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Why are suicide rates rising in young men but falling in the elderly?—a time-series analysis of trends in England and Wales 1950–1998

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Abstract

Suicide rates doubled in males aged <45 in England and Wales between 1950 and 1998, in contrast rates declined in older males and females of all ages. Explanations for these divergent trends are largely speculative, but social changes are likely to have played an important role. We undertook a time-series analysis using routinely available age- and sex-specific suicide, social, economic and health data, focussing on the two age groups in which trends have diverged most—25–34 and 60+ year olds. Between 1950 and 1998 there were unfavourable trends in many of the risk factors for suicide: rises in divorce, unemployment and substance misuse and declines in births and marriage. Whilst economic prosperity has increased, so too has income inequality. Trends in suicide risk factors were generally similar in both age–sex groups, although the rises in divorce and markers of substance misuse were most marked in 25–34 year olds and young males experienced the lowest rise in antidepressant prescribing. Statistical modelling indicates that no single factor can be identified as underlying recent trends. The factors most consistently associated with the rises in young male suicide are increases in divorce, declines in marriage and increases in income inequality. These changes have had little effect on suicide in young females. This may be because the drugs commonly used in overdose—their favoured method of suicide—have become less toxic or because they are less affected by the factors underlying the rise in male suicide. In older people declines in suicide were associated with increases in gross domestic product, the size of the female workforce, marriage and the prescribing of antidepressants. Recent population trends in suicide appear to be associated with by a range of social and health related factors. It is possible that some of the patterns observed are due to declining levels of social integration, but such effects do not appear to have adversely influenced patterns in older generations.

Keywords: Suicide; Temporal trends; Time series; England and Wales; Socioeconomic factors; Gender

Introduction

Suicide is one of the principal causes of premature mortality in young adults in industrialised countries. The last 50 years have seen striking changes in its occurrence in England and Wales (see Fig. 1) (Charlton et al., 1992; McClure, 2000). In males aged <45 years rates have doubled, whilst they have declined substantially in females and older males. Similar increases in young male suicide have occurred in other industrialised nations although, in contrast to the pattern in England and Wales, many of these countries have also experienced rises in young female suicide (Charlton et al., 1993, Cantor, 2000). Explanations for these trends remain largely speculative.

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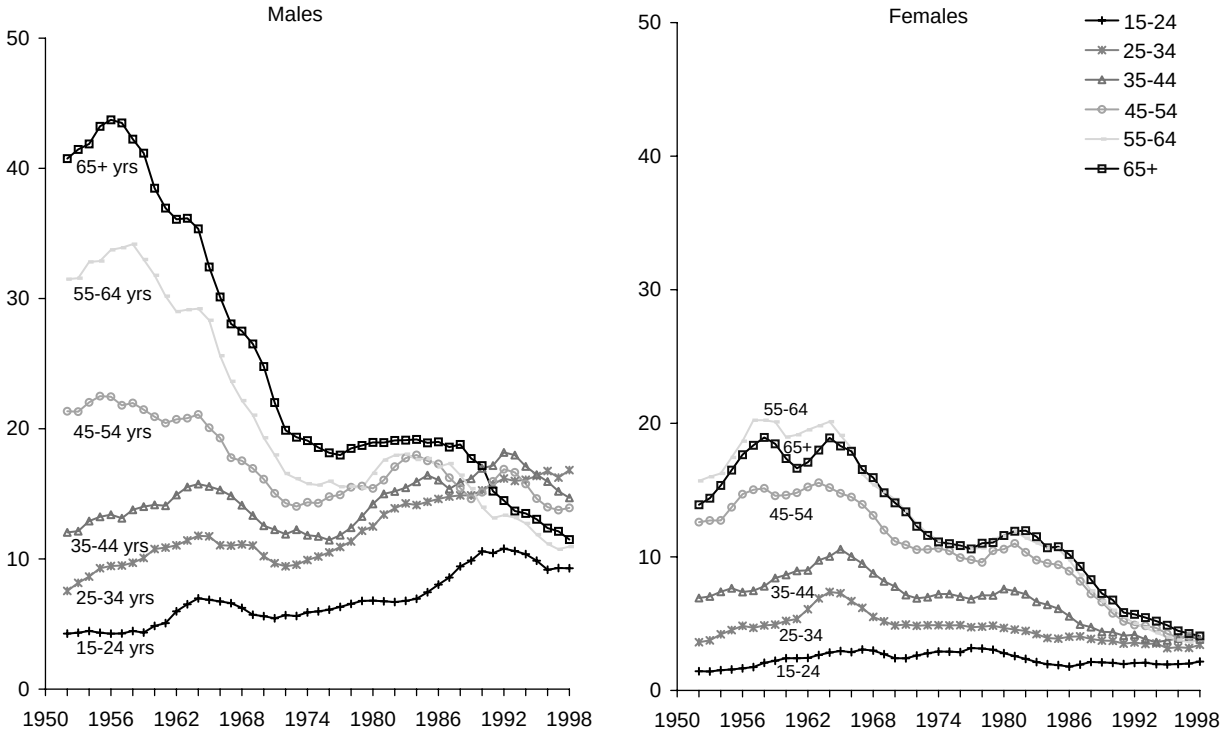

Fig. 1. Age-standardised suicide rates per 100 000 population in 10 year age bands: E&W, 1950–1998. (3-year moving averages)

Over 100 years ago, Durkheim recognised that societal changes, such as economic crises or periods of war, contribute to changing patterns of suicide (Durkheim, 1952). He viewed suicide rates as 'social facts' and argued that they may be influenced by, amongst other factors, the extent to which individuals are integrated within society. Durkheim argued that social integration could be achieved through family support together with religious, political and work affiliations (Durkheim, 1952). Sociological and epidemiological inquiry over the course of the last century has confirmed and refined Durkheim's theories, identifying the importance of patterns of unemployment, divorce, alcohol misuse and religion in explaining national differences and trends in suicide (Gunnell et al., 1999a; Lester, Curran, & Yung, 1991; Makela, 1996; Lester, 1997; Neeleman et al., 1997). In the last decade, it has been theorised that income inequality may too be an important additional influence on levels of social integration (Wilkinson, 1996; Kawachi & Kennedy, 1997).

The differing age- and sex-specific trends in suicide suggest that the societal processes underling them may be different in the various sociodemographic groups. Alternatively, common adverse influences may be offset by varying distributions of protective factors. With some exceptions (Morrell et al., 1993; Gunnell et al., 1999a; Makela, 1996), however, most previous assessments of the causes of recent changes in national suicide rates have investigated factors associated with time trends in overall population suicide rates (i.e. all age-groups combined) (Weyerer & Wiedenmann, 1995; Low et al., 1981; Lester & Yang, 1991). Such analyses cannot elucidate factors underlying the markedly varying time trends in different age–sex groups. Furthermore, many studies have assessed the effects on suicide rates of changes in single factors such as unemployment (Crombie, 1990; Gunnell et al., 1999a) or alcohol intake (Yip, Callanau, & Yuen, 2000). In other studies, associations between two or more factors have been examined but important variables, such as unemployment or alcohol consumption (Stack, 1990; Leenaars, Yang, & Lester, 1993), have been neglected. Inconsistent findings have emerged from these studies and in view of the degree of correlation between many proposed 'risk factors' it is challenging to identify the factors underlying recent trends.

