

## Influence of cohort effects on patterns of suicide in England and Wales, 1950–1999

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**Background** Age- and gender-specific suicide rates in England and Wales have changed considerably since 1950.

**Aims** To assess whether cohort effects underlie some of these changes.

**Method** Graphical displays to assess age–period–cohort effects on suicide for the period 1950–1999.

**Results** Successive male birth cohorts born after 1940 carried with them, as they aged, a greater risk of suicide than their predecessors although this effect diminished for the 1975 and 1980 birth cohorts. There was less clear evidence of any increased risk of suicide in post-war female birth cohorts.

**Conclusions** Succeeding generations of males born in the post-war years have experienced increasing rates of suicide at all ages, an observation in keeping with patterns seen in other countries. If these trends continue into middle- and old-age they will lead to a great increase in overall male suicide rates.

**Declaration of interest** None.

There have been marked changes in age- and gender-specific suicide rates in England and Wales over the past 50 years (Charlton *et al*, 1992; McClure, 2000). A feature of the recent trends has been the rise in young male suicides.

An important public health concern is that birth cohorts could carry with them their increased predisposition to suicide as they age. Such cohort effects could arise because of the exposure of particular generations to factors during their development or early adult life that have a long-term impact on their risk of suicide throughout life. Sixteen years ago an analysis of suicide trends in Britain up to 1980 found no evidence for birth cohort effects (Murphy *et al*, 1986). This finding contrasted with similar analyses that identified such effects in both Canada and the USA (Murphy & Wetzel, 1980; Solomon & Hellon, 1980). The years covered in the earlier analysis of data for England and Wales included only the first 10 years (1970–1980) of the period over which young male suicide rates increased most rapidly. Subsequent analyses of suicides up to 1985 (Surtees & Duffy, 1989) and 1990 (Charlton *et al*, 1992) found some evidence of birth cohort effects in younger males and females. In males, each successive 10-year birth cohort, born in the post-war years, experienced higher suicide rates at all ages; in contrast, each successive cohort of females appeared to experience lower suicide rates.

Here we update and refine the earlier assessments of cohort effects in England and Wales to investigate evidence for cohort effects on suicide between 1950 and 1999. As suicide rates in the post-war years have been influenced by changes in the lethality of commonly used methods of suicide and changes in the coding of suicides (period effects: Kreitman, 1976; Charlton *et al*, 1992; Gunnell *et al*, 2000), we assessed the effects of both these factors on apparent trends.

## METHOD

### Data sources

Suicide rates were based on mortality and population data produced by the Office for National Statistics, 1950–1999 (Office for National Statistics, 2001). Suicide deaths were extracted on the basis of the codes used to identify suicides or probable suicides in the International Classification of Diseases (ICD, revisions 6 to 9, latterly World Health Organization, 1977). The years we have studied span four revisions of the ICD, and the codes used for suicide over these years are as follows: 6th revision ICD E970–E979; 7th ICD E970–E979; 8th ICD E950–E959; 9th ICD E950–E959. In the eighth and ninth revisions of the ICD, a new category of ‘undetermined deaths’ (E980–E989) – deaths given open verdicts by coroners – was introduced. As most such deaths are suicides, and in keeping with official reporting of national suicide rates (Charlton *et al*, 1992; Kelly & Bunting, 1998), we included these in our analysis (see below). We excluded deaths coded E988.8 (accelerated registrations) as most of these are homicides.

### Age, period and cohort effects

Distinguishing age, period and cohort effects from each other is problematic because of the linear dependency between these three variables; this is known as the identification problem. A number of different graphical and modelling approaches to delineate these effects have been suggested in the literature (Robertson & Boyle, 1998a,b). Previous authors have found that age–period–cohort modelling does not add greatly to the information obtained from graphical approaches (see, for example, Allebeck *et al*, 1996; Newman & Dyck, 1988) and for this reason we have mainly restricted our analysis to graphical assessments of trends.

