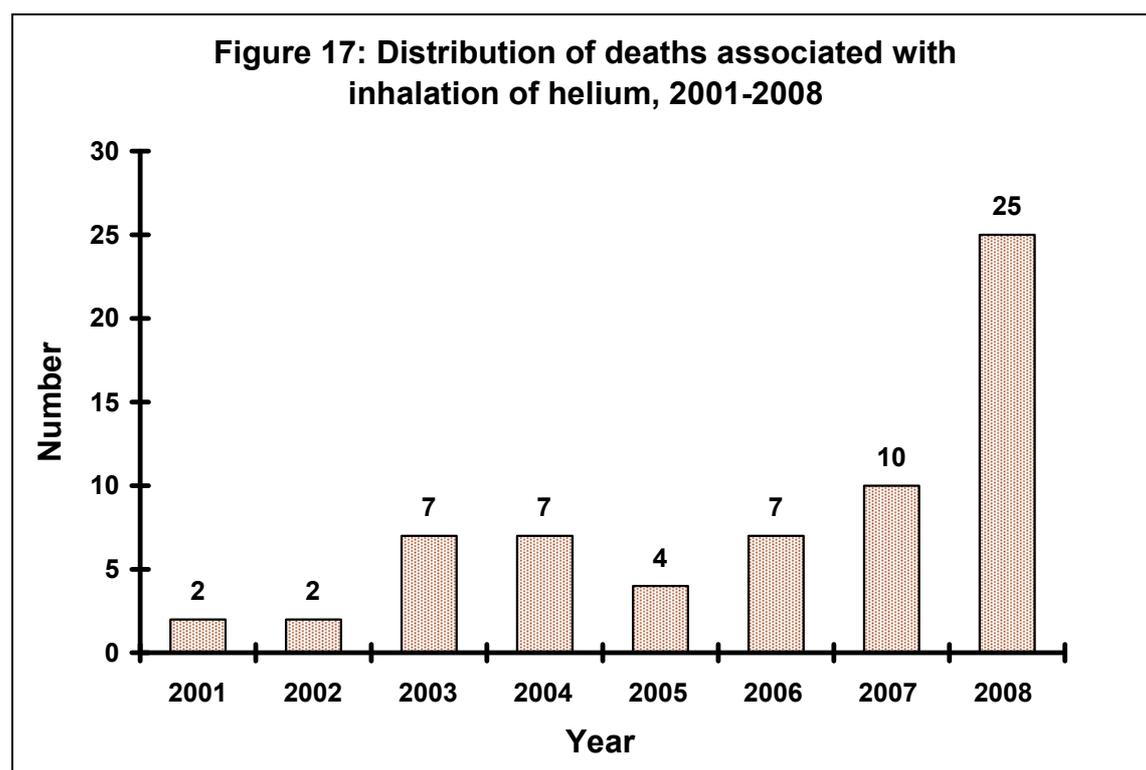


Table 15 shows the distribution of deaths associated with helium inhalation by age-group and gender. In 2008, there were 25 cases identified of those who committed suicide by inhalation of helium while these were 39 cases (61%) during the previous seven years (2001-07). Overall, the majority 80% were male, this percentage unchanging over time. Deaths were more pronounced among the 20-39 years age-group as compared to other age-groups shown in Table 15.