Focussing on the two age/sex groups with the most divergent suicide trends in post-war Britain, i.e. 25–34 and 60+ year old men and women (see Fig. 1), the principle aim of this research was to identify the social, health and economic factors associated with recent

Table 1
Social, economic and environmental factors associated with an individual's risk of suicide (from prospective person-based studies) and population trends in suicide (from time-series analyses)

Factor	Estimated association with suicide in individuals	Association with time trends in suicide in populations
Social and economic factors		
Unemployment	2–3 fold increased risk (males and females) (Lewis & Sloggett, 1998; Platt, Micciolo, & Tansella, 1992)	Rises in unemployment are generally associated with increases in suicide, but the evidence is inconsistent (Platt & Hawton, 2000; Pritchard, 1988; Gunnell et al., 1999; Lester & Yang, 1991; Crawford & Prince, 1999)
Divorce	2–5 fold increased risk (risk generally greater in males than females) (Kreitman, 1988; Bulusu & Alderson, 1984; Charlton et al., 1993)	Rises in divorce rates are generally associated with increases in suicide, but the evidence is inconsistent (Lester et al., 1991; Lester & Yang, 1991; Stack, 1990)
Low socio-economic position/ poverty	4 fold increased risk in social class V compared to I (Drever, Whitehead, & Roden, 1996)	Increases in socio-economic deprivation generally associated with increases in suicide (McLoone, 1996; Whitley et al., 1999; Weyerer & Wiedenmann, 1995)
Motherhood	2–5 fold lower risk in first postnatal year (women) (Gissler, Hemminki, & Lonnqvist, 1996; Appleby, 1991)	No consistent associations have been found with birth rates (Lester et al., 1991)
Social fragmentation	Associations have not been investigated	Increases in marker of social fragmentation generally associated with increases in suicide (Whitley et al., 1999; Sainsbury et al., 1979; Makinen, 1997)
Female participation in the labour market	A marker for changes in the role of men in society so not examined from an individual perspective	Inconsistent evidence, theoretical arguments suggest it may be associated with increased risk of suicide in males (Platt & Hawton, 2000)
Alcohol misuse	5 fold increased risk (Harris & Barraclough, 1998)	Inconsistent evidence—studies generally suggest increased levels of alcohol consumption are associated with increases in suicide (Caces & Harford, 1998; Norstrom, 1995; Wasserman & Varnik, 1998; Skog, 1993)
Drug abuse	10 fold increased risk (Harris & Barraclough, 1998)	Associations have not been investigated
Levels of religious belief/church attendance	One study reports religious beliefs inversely associated with acceptability of suicide (Neeleman et al., 1997)	Some evidence that higher levels of religious belief are associated with lower suicide rates (Lester, 1997; Breault, 1986; Neeleman, 1998)
Levels of detection and treatment of mental illness as indicated by trends in antidepressant prescribing	Clinical trials generally underpowered to detect effect of antidepressant prescribing on suicide (Khan, Warner, & Brown, 2000)	Some evidence that trends in antidepressant prescribing are associated with reductions in suicide (Isacsson, 2000; Rihmer, Belso, & Kalmar, 2001; Rutz et al., 1992)
Changes in availability/lethality of favoured methods of suicide	Presence of a firearm in the household associated with a 5-fold increased risk of suicide in one study (Kellermann et al., 1992)	For commonly used methods—barbiturates, car exhaust gas and domestic gas changes reduced availability leads to reduction in suicide(method specific and overall) (Kreitman, 1976; Gunnell, Middleton, & Frankel, 2000)

patterns. Where possible we have used age- and sex-specific risk factor data. The main factors we have examined are those consistently associated with suicide risk in prospective person-based research and in time-series analyses (see Table 1). We also examined associations with three other measures—income inequality, gross domestic product (GDP) and measures of state support for the elderly. We investigated the

influence of income inequality (measured using the GINI coefficient) as it has been hypothesised that increased inequality contributes to reduced social integration and increased mortality (Wilkinson, 1996; Kawachi & Kennedy, 1997). We hypothesised that changing levels of income inequality may influence suicide rates through a similar mechanism. We examined associations with GDP to investigate whether changes in a nation's economic performance, which have been shown to influence population levels of life satisfaction (Di Tella, MacCulloch, & Oswald, 2001), may also affect patterns of suicide. Lastly, as it has been suggested that declining suicide rates in older people may be due to increased levels of state income support and welfare provision (Hoxey & Shah, 2000), we used markers of these changes to assess their association with suicide rates in the elderly.

Methods

Data sources

Suicide data

We obtained routinely available mortality data for England and Wales for the period 1950–1998 from the Office of National Statistics (ONS). For consistency across time we have used suicide data only—deaths coded E950-9 in the International Classification of Diseases (ICD) ICD 8 & 9 and E970-9 in ICD7. The category undetermined deaths—those given a coroner's open verdict and ICD9 coded E980–E989—was introduced in 1968. Rather than include undetermined deaths for only part of the period investigated, with the exception of a sensitivity analysis to assess the impact of excluding such deaths (see below), we have excluded them from all analyses. This should not bias our results as trends in suicide deaths paralleled those for undetermined deaths after 1968 (Charlton et al., 1992).

Measures of social, economic and health-related changes

Population data were based on decennial censuses (1951,1961,1971,1981, & 1991) and subsequent mid-year estimates; mid-year estimates for 1992-6 will be revised in the light of the 2001 census.

Data on social and economic explanatory variables were obtained from the sources listed in Appendix A. Where it was not possible to obtain data specifically for 25–34 and 60+ years olds, the age-groups chosen were those most closely corresponding to these ages.

For several of the aspects of societal change theorised as underlying recent trends in suicide—welfare provision for the elderly, substance misuse and religious beliefs—we were either unable to identify satisfactory measures or, where such measures existed, we were unable to identify a complete series of data for 1950–1998. In the absence of direct measures of welfare provision for the elderly we used three indirect measures: (i) the proportion of 60+ year olds whose incomes were 50% below mean national incomes; (ii) antidepressant prescribing rates to those aged 55+ and (iii) the number of geriatric medical staff per 100,000 aged 60+. As the latter two series began in the mid-1960s/early 1970s we could not include them in our full models (see below). In the absence of age-specific data on drug and alcohol consumption spanning the period studied we used age-specific cirrhosis and drug related mortality figures (cirrhosis: ICD 7 (up to 1967)): 581.0 and 581.1; ICD 8 (1968–1978): 571.0 and 571.9; ICD 9 (1979–1998): 571.0–571.9; drug mortality: ICD 7 (up to 1967): 323.0 ICD 8&9 (1968–1998): 304.0–304.9.