### Assessment of age and period effects

We assessed the extent to which suicide varies with age by plotting age- and gender-specific trends in suicide (1950–1999) within six age bands: 15–24; 25–34; 35–44; 45–54; 55–64; and 65+. Period effects refer to the extent to which living in a particular time period affects disease risk similarly in all groups in the population, regardless of age and birth cohort. We investigated period effects by plotting

age-specific suicide rates in five different time (of death) periods: 1955–1959; 1965–1969; 1975–1979; 1985–1989; and 1995–1999. We omitted the intermediate periods (1950–1954, 1960–1964, etc.) to simplify the graphical presentation of the data. We also assessed period effects by: (a) looking for changes in age-specific trends common to all age–gender groups in the graphs of age-specific rates; and (b) by excluding some methods of suicide and undetermined deaths from our analysis of cohort effects (see below).

**Assessment of cohort effects**

We investigated the influence of cohort effects on suicide rates by plotting suicide rates at age 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54 and 55–59 for those born in nine successive 5-year birth cohorts – i.e. births around 1940, 1945, 1950 and so on up to 1980. Office for National Statistics mortality data are summarised as the number of deaths, by year, within 5-year age bands. Each of our estimates of the suicide rate for a particular birth cohort at a given age, therefore, includes the mortality experience of people born over a 9-year period centred around

the specified year of birth of the birth cohort (see Table 1). For example, for the 1940 birth cohort (highlighted), we used the suicide rates for 15- to 19-year-olds between 1955 and 1959 as our estimate of their suicide rates at age 15–19. Likewise, for our estimate of their suicide rates at age 20–24, we used the suicide rates of 20- to 24-year-olds between 1960 and 1964, and so on. As can be seen in Table 1, deaths in any particular year within an age band never contribute to more than one birth cohort’s estimated mortality rate. Deaths occurring among those born in the years around the mid-year of each birth cohort contribute to a diminishing extent as one moves towards the mid-year of the next birth cohort.

**Assessment of cohort effects with adjustment for possible period effects**

Changes in the toxicity of domestic gas, car exhaust gases and the drugs most commonly taken in overdose have all influenced patterns of suicide in England and Wales over the past 50 years (Kreitman, 1976; Gunnell *et al*, 2000; Amos *et al*, 2001). To assess the influence of these period

effects on suicide rates, we first examined cohort effects for all suicides regardless of the method of suicide, and then for non-overdose, non-gas suicides only. The main methods of non-overdose, non-gas suicide in England and Wales are hanging, jumping and drowning (Charlton *et al*, 1992) and these methods have not changed in lethality or availability in the post-war years.

Similarly, over the period covered by this analysis there was a change made in the official classification of suicide (see above). The category undetermined deaths (those given a coroner’s open verdict) was introduced in 1968. As this change in the categorisation of deaths could have influenced the number of officially recorded suicides subsequent to 1968 (a period effect), we investigated the influence on any apparent birth cohort effects of restricting our analyses to those deaths given a suicide verdict alone (ICD–9, E950–959).

To further investigate the presence of birth cohort effects, we assessed the extent to which the ranking of successive birth cohort’s suicide rates at age 15–19 were sustained at later ages by calculating Kendall’s rank correlations of their rankings using Stata (version 7.0; StataCorp, 2001).

**Table 1** Diagram showing data used to construct birth cohort specific suicide rates (focusing on 1940 birth cohort)

Age at death (years)	Year of birth																		
	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
	Year of death																		
15	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
16	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	
17	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969		
18	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969			
19	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969				
20					1960	1961	1962	1963	1964	1965	–		–						
21				–	1960	1961	1962	1963	1964	–	1966								
22			–	1960	1961	1962	1963	1964	–	1967									
23		–	1960	1961	1962	1963	1964	–		1968									
24		1960	1961	1962	1963	1964	–			1969									
25					–	1965	1966	1967	1968	1969	1970								
26				–	1965	1966	1967	1968	1969	–	1971								
27			–	1965	1966	1967	1968	1969	–		1972								
28		–	1965	1966	1967	1968	1969	–			1973								
29		1965	1966	1967	1968	1969	–				1974								