Figure 18 shows causes of death due to

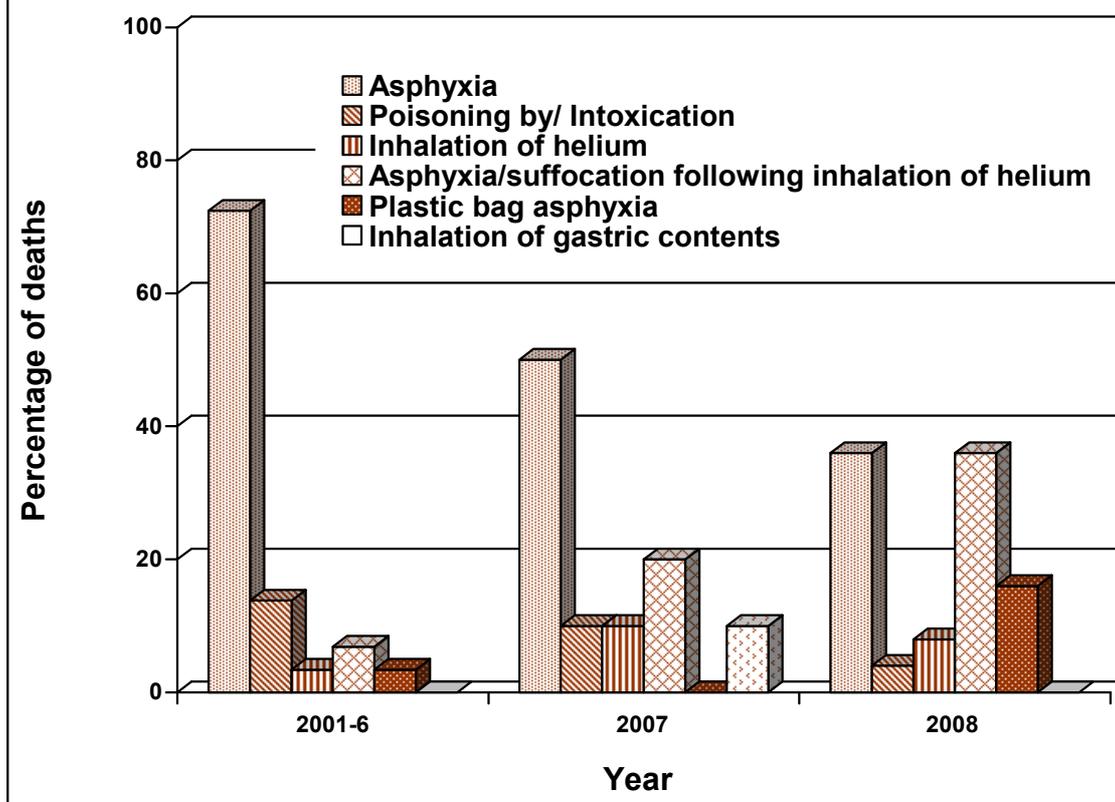
inhalation of helium between 2001 and 2008. The majority of deaths were caused by asphyxia, including plastic bag over the head, due to inhalation of the gas.

The monitoring by this project of deaths involving the deliberate inhalation of gases and vapours has allowed the identification of a rapid increase in deaths resulting from the use of helium. This figure is particularly pronounced between 2007 and 2008, and appears to principally involve suicides. Early indications show that this trend is continuing.

Table 15: Age- and gender distribution of deaths due to helium inhalation

Age group	2001-6		2007		2008	
	Male	Female	Male	Female	Male	Female
< 20 years	0	1	0	0	1	0
%	0.0	16.7	0.0	0.0	5.0	0.0
20-39	13	3	4	0	9	2
%	56.5	50.0	50.0	0.0	45.0	40.0
40-59	7	2	3	1	9	3
%	30.4	33.3	37.5	50.0	45.0	60.0
60 & above	3	0	1	1	1	0
%	13.0	0.0	12.5	50.0	5.0	0.0
All ages	23	6	8	2	20	5
%	100.0	100.0	100.0	100.0	100.0	100.0

Figure 18: Causes of death due to helium inhalation, 2001-2008



Commentary

The purpose of this Project is to monitor trends in deaths associated with the abuse of volatile substances. This report reports on those trends rather than providing an exhaustive commentary. The results presented here indicate that there has been a significant overall decline in deaths from volatile substance abuse in the United Kingdom since 1992. However, efforts to educate people on the dangers of inhalation of volatile substances should continue, especially since young people are at greater risk of dying from VSA than from drug misuse or other causes of death. Although helium is not a volatile substance, monitoring of this gas shows an increasing trend in suicide from helium inhalation. Consideration may need to be given to raising awareness of this issue.