Religious integration is thought to offer protection against suicide (Durkheim, 1952; Lester, 1997; Breault, 1986; Neeleman, 1998). Previous analyses have used variables such as church membership (Breault, 1986) and levels of Roman Catholicism (Lester, 1997; Durkheim, 1952) as markers of religious integration. We were unable to identify time-trend data for these variables for England and Wales and so elected to use the ratio of religious: civil weddings as a crude indicator of changes in the church as a source of societal integration.

We were unable to identify age-specific data for some variables—ratio of religious: civil weddings, income inequality, GDP per capita, access to cars and toxic gas supplies. For other variables we felt the use of age-specific data was inappropriate. Trends in unemployment and female labour force participation in the 60+ age group are difficult to interpret as most people of this age and above have retired. We therefore used all-age male unemployment and all-age female labour force participation rates as markers for the prevailing economic environment in this age group.

We used information on total antidepressant prescribing as a measure of diagnosed and treated depression, the principal antecedent of suicide. For assessing rates of divorce we used the married population as the denominator and for rates of marriage we used the unmarried population as the denominator.

Measures of the changing lethality of commonly used methods of suicide

As changes in the availability of commonly used methods of suicide influence method-specific and overall suicide rates (Kreitman, 1976) we also examined changes in the availability of three commonly used methods of suicide over the last 50 years—domestic gas (Kreitman, 1976), prescribed drugs with high toxicity in overdose (barbiturates and tricyclic antidepressants (Henry, Alexander, & Sener, 1995)) and cars without catalytic converters (Kendell, 1998).

Statistical Analyses

Analyses were carried out using Stata version 6.0. We used graphical assessments as well as more formal statistical approaches to investigate factors of possible importance in explaining recent secular trends. The years chosen for the statistical analysis (1962–1996) were selected as those most comprehensively covered by the available social and economic data. Data on some variables (age-specific antidepressant prescribing, number of geriatric medical staff and the proportion of 60+ year olds on low income) were not available for a considerable period of the 35 years covered by our time-series analysis and these were therefore not included in full statistical models. We used Pearson's correlation coefficients throughout.

An important statistical issue with the analysis of time-series data is serial autocorrelation (non-independence) of data from consecutive years (Chatfield, 1975; Cook & Campbell, 1979). This breaks one of the basic assumptions of most regression techniques—that the errors are identically and independently distributed. To deal with this problem we first examined correlations between *differences* in suicide rates in consecutive years and *differences* in each of the exposure measures examined. To investigate factors independently associated with trends in suicide we then used Cochrane–Orcutt regression. This is a linear regression model which corrects for serially correlated errors using the Cochrane–Orcutt iterative process (see Cochrane & Orcutt, 1949).

Our approach to multivariable modelling was to first examine associations with three factors consistently shown in person-based research to influence suicide rates i.e. unemployment (Platt & Hawton, 2000; Iversen et al., 1987; Lewis & Sloggett, 1998), divorce (Bulusu & Alderson, 1984; Kreitman, 1988) and alcohol consumption (Harris & Barraclough 1998; Andreasson, Allebeck, & Romelsjo, 1988). Using models including these three factors, we then assessed the additional effect of each of the factors investigated in the correlation analyses individually and then in combination.

As in previous analyses (Gunnell et al., 1999a) we assessed the influence of changes in method availability and lethality on population suicide rates (Kreitman, 1976) by repeating all analyses using rates of non-poison, non-gas suicides. We did collect data on trends in the availability of potentially toxic drugs, coal gas supply and the number of cars without catalytic converters, but because these measures were highly correlated with those of social and economic circumstances we did not examine the influence of these in the multivariable analyses.

In a sensitivity analysis we assessed whether our findings were influenced by the decision (see above) to exclude undetermined deaths from our assessment of suicide trends after 1968. We repeated our analysis of *differences* in suicide rates in consecutive years and *differences* in each of the exposure measures for the years 1968–1996, using suicide and undetermined deaths, rather than suicide deaths alone.

Results

Suicide trends

Fig. 1 shows age-specific trends in suicide in England and Wales over the last 50 years. The most striking feature over the years displayed is the reduction in suicide rates in males aged 55 and over. The rises in suicide in 15–24 and 35–44 year old males seen in the 1970s and 1980s have recently levelled off, but rates are still rising in 25–34 year old males and this group now has the highest rate of all age–sex groups. In females, with the exception of 15–24 year olds, there have been marked declines in suicide rates, particularly in those aged over 45 years. The net effect of these post-war trends has been a convergence in age-specific rates in males and females. In 1950 there were approximately ten-fold differences between the rates in the male age groups with the highest rates (41 per 100,000 in those aged 65+) and those with lowest rates (4 per 100,000 in 15–24 year olds). By 1998, 15–24 year olds still have the lowest rates (9 per 100,000) but their rates were only half those of those in the group with the highest rates: 25–34 year olds (18 per 100,000). An even greater convergence has occurred in female rates.

Fig. 2 shows trends in overall (Fig. 2a) and non-poison, non-gas (Fig. 2b) suicide between 1950 and 1998 in the two age-groups forming the basis of our detailed analysis: 25–34 and 60+ year old males and females. In males similar trends are observed in both figures. In females the pattern of decline in overall suicide rates in older women is similar to that seen in older men. Rates in the younger women peak in the mid 1960s (due to the epidemic of barbiturate overdoses at that time) and have declined slightly since then. When poison and gas suicides are excluded, trends in young females are similar to those seen in younger men, with a steady increase between 1950 and 1998. One consistent feature in Figs. 2a and b is a temporary upturn in the previously declining suicide trends in older men and women in the late 1970s/early 1980s. In a separate analysis (not shown) this upturn was seen in 60–64, 65–74 and 75+ year olds of both sexes, though the rise was most striking in the 75+ age group. The timing of this increase corresponds most closely in time with the economic recession in the 1970s/80s (see below).

Trends in social and economic risk factors

Trends in age-specific social and economic risk factors are shown in Fig. 3. In 25–34 year olds there have been

(a)

(b)

Fig. 2. (a) Age-standardised suicide rates per 100 000: E&W, 1950–1998. [All methods (3-year moving averages)]. (b) Age-standardised suicide rates per 100 000: E&W, 1950–1998 [All methods excluding poisoning and gassing (3-year moving averages)].