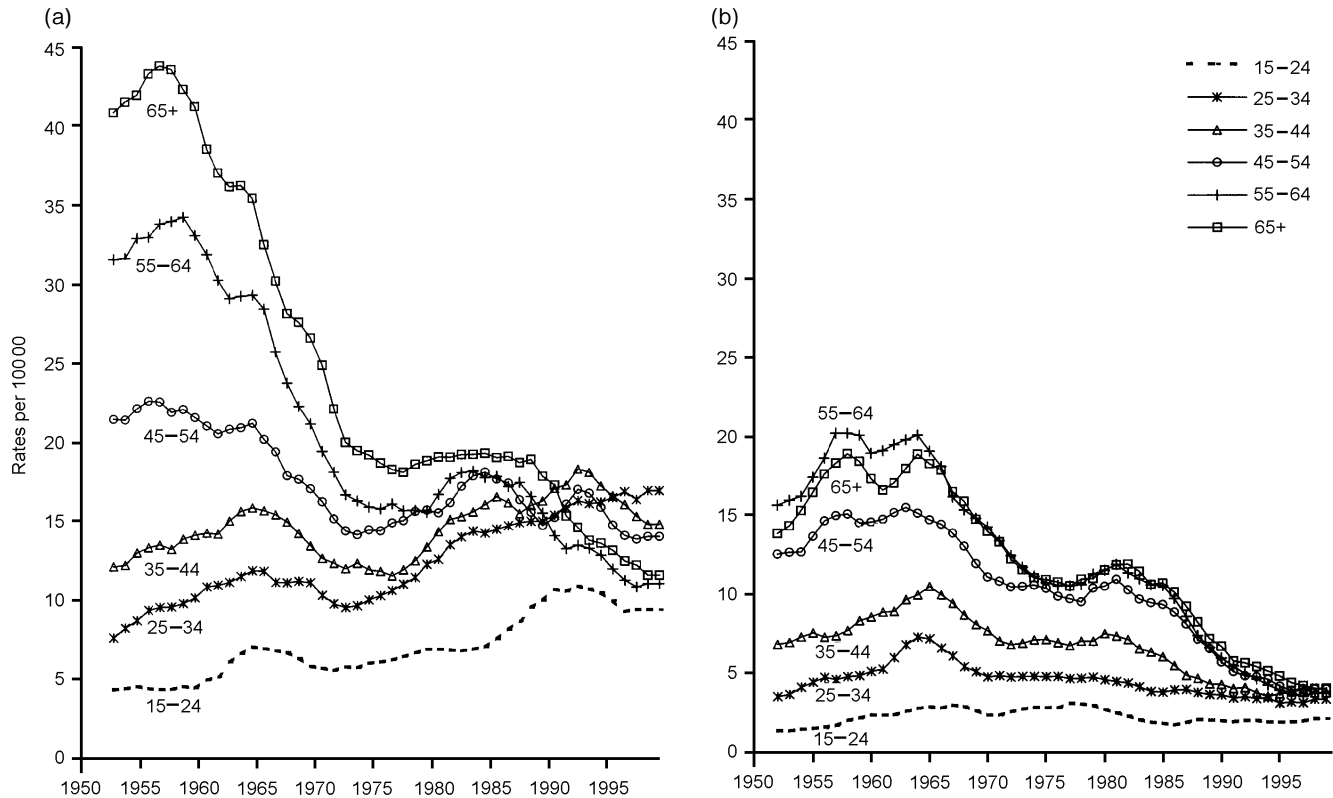


Fig. 1 Age-standardised suicide rates: 1950–1999 England and Wales (3-year moving averages) in (a) males and (b) females.