Overall, the patterns of death associated with VSA in the UK remained fairly stable in 2008. This was true, especially in respect of the products and substances abused the place of death, as well as the age- and gender-distributions. However, the main change was a decline in the number of deaths from 59 to 36, the lowest since 1980.

This notable decline in deaths between 2007 and 2008 would appear to be an actual decline rather than the result of changes in the project personnel. Case-ascertainment methods have remained consistent with previous years and, if anything, made more robust through greater triangulation of sources and the use of additional information flows. It is possible that the decline in deaths between 2007 and 2008 may be due to falls in the following types of fatalities:

- Deaths among those aged 25 years and over;
- Deaths associated with gas fuels, especially lighter fuel and butane gas cans;
- Accidental deaths; and
- Deaths due to the direct toxic effects of the inhaled substances, including plastic bag asphyxia.

However, this large fall in deaths from one year to another should be seen as part of a longer-term downward trend. This becomes clearer when special statistical techniques are applied, as discussed elsewhere in this report. It may be that, as in some previous years, further deaths that occurred in 2008 will be notified retrospectively by coroners as their inquiries are completed.

Data for recent years suggests that one-third of deaths associated with volatile substance abuse still occur amongst those aged under-20 years, predominantly among males. More than half of these premature fatalities are accidental in nature. Therefore, it is important to initiate public health strategies to prevent the risk of accidental death for those abusing volatile substances. In a high proportion (69%) of such deaths in 2008 other psychoactive substances, including alcohol was found to be present at post mortem. These findings underline the continuing emergence of polysubstance abuse and the potentially fatal role in death of combining such substances.

Suicide rates associated with the inhalation of a volatile substance have fallen steadily, yet continue to occur predominantly amongst males. This decline may be due, in part, to an increase in the number of deaths involving the deliberate inhalation of helium, particularly in recent years. It should be possible to reduce the number of suicides using volatile substances and gases if the availability and accessibility of such substances were more restricted. There is evidence that the introduction of legislation has had no effect on the availability of products such as butane gas lighter refills (Esmail *et al*, 1992). If safer alternatives were in the market, there would be fewer and less easily accessible substances for committing suicide.

This report documents, for the first time anywhere, an emerging issue of an increasing number of suicides due to deliberate helium inhalation. The numbers more than tripled between 2006 and 2008, and appears to principally involve suicides. Early indications show that this trend is continuing. Those who committed suicide by inhalation of helium were mainly adult males, including those of aged 20-39 years. This phenomenon merits further detailed research.

Deaths involving nitrous oxide and nitrites are still occurring, albeit at low levels. These still need to be monitored closely, as they are more frequent than in previous decades.

This report, as well as demonstrating what has happened in 2008 and previous years in terms in respect of deaths involving volatile substances, also provides an indication of possible evolving changes in use patterns, and newly-emerging issues.

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Appendix

Description and examples of commonly abused volatile substances and solvents

This is not meant to be an exhaustive list, but it does give some examples of the substances typically abused in the UK.

Type	Description	Examples
Aerosols	Sprays containing propellants and solvents	Contact adhesives Hairsprays Fabric protector sprays Insect sprays Spray paints Vegetable oil sprays
Gases	Medical anaesthetics Gases used in household or commercial products	Chloroform, ether, halothane, nitrous oxide (laughing gas) Butane lighters, butane/propane canisters, whipped cream dispensers, refrigerants, and home carbonation systems for soft drinks.
Nitrites	'Poppers' act primarily to dilate blood vessels and relax muscles, unlike most other volatile substances which are used to alter mood. Nitrites are used chiefly to enhance sexual experiences.	Amyl nitrite, butyl nitrite
Volatile solvents	Liquids that vaporise at room temperature. Contained in a range of cheap, easily available products used for normal domestic and industrial purposes	Paint thinners and removers /strippers Dry-cleaning fluids Degreasers Petrol and petroleum products Glues

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