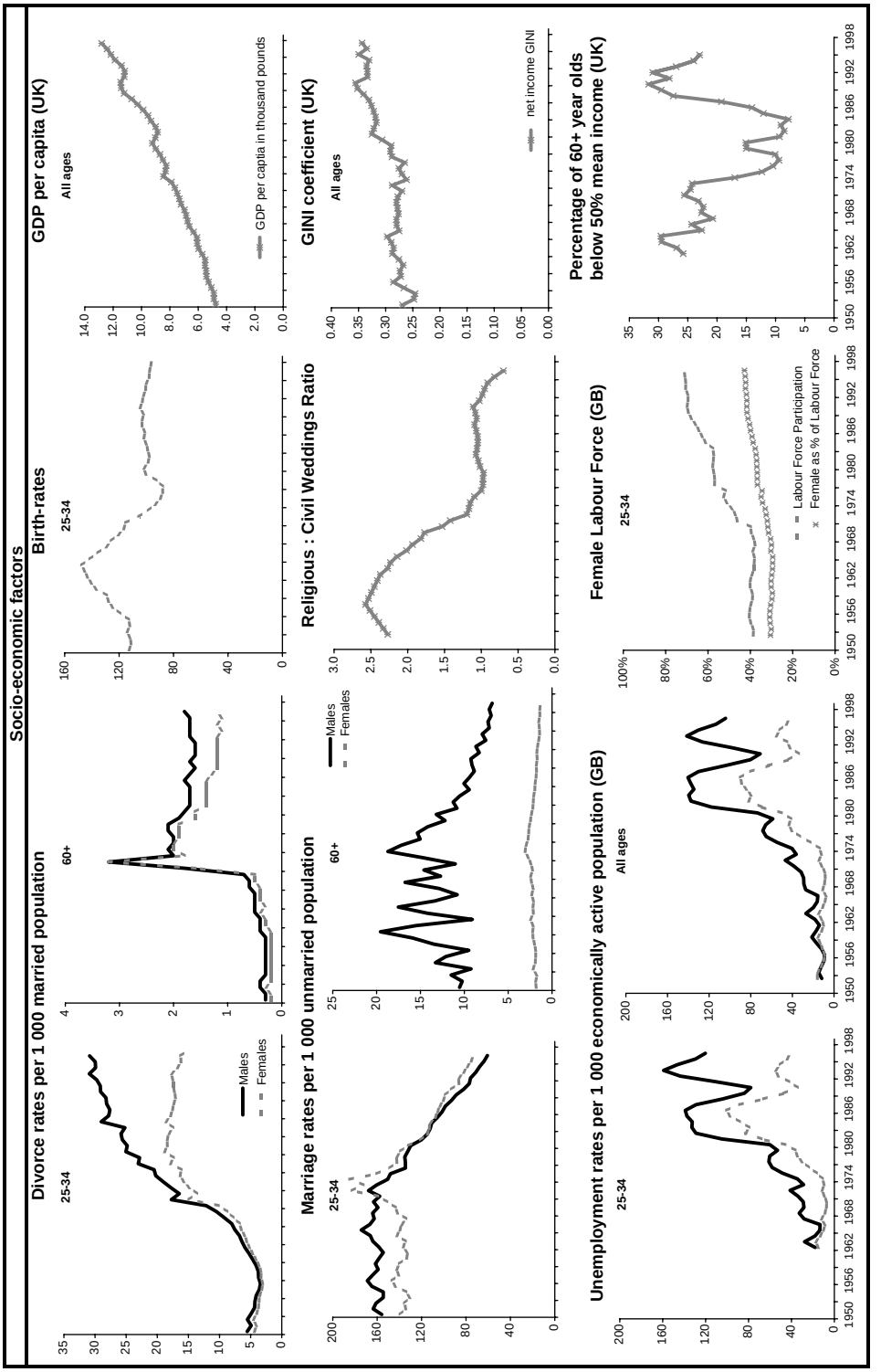

Fig. 3. Trends in social and economic factors: England and Wales 1950–1998. * Where data for England and Wales were not available, data for Great Britain or United Kingdom were used instead.

unfavourable trends over much of the period investigated. The sharp rise in divorces in 1972 corresponds to the introduction on 1 January 1971 of the Divorce Reform Act (Haskey, 1984). Rates of divorce in older people are much lower than in the 25–34 year olds and apart from the steep rise in 1972, show no evidence of an increasing trend. Unemployment and female participation in the labour force have increased and birth rates have declined. Marriage rates in those aged 60+ are higher and more variable in men because of the smaller number of unmarried men—there are many more single (widowed) women.

Increases in GDP have been accompanied by a rise in income inequality (GINI coefficient). The ratio of church: civil weddings has declined.

Trends in substance misuse, treatment of depression, healthcare provision for the elderly and method availability

Trends in the measures of substance misuse and antidepressant prescribing generally suggest similar deteriorations in the risk factor profile (or improvements in treatment) in all age–sex groups over the study period (Fig. 4). There are two exceptions to this general pattern: 25–34 year old males have experienced much steeper rises than females in drug-related mortality and smaller increases in antidepressant prescribing. We used the number of medical geriatric staff as a marker for health care provision in the elderly—this shows general improvements have occurred over the last 30 years.

The toxicity of domestic gas declined dramatically in the 1960s (Fig. 4). Throughout the 1960s and 1970s the prescribing of drugs dangerous in overdose (barbiturates and tricyclic antidepressants) declined but have recently risen very slightly because of an increase in the prescribing of tricyclic antidepressants. In recent years the number of cars without catalytic converters has declined.

For all the measures examined graphically, with the exception of divorce, antidepressant prescribing and drug-related mortality, there is no clear cut evidence of differing trends in young males compared to older people and young females.

Correlations between risk factors

Table 2(a) and (b) present correlations between the trends in the risk factors in 25–34 year old and 60+ year old males. Patterns were similar in females (not shown). As suggested by Figs. 3 and 4, trends in the risk factors were strongly inter-correlated. In 25–34 year old males, for example, around half of the correlation coefficients were greater than 0.80 and many over 0.90. Thus distinguishing factors independently were associated with recent trends is problematic.

Correlations between differences in suicide and differences in risk factors

Table 3 shows the correlations between year on year changes in suicide rates and changes in the risk factors. Positive correlations indicate that increases in the factor are associated with increases in suicide. Negative correlation coefficients indicate protective effects of the factor examined. For overall suicide rates the strongest associations with factors other than indicators of method availability in each age–sex group were: (a) young males: marriage ($r = -0.26$); (b) older males: ratio of religious: civil weddings ($r = 0.40$), antidepressant prescribing ($r = -0.37$), cirrhosis mortality ($r = 0.37$), females as a percentage of the workforce ($r = -0.33$), GINI coefficient (income inequality) ($r = 0.26$); (c) young females: drug mortality ($r = 0.25$); (d) older females: marriage ($r = -0.48$) and the ratio of religious: civil weddings ($r = 0.29$). In all age–sex groups except young women decreases in coal gas volume were associated with decreases in suicide. In older men increases in the prescribing of tricyclic antidepressants and barbiturates were associated with decreases in suicide.