**RESULTS**

**Age and period effects**

Trends in suicide (excluding undetermined deaths) between 1950 and 1999 differed markedly by age and gender (Fig. 1). Suicide rates doubled in men aged 15–44 years although, with the exception of 25- to 34-year-olds, they began to decline in the 1990s. In older men and women in all age

groups, except those aged 15–24, rates have declined since the 1960s. The varying rates by age group provide evidence of an age-by-period interaction; the relative rates of different age groups vary in different time periods. The relatively consistent ranking of age-specific suicide rates in females provides evidence of an age effect; regardless of time period, suicide rates are highest in women aged 55+ and lowest in those aged

< 34. Possible period effects are suggested by the fall in suicide rates occurring in all age-gender groups in 1965–70 and the rise in most groups in the late 1970s/early 1980s.

Figure 2 further investigates period effects. Suicide rates in the six age groups are shown for five time (of death) periods. Period effects are present if the suicide rate at all ages in a particular time period is higher or lower than that in other time periods and if there is evidence of parallelism between the lines. There is no strong evidence of period effects in males; the profile of age-specific suicide rates varied markedly between 1955 and 1995. In females, Fig. 2 indicates that there have been year-on-year decreases in suicide rates across all age groups except 15- to 24-year-olds over the time studied, indicative of period effects.

**Cohort effects**

Figure 3 shows that in every 5-year age band up to age 30–34, suicide rates were higher in each successive birth cohort. This indicates a possible birth cohort effect on youth suicide. This observation is supported by the finding of significant

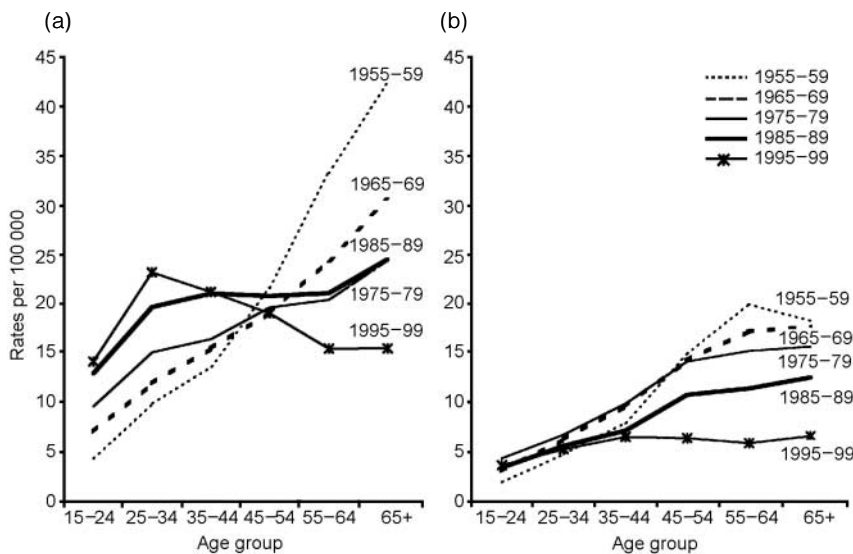


Fig. 2 Suicide and undetermined death rates by time (of death) period in (a) males and (b) females.

correlations (generally  $>0.75$ ) between the ranking of each birth cohort's suicide rates at age 15–19 with the ranking at subsequent ages (Table 2). There is evidence, however, that suicide rates for the 1975 and 1980 birth cohorts at age 15–19 and 20–24 (1975 birth cohort only) are similar to those of the 1970 birth cohort. For the earlier born (pre-1960) birth cohorts there is some evidence that suicide rates peak at successively younger ages: 45–49 years for 1940 and 1945 birth cohorts, and 40–44 for the 1950 birth cohort, indicating a possible period effect as peaks occur in the same time period (around 1990).