We repeated this analysis for the years 1968–1996 using changes in suicide *and* undetermined death rates rather than suicide deaths alone. Our findings were largely unchanged except in young females where the strength of the association with divorce decreased substantially ($r = 0.04$) and with GDP increased ($r = -0.27$).

For the non-poison non-gas suicides the associations were generally similar to those for overall suicide. The main exceptions were seen in 25–34 year old males where the association with income inequality increased (from $r = 0.10$ to 0.33) and in young females where associations with divorce and cirrhosis mortality became stronger and the previously positive association with female workforce participation was reversed.

Time-series analysis (Cochrane–Orcutt regression)

Table 4 summarises the factors found to be associated (at $p < 0.05$) with suicide risk in multivariable regression analyses. In young males increases in marriage were associated with decreases in suicide, while rises in divorce, GINI coefficient and the proportion of civil weddings were associated with an increase in suicide. In young females the only factors independently associated with suicide were divorce and unemployment. In contrast to the pattern seen in males, increases in divorce were associated with decreases in suicide in young females in the models based on all suicides, however, there was a borderline association in the opposite direction in models based on non-gas,

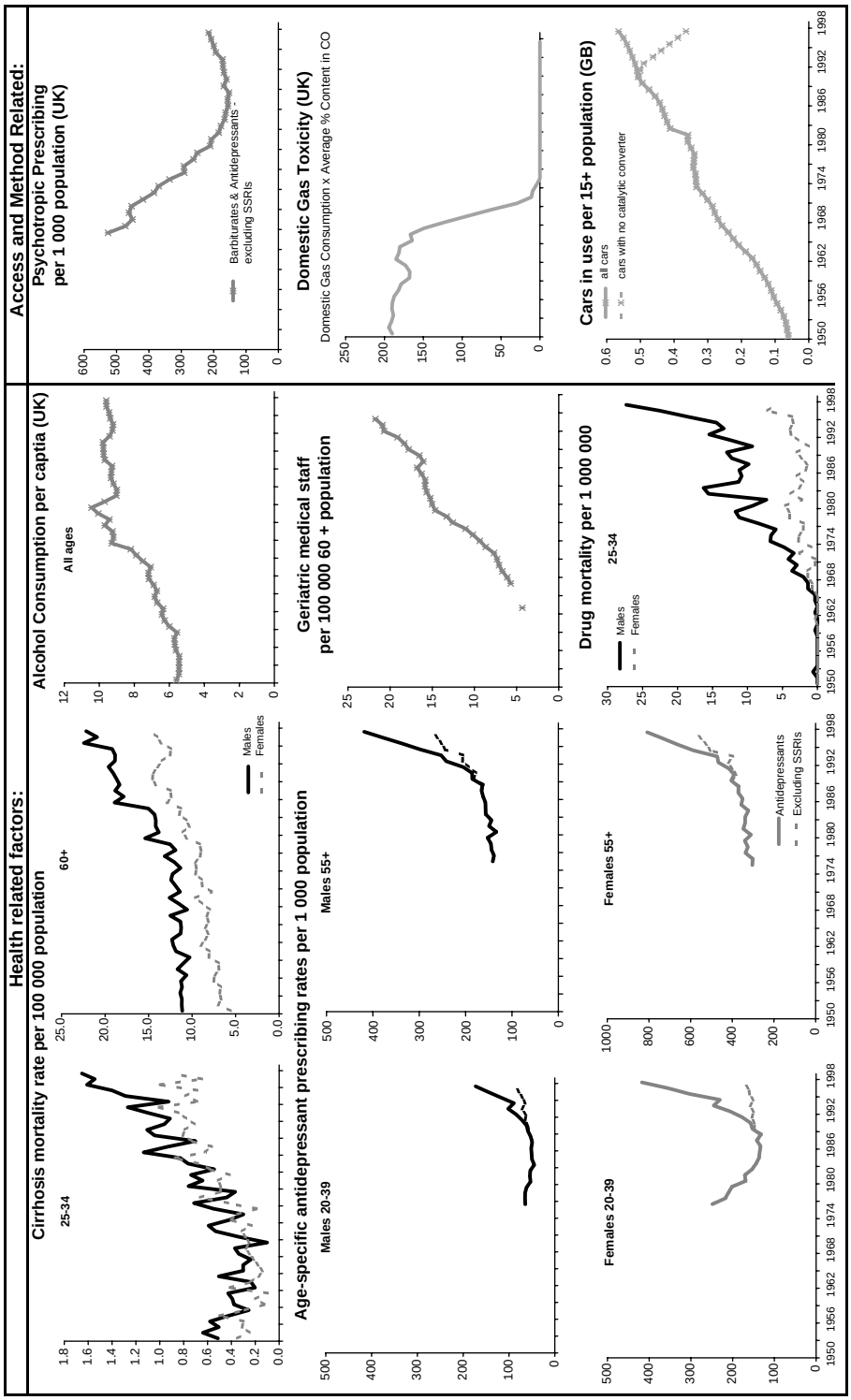

Fig. 4. Trends in health and access/method related factors: England and Wales 1950–1998. * Where data for England and Wales were not available, data for Great Britain or United Kingdom were used instead.

Table 2
Correlation (Pearson's) between absolute levels of risk factors 1962–1996: males aged (a) 25–34 and (b) 60+