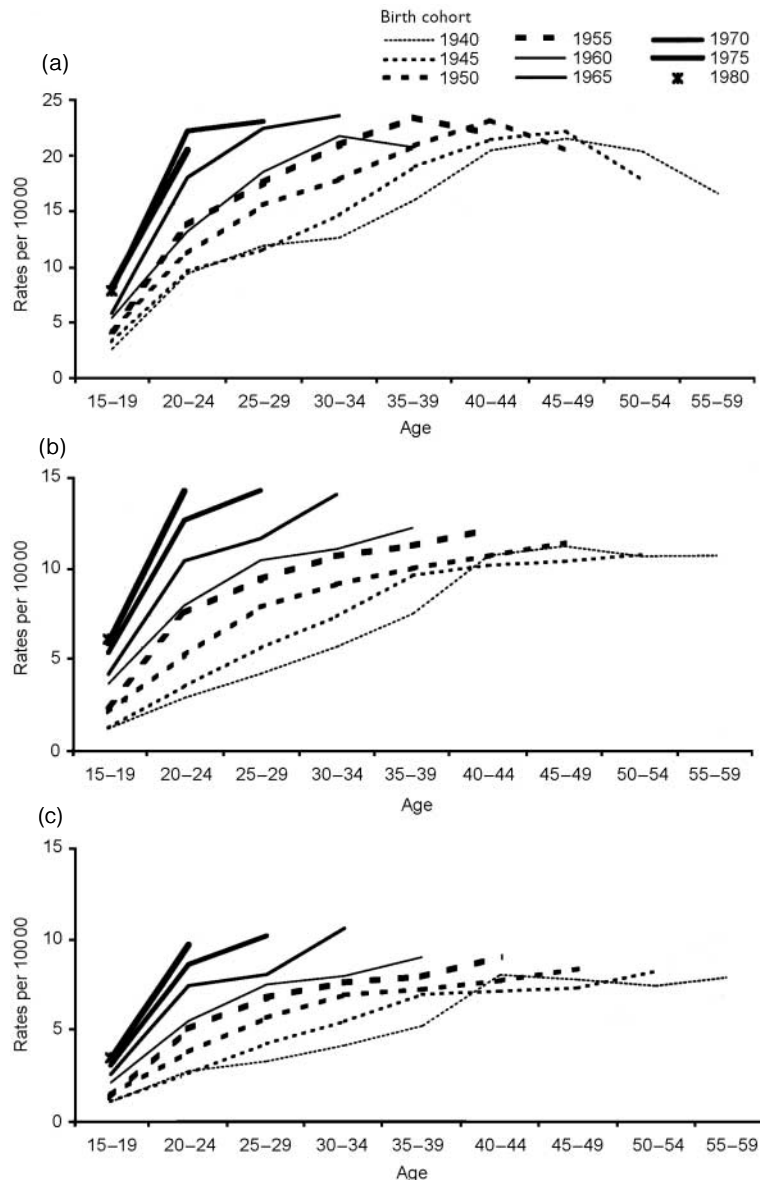
In Fig. 3b suicides by overdose and gassing are excluded. Similar birth cohort effects were observed, but in contrast to those shown in the full analysis, there was no evidence that rates peaked earlier in later born cohorts, supporting the suggestion that this was a period effect because of the popularity and lethality of a particular method of suicide. As this occurred towards the end of each cohorts' period of follow-up, the effect could reflect the recent decrease in suicides because of the reduced toxicity of car exhaust gases (Amos *et al*, 2001). Exclusion of undetermined deaths in Fig. 3c does not alter these conclusions.

In females (Fig. 4a), unlike males, there is no clear evidence that successive birth cohorts have experienced monotonic increases in their suicide rates at all ages. The statistical analysis in Table 2 supports this finding. In the analysis excluding overdose and gassing (Fig. 4b) and undetermined deaths (Fig. 4c), which together account for over half of all female suicides, there is a suggestion that the 1975 and 1980 birth cohorts experienced higher suicide rates than previous birth cohorts, but because of the limited number of data points it is not possible to reach a firm conclusion about this.

## DISCUSSION

### Main findings

We have found evidence for a cohort effect on suicide rates in males born after 1940. Over the period we examined, successive male birth cohorts appear to have experienced a higher risk of suicide throughout their lives than earlier-born cohorts. These effects do not seem to be because of changes in the official classification of suicide or in the lethality of commonly used methods. The cohort



**Fig. 3** Male rates of suicide and undetermined death in successive 5-year birth cohorts at different ages.

(a) All suicides and undetermined deaths; (b) suicides and undetermined deaths except those by overdose and gassing; (c) overdose, gassing and undetermined deaths excluded.