	Unemployment	Female work force participation	Females as % of total work force	Marriage	Divorce	Alcohol consumption	Cirrhosis mortality	Drug abuse mortality	GDP per capita	GINI income inequality	Religious: civil weddings	Anti-depressant prescribing
(a) *Males aged* 25–34												
Unemployment	1.00											
Female participation in work force	0.86[a]	1.00										
Females as % of total work force	0.88[a]	1.00[a]	1.00									
Marriage	−0.89[a]	**−0.96**[a]	**−0.97**[a]	1.00								
Divorce	0.88[a]	**0.97**[a]	**0.97**[a]	**−0.91**[a]	1.00							
Alcohol consumption[c]	0.63[a]	0.84[a]	0.82[a]	−0.69[a]	0.89[a]	1.00						
Cirrhosis mortality	0.83[a]	0.89[a]	**0.91**[a]	**−0.92**[a]	0.84[a]	0.65[a]	1.00					
Drug abuse mortality	0.85[a]	0.89[a]	**0.91**[a]	−0.89[a]	**0.90**[a]	0.77[a]	0.89[a]	1.00				
GDP per capita[c]	0.83[a]	**0.97**[a]	**0.98**[a]	**−0.97**[a]	**0.94**[a]	0.78[a]	**0.92**[a]	0.89[a]	1.00			
GINI income inequality[c]	0.83[a]	0.88[a]	0.89[a]	**−0.92**[a]	0.83[a]	0.61[a]	0.81[a]	0.79[a]	0.87[a]	1.00		
Religious: civil weddings[c]	−0.71[a]	−0.85[a]	−0.84[a]	0.72[a]	**−0.91**[a]	**−0.94**[a]	−0.71[a]	−0.83[a]	−0.81[a]	−0.58[a]	1.00	
Anti-depressant prescribing[c]	0.52[a]	0.69[a]	0.69[a]	−0.74[a]	0.63[a]	0.44[b]	0.78[a]	0.77[a]	0.76[a]	0.50[a]	−0.70[a]	1.00
(b) *Males aged* 60+												
Unemployment[d]	1.00											
Female participation in work force[d]	0.82[a]	1.00										
Females as % of total work force[d]	0.85[a]	**0.96**[a]	1.00									
Marriage	−0.74[a]	−0.72[a]	−0.85[a]	1.00								
Divorce	0.47[a]	0.70[a]	0.50[a]	−0.10	1.00							
Alcohol consumption[c]	0.67[a]	**0.91**[a]	0.79[a]	−0.50[a]	0.78[a]	1.00						
Cirrhosis mortality	0.74[a]	0.86[a]	**0.93**[a]	−0.81[a]	0.37[b]	0.68[a]	1.00					
GDP per capita[c]	0.78[a]	**0.94**[a]	**0.99**[a]	−0.81[a]	0.51[a]	0.78[a]	**0.94**[a]	1.00				
GINI income inequality[c]	0.80[a]	0.80[a]	0.89[a]	−0.88[a]	0.24	0.61[a]	**0.91**[a]	0.87[a]	1.00			
Religious:civil weddings[c]	−0.73[a]	**−0.92**[a]	−0.82[a]	0.53[a]	−0.83[a]	**−0.94**[a]	−0.66[a]	−0.81[a]	−0.58[a]	1.00		
Geriatric staff[c] ($n = 29$)	0.85[a]	**0.94**[a]	**0.98**[a]	**−0.90**[a]	0.34	0.74[a]	0.86[a]	**−0.95**[a]	**0.90**[a]	−0.77[a]	1.00	
Pensioners' income[c] ($n = 34$)	−0.34	−0.17	−0.03	−0.03	−0.36[b]	−0.37[b]	0.17	0.06	0.06	0.40[b]	0.01	1.00
Anti-depressant prescribing[c]	0.42[b]	0.68[b]	0.71[a]	−0.57[a]	0.26	0.45[b]	0.55[a]	0.76[a]	0.50[a]	−0.70[a]	0.76[a]	0.23	1.00

Correlations greater than 0.90 shown in bold.
[a] $p < 0.01$.
[b] $p < 0.05$.
[c] These variables are not age- and sex-specific.
[d] These variables are not age-specific.

Table 3
Correlation (Pearson's) of change in age-specific social, economic and health variables with change suicide rates in 25–34 year old and 60+ males and females 1962–1996: all methods and all methods excluding overdose and gassing

	All methods		Non-poison, non-gas	
	25–34 year olds	60+ year olds	25–34 year olds	60+ year olds
Males				
Unemployment[a]	0.15	0.13	0.01	0.07
Female participation in workforce[b]	−0.01	−0.20	−0.16	−0.11
Females as % of total workforce[b]	−0.11	−0.33[c]	−0.22	−0.20
Marriage	−0.26	−0.04	−0.20	−0.11
Divorce	−0.08	−0.21	0.01	−0.03
Alcohol consumption[d]	−0.07	0.10	0.04	0.17
Cirrhosis mortality	0.03	0.37[e]	−0.07	0.25
Drug abuse mortality	−0.06	—	−0.10	—
GDP per capita[d]	−0.05	0.15	0.16	0.10
GINI income inequality[d]	0.10	0.26	0.33[c]	0.16
Religious:civil weddings[d]	0.20	0.40[e]	0.01	0.06
Geriatric staff[d,f]	—	0.00	—	−0.16
Pensioners' income[d,f]	—	0.21	—	−0.01
Anti-depressant prescribing[d,f]	−0.17	−0.37[e]	−0.09	−0.31
Car use (no catalytic convertors)[d]	−0.01	−0.09		
Coal gas volume[d]	0.24	0.32[c]		
Barbiturate and non-SSRI antidepressant prescribing[d,f]	0.17	−0.49[e]		
Females				
Unemployment[a]	0.17	0.06	0.10	0.00
Female participation in workforce[b]	0.24	0.10	−0.06	0.23
Females as % of total workforce[b]	0.10	0.10	−0.20	0.06
Marriage	0.02	−0.48[e]	0.14	−0.29[e]
Divorce	0.14	−0.04	0.32[c]	0.00
Birth rate	0.17	—	0.11	—
Alcohol consumption[d]	−0.04	−0.04	0.22	0.11
Cirrhosis mortality	−0.05	0.17	−0.33[c]	0.22
Drug abuse mortality	0.25	—	0.07	—
GDP per capita[d]	−0.08	−0.13	0.11	−0.17
GINI income inequality[d]	−0.04	0.21	−0.04	0.25
Religious:civil weddings[d]	0.11	0.29[c]	−0.07	−0.04
Geriatric staff[d,f]	—	0.21	—	0.13
Pensioners' income[d,f]	—	0.16	—	−0.02
Anti-depressant prescribing[d,f]	0.11	−0.09	0.04	−0.22
Car use (no catalytic convertors)[d]	−0.15	−0.22		
Coal gas volume[d]	0.00	0.30[c]		
Barbiturate and non-SSRI antidepressant prescribing[d,f]	0.11	−0.08		

—: These variables are not relevant in this age-group.

[a] Unemployment is age- and sex-specific in 25–34 year olds but total (not age-specific) male unemployment was used to assess associations in 60+ year old males and females.

[b] These variables are age-specific in 25–34 year olds but not in 60+ year olds, all-age female labour force participation was used to assess associations in those aged 60+ years.

[c] $p<0.10$.

[d] These variables are not age- and sex-specific.

[e] $p<0.05$.

[f] These correlations are not based on 34 number of observations but only $n=27$ for geriatric staff, $n=33$ for pensioners' income and $n=29$ for antidepressant prescribing.

non-overdose suicides ($p=0.08$). As these latter models take account of changes in method lethality, which have had a more profound influence on female suicide rates, they are perhaps a more reliable indicator of relevant determinants of trends. There were borderline associations between increasing alcohol consumption and

increases in suicide in young males ($p = 0.10$) and females ($p = 0.06$).