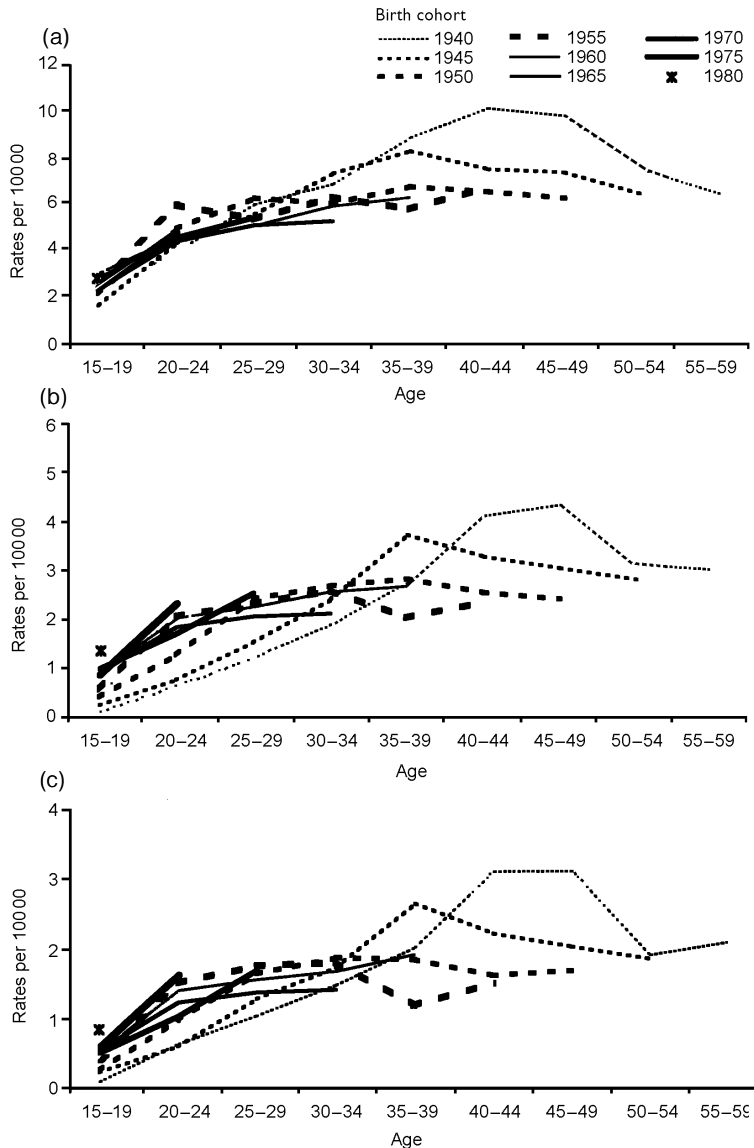
effects may be diminishing in the most recent two male birth cohorts (1975 and 1980). In females, apart from an indication in the assessment of non-overdose/non-gas suicides of a rise in the suicide rates of the 1975 and 1980 birth cohorts, no similar effects were seen.

### Strengths and limitations

The main limitation of our analysis is the rather short period of follow-up for the cohorts that have experienced some of the highest levels of suicide before the age of 30. It is possible that as they age these birth cohorts will no longer continue to

experience such high death rates. Indeed, there is evidence of such a diminution in the cohorts born before 1960.

We did not attempt to undertake age-period-cohort modelling in view of the recognised limitations of these approaches (Newman & Dyck, 1988; Lee & Lin, 1995). Our graphical displays allow us to investigate age and period effects, but because of their linear dependency assessment of their separate effects is problematic. The most consistent evidence of a period effect was the decrease in suicides in all age-gender-groups in the late 1960s (Fig. 1). The most likely explanation for this is the detoxification of the domestic



**Fig. 4** Female rates of suicide and undetermined death in successive 5-year birth cohorts at different ages. (a) All suicides and undetermined deaths; (b) suicides and undetermined deaths except those by overdose and gassing; (c) overdose, gassing and undetermined deaths excluded.

gas supply and the subsequent reduction in both domestic gas and overall suicides (Kreitman, 1976). The rise in suicides in most age–gender–groups in the late 1970s/early 1980s coincides with the rise in unemployment at that time (Gunnell *et al*, 1999) and could reflect the effects of economic recession on suicide.

As far as we could, we controlled for the period effects of changes in the availability/lethality of common methods of suicide (domestic gas poisoning and overdose) by carrying out an analysis restricted to those suicides using other methods. Although this approach takes no account of possible ‘method transfer’ to methods other than overdoses and

gassing, there is some epidemiological evidence that people who use another method of suicide rather than gassing tend to use overdose, and this method was also excluded from this restricted analysis (Gunnell *et al*, 2000). Furthermore we investigated the effects of changes in the official coding of suicide deaths by inspecting figures based on suicide deaths alone, excluding undetermined deaths (ICD–8 and 9 E980–E989). The change in coding did not appear to influence the patterns we observed. By restricting our analysis to post-war deaths we ensured the well-recognised effects of war on national suicide rates (Charlton *et al*, 1992) did not influence observed trends.

We were, however, unable to control for other possible period effects, such as the economic recession in the 1980s and associated raised levels of unemployment (Gunnell *et al*, 1999). Our analysis of period effects in males (Fig. 2) revealed no strong evidence of such effects. Thus, the year-on-year rises in young male suicide are more likely to be cohort effects or reflect the influence of year-on-year changes in risk factors for suicide, which have varying effects on different age–gender groups.

**Cohort effects on suicide reported in other countries**

Analyses of national mortality data up to the early 1990s for the USA (Murphy & Wetzel, 1980), Canada (Solomon & Hellon, 1980), Italy (La Vecchia *et al*, 1986), New Zealand (Skegg & Cox, 1991), Spain (Granizo *et al*, 1996), Sweden (Allebeck *et al*, 1996) and Belgium (Moens *et al*, 1987), using a range of different analytical approaches, have reported that suicide rates in successive male birth cohorts have increased in the post-war years. In contrast, an analysis of successive Danish birth cohorts, up to 1971 births, found no evidence of such an effect (Bille-Brahe & Jessen, 1994). Similarly in Australia, successive birth cohorts followed up to 1979 showed little evidence of cohort effects, except in the youngest (1955 and 1960) birth cohorts (Goldney & Katsikitis, 1983). A more recent analysis of Australian data up to 1999, however, reports post-war patterns of male suicide consistent with those seen in our analysis (Snowdon & Hunt, 2002).

Findings for female suicides are less consistent than those for males. In Britain declines in the suicide rates of successive post-war cohorts have been reported (Surtees & Duffy, 1989), whereas there have been increases in successive female birth cohorts in the USA (Murphy & Wetzel, 1980), Canada (Solomon & Hellon, 1980), Belgium (Moens *et al*, 1987) and, to a lesser extent, Australia (Goldney & Katsikitis, 1983). No effects were seen in New Zealand (Skegg & Cox, 1991), Denmark (Bille-Brahe & Jessen), Italy (La Vecchia *et al*, 1986) or Sweden (Allebeck *et al*, 1996).

Differences between studies could reflect real variations in national patterns of suicide, differences in the period studied, the analytical approaches used, or

**Table 2** Kendall's rank correlations (and *P* value of test of independence) between ranks of each cohort's suicide rate at age 15–19 and the rank of their rates at subsequent ages

Gender (age)	<i>n</i> of rank estimates	Suicide and undetermined mortality rates (all methods) (15–19)		Suicide and undetermined mortality rates (all methods excluding overdose and gassing) (15–19)		Suicide mortality rates (excluding undetermined deaths and deaths by overdose and gassing) (15–19)	
		Kendall's rank correlation	<i>P</i> value for test of independence <sup>1</sup>	Kendall's rank correlation	<i>P</i> value for test of independence <sup>1</sup>	Kendall's rank correlation	<i>P</i> value for test of independence <sup>1</sup>
<b>Males</b>							
20–24	8	0.786	0.009	1.000	0.001	0.857	0.004
25–29	7	0.810	0.016	1.000	0.003	0.905	0.007
30–34	6	0.867	0.024	1.000	0.009	0.867	0.024
35–39	5	0.400	0.46	1.000	0.028	0.800	0.086
40–44	4	1.000	0.089	0.333	0.73	0.000	1.00
45–49	3	–0.333	1.00	0.333	1.00	0.333	1.00
<b>Females</b>							
20–24	8	0.429	0.17	0.357	0.30	0.643	0.035
25–29	7	–0.524	0.13	0.429	0.23	0.238	0.54
30–34	6	–0.467	0.26	0.067	1.00	–0.200	0.71
35–39	5	–0.800	0.086	–0.400	0.46	–0.400	0.46
40–44	4	–0.667	0.31	–1.000	0.089	–1.000	0.089
45–49	3	–1.000	0.30	–1.000	0.30	–1.000	0.30

1. A significant result gives evidence against the null hypothesis of independence.

study power. Analyses of suicide trends in small countries and in women, where the numbers of suicides are relatively low, are unable to give precise estimates of suicide rates within a particular age–period–cohort grouping. Detection of cohort effects in this context is difficult because of fluctuations in rates based on few events. The different findings could also reflect the varying influence of period effects in different countries and the capacity of the analytical approaches used to assess and control for such effects. Goldney & Katsikitis (1983), for example, suggested that differences in the findings in Australia compared with the USA and Canada could have arisen through the period effects of restrictions on the prescribing of barbiturates in Australia introduced in 1967. More recent analyses of Australian and Canadian suicide trends suggest similar birth cohort effects to those seen in this analysis of data in England and Wales (Mao *et al.*, 1990; Snowdon & Hunt, 2002).

### Possible explanations for birth cohort effects

Taken together, the evidence from a range of industrialised countries suggests that, at

least up until the 1970 birth cohort, each successive post-war cohort of males has experienced a higher suicide rate than its predecessor. Findings for females are less clear-cut. There are a number of possible explanations for the cohort effects observed in males. First, cohort effects could result from the long-term impact of changing levels of exposure in childhood or early adulthood to some environmental influence on long-term mental health. Such factors might include increasing levels of parental separation (Agid *et al.*, 1999), increased substance misuse (Christophersen *et al.*, 1998), or changes in the labour market such as increased female participation (Platt & Hawton, 2000). Second, it is possible that increased media portrayals of idealised lifestyles in televised drama and advertising materials results in young people having increased, but unrealistic, expectations from life. Such mismatches between expectation and reality could lead to increases in suicide risk. Similarly, changes in the media portrayal of suicide (as relatively commonplace and acceptable) could permanently influence the attitudes of young viewers regarding its cultural normality, and hence their likelihood of committing suicide in times of crisis. Last, the effects could conceivably result from changes in the

popularity of particular methods of suicide in successive generations. Such an effect could occur if an individual's preferred method of suicide is based on early life experiences (e.g. media portrayal) and remains the same thereafter. In the UK, for example, it is possible that the increased suicide rates in successive male birth cohorts could reflect a greater preference for hanging as a method of suicide; this method is more usually fatal than the other commonly used methods such as overdose and gassing (Pounder, 1993).

Reasons why these effects should influence female suicide rates to a lesser extent are unclear, although there is a suggestion that similar patterns could be beginning to emerge in younger female generations in England, and in the analyses based on large populations such as the USA and Australia (see above). The main social change among women in the post-war years has been their increased engagement in the labour market and greater equality with men.

### Public health implications

If younger birth cohorts carry their increased suicide rates through into later life then the recent falls in suicide rates in England and Wales will be reversed (Kelly &

Bunting, 1998). Possible