In older males and females increases in GDP and female labour participation were most consistently associated with declines in suicide. Markers of increases in alcohol consumption and unemployment were also associated with adverse trends in both sexes.

Discussion

Main findings

Four main findings emerged from our analyses. First, the increases in young male suicide in England and Wales in the last 30 years have paralleled rises in a number of risk factors for suicide in this age group, namely unemployment, divorce, alcohol and drug abuse, and declines in marriage. In keeping with the findings of Charlton and colleagues in their assessment of post-war suicide trends up to 1990 (Charlton et al., 1993) one of the factors most consistently associated with patterns of suicide in our models was the change in young peoples relationship patterns. Young females have also been subject to changes in these factors, but they are either less susceptible to their effects or changes in the lethality of drugs commonly used in overdose, their favoured method of suicide, may have averted the similar rise in their suicide rates that has been seen in other countries (Gunnell et al., 1999b). Second, in people aged over 60 there is some evidence that increases in national GDP, anti-depressant prescribing and other measures of improved healthcare provision for older people may have been associated with a decline in suicide. Third, suicide rates in different age–sex groups have converged over the last 50 years, possibly suggesting greater age equality in social and economic circumstances. Lastly, adverse trends in many suicide risk factors between 1962–1996 were highly correlated with one another, indicating all trends may be markers of more fundamental societal changes. For example in 25–34 year old males correlations of unemployment with divorce, female participation in the workforce and cirrhosis mortality were: 0.88, 0.86 and 0.83, respectively. This highlights the problems in trying to implicate single factors as underlying recent adverse trends in the young and favourable changes in the elderly.

Table 4
Factors independently associated ($p<0.05$) with age and gender specific trends in suicide (1962–1996) in Cochrane–Orcutt regression analysis

Age groups	Males	Females
25–34 year olds	*Models based on all suicides*	*Models based on all suicides*
	(+) Divorce[a]	(−) Divorce[a]
	(+) Ratio of religious to civil weddings[b,c]	
	(−) Marriage[c]	
	Models based on non-gas, non-overdose suicides	*Models based on non-gas, non-overdose suicides*
	(+) Divorce[a]	(+) Unemployment[a]
	(+) GINI coefficient[b,c]	
	(−) Marriage[c]	
60+ year olds	*Models based on all suicides*	*Models based on all suicides*
	(+) Total male unemployment[b,c]	(+) Alcohol consumption[b,c]
	(+) Alcohol consumption[b,a]	(−) Females as % of total workforce[d,c]
	(+) Cirrhosis mortality[a]	(−) Marriage[c]
	(+) Ratio of religious to civil weddings[b,c]	(−) GDP[b,a]
	(−) Females as % of total workforce[d,c]	
	Models based on non-gas, non-overdose suicides	*Models based on non-gas, non-overdose suicides*
	(+) Total male unemployment[c]	(+) Total male unemployment[c]
	(+) Alcohol consumption[b,c]	(+) Alcohol consumption[b,c]
	(+) Cirrhosis mortality[c]	(−) Marriage[a]
	(−) Female participation in the workface[d,a]	(−) GDP[b,c]
	(−) GDP[a,b]	

(+) indicates that suicide risk increases, (−) that suicide risk decreases with increases in the factor examined.
[a] $p<0.05$.
[b] These variables are not age- and sex-specific.
[c] $p<0.01$.
[d] This variable is age-specific in 25–34 yr olds but based on all-age female labour force participation in those aged 60+.

Generally the direction of the associations reported here was consistent with our expectations from the literature. The main exception to this was the association between decreases in religious beliefs (as measured by decreases in the ratio of religious: civil weddings) and decreases in suicide in younger and older men (see Tables 3 and 4).

Limitations to using time-series analysis to understand temporal changes in suicide

The statistical problems with interpreting time trends when the individual values exhibit strong autocorrelation and when the potential explanatory factors are also highly correlated (collinearity) are well known. Furthermore, because the time span for these analyses was limited to at most 35 years, most of the risk factors examined showed only monotonic increases or decreases over the period. We overcame such limitations, at least in part, by our assessment of associations of differences in risk factors with differences in suicide and by our use of Cochrane–Orcutt regression.

Some time-series analyses are limited by the fact that whilst changes in two phenomena may be highly correlated at a population level, they may not be at an individual level. We therefore took care to restrict our analysis to factors either previously shown to be associated with suicide risk at the individual level or for which there were good theoretical grounds to hypothesise a causal association with suicide trends. Furthermore, some of the risk factors we examined were population attributes, such as income inequality and GDP, rather than characteristics of individuals. A consequence of our desire to examine a broad range of factors was that we examined associations with 18 risk factors in four different age–sex groups in relation to overall and method-specific suicide rates. The large number of factors investigated increases the likelihood of some false positive findings. For this reason we focus on patterns of relationship and consistency of findings rather than single associations in our discussion.

Because of uncertainty concerning the appropriate time lags to build into models we have made no attempt to assess possible lagged effects of the exposures examined. However, for at least some of the variables examined e.g. cirrhosis mortality and divorce, these are likely to be important. It is also possible that as risk factors such as divorce and unemployment become more prevalent in the population the risk associated with these factors diminishes. For example, research in Finland indicates that mortality associations with unemployment are weaker in times of high unemployment (Martikainen & Valkonen, 1996). However, against the background of rises in divorce in Britain there is no evidence that the risk of suicide amongst the divorced has declined (Bulusu & Alderson, 1984).

Some of the variables we used as measures of prosperity in the elderly, society's religious integration and changes in health care provision were not ideal. Furthermore, secular trends in levels in some of these variables may be subject to differing interpretation. For example, increases in antidepressant prescribing could reflect better recognition and treatment of mental illness or a deterioration in population mental health leading to increased prescribing. The official coding of suicide may too have changed over the 24 year period examined—decreased stigmatisation of suicide may have increased coroner's likelihood of giving suicide verdicts. We would be surprised, however, if changes in recording systems had had different effects on time trends in males compared to females and young compared to old subjects.

Finally, there are problems with modelling changes in the availability of potentially lethal methods of suicide as the approaches we have used here take no account of 'method transfer'. However, in a recent analysis of suicide trends in England and Wales we have shown that where such transfer occurs it is most likely to be between the two methods whose availability has changed most (overdose and gassing) (Gunnell et al., 2000) and so analyses were repeated with these two methods excluded. The effect on suicide trends of changes in the availability of particular methods appears to be most important for women as they favour the methods (overdose and domestic gas poisoning) whose lethality has changed most over the last 40 years. Associations in relation to overall suicide rates in females should therefore be interpreted with caution (Gunnell et al., 1999b). This is highlighted by the associations with measures of female labour force participation in 25–34 year old females which were in opposite directions in models based on all suicides vs. non-gas, non-poison suicides (see Table 3).

Explanations for divergent age- and gender-specific suicide rates

The timing of the increases in drug abuse and alcohol mortality coincide most closely with the rises in young male suicide in the late 1960s. However, rises in alcohol consumption and increases in cirrhosis mortality in the elderly occurred at the same time as declines in their suicide rates. These trends indicate either that changes in alcohol consumption do not greatly influence suicide rates in elderly people or that other protective factors in the elderly are more important.

We found no evidence that temporal changes in a single factor underlie the discordant trends in young male compared to female and older male suicide. Changes in factors such as unemployment, however, are unlikely to have a direct effect on post-retirement age groups. Likewise it is possible that greater economic

prosperity, as indexed by rises in GDP, have brought benefits to older people but that such benefits have been offset in younger people by changes in relationship patterns, greater job insecurity, increases in income inequality and unemployment. The beneficial effects of increased anti-depressant prescribing and detrimental effects of rises in cirrhosis mortality appeared to be specific to those aged 60+. It is of note that whilst antidepressant prescribing has increased in all groups, the smallest increase occurred in young men. We have shown in a recent analysis, however, that between 1975 and 1998 there was a proportionately greater increase in antidepressant prescribing to males than females in Britain (Middleton, Gunnell, Whitley, Dorling, & Frankel, 2001).

Secular trends in mental illness

The same factors underlying changing patterns of suicide may have influenced trends in the two principal psychiatric conditions contributing to suicide in the general population—depression and schizophrenia (Foster, Gillespie, & McClelland, 1997). There are no prospectively collected data on time trends in the population prevalence of these conditions in post-war years in England and Wales. For schizophrenia there is some evidence from other countries of a decrease in incidence, although the evidence is not clear-cut due to changing patterns of diagnosis and hospitalisation (Suvisaari et al., 1999). Whilst there is some evidence that the prevalence of depression has increased in recent years, (Fombonne, 1994; Cross-National Collaborative Group, 1992), findings are inconsistent, (Murphy et al., 2000) and most research in this area is based on recall of age at first onset of depression (Cross-National Collaborative Group, 1992). It is the underlying causes of any change in the incidence of psychiatric illness that were of interest to us here.

Do adverse trends in risk factors point to increasing social fragmentation?

The most striking feature of the graphical presentation of risk factors examined is the adverse trend over the study period in many of the recognised social and economic risk factors for suicide namely increases in unemployment, divorce, being unmarried, substance misuse and decreases in motherhood (and consequently fatherhood). It is likely that changes in a combination of these factors underlie the recent rise in young male suicide. Some of these factors may act as markers for more profound changes in the fabric of society that are affecting young people. For example, it has recently been shown that the greatest rises in youth suicide in Britain occurred in areas of the country which experienced the greatest increases in social fragmentation (Whitley et al., 1999). Analysis of this issue from a European perspective has, however, produced conflicting findings (Makinen, 1997; Sainsbury, Jenkins, & Levey, 1979).

Conclusions

This analysis indicates that no single factor can be clearly implicated as underlying recent trends in suicide. The causes of suicide are complex and multifactorial. Population trends are therefore likely to be influenced not only by social changes and patterns of health and healthcare, but also by trends in the lethality of popular methods used for suicide. Importantly the data presented here underline the striking differences in effects of societal changes on suicide risk at different stages of the life course. To understand the important influences on suicide risk in different age groups future studies must investigate the experiences of older and younger individuals separately. Likewise, the observed trends will have different public health and social policy implications in each age/sex group.

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Appendix A

Variable	Source	Age groups for which data are available
Population (E&W)	ONS	25–34, 60+
Social and Economic factors		
Registered unemployed (GB)	1962–1977: The ministry of Labour Gazette 1978–1998: Department of Employment Gazette	25–34 and all ages

Labour force (GB) (Employees)	1952–1971: Annual Abstract Statistics 1962 & 1973 1971–1996: Labour Market Trends, Feb 1997	25–34
Divorces (E&W)	1950–1996: OPCS marriages & divorce statistics	25–34, 60+
Marriages (E&W)	1948–1996: OPCS marriages & divorce statistics	25–34, 60+
Births (E&W)	1950–1997: ONS birth statistics	25–34
Mean income (UK): percentage of people aged 60+ and all ages below 50% of mean income	1961–1995: Households below average income: Department of Social Security. Government Statistical Service. Stationary Office.	60+ and all ages
GDP per capita (UK) (and growth of GDP per capita)	1948–1997: ONS: Economic Trends, Annual Suppl. 1998, Govt. Statistical Service, London: Stationary Office.	Not age-specific
Income inequality—GINI (UK)	1948/9 to 1996/7: Annual abstract statistics	Not age-specific
Ratio of religious: civil weddings (E&W)	OPCS marriages & divorce statistics—1952–1997	Not age-specific
Health-related factors		
Cirrhosis mortality (E&W)	1950–1998: ONS 20th century mortality. Codes used: ICD 6&7 (1950–1967): 581.0 and 581.1 ICD 8 (1968–1978): 571.0 and 571.9 ICD 9 (1979–1998): 571.0–571.9	25–34, 60+
100% alcohol consumption per capita (UK)	1944/5 to 1997/8: Statistical Handbook of the Brewers' Society	Not age-specific
Mortality from drug-abuse (E&W)	1950–1998: Drug dependence mortality ONS 20th century mortality Codes used: ICD 6&7 1950–1967: 323.0 ICD 8&9 1968–1998: 304.0–304.9	25–34
Drug addicts notified (UK)	1973–1995: Home Office drug addict notifications	<50
Geriatric medical staff (E&W)	1963, 1966–1994: Health and Personal Social Services statistics for England (and separately for Wales). Whole-time equivalent medical staff in geriatric medicine and (after 1989 including) old-age psychiatry. This includes consultants, staff grade (from 1989), associate specialists, senior registrar, registrar, senior house officer and house officer	Not age-specific
Prescribing of antidepressants (UK)	1975–1998: IMS Health, Middlesex	20–39, 55+
Access and Methods		
Prescribing of psychotropic drugs toxic in overdose (UK)	1975–1998: IMS Health, Middlesex: barbiturates and non-SSRI antidepressants	Not age-specific
Domestic gas consumption (UK) and gas toxicity index (toxicity index based on % carbon monoxide content of domestic gas supply, in relation to the volume of gas supplied)	1943–1994: (1) Ministry of Power, Statistical Digest, 1962, (2) Ministry of Technology, Digest of Energy Statistics, 1970, (3) from 1965- : Department of Energy, Digest of UK Energy Statistics	Not age-specific
Cars and catalytic converters (GB & NI)	1946–1997: The motor industry in Great Britain. World automotive statistics, 1991 & 1998, London: The Society of Motor Manufacturers and Traders Ltd	Not age-specific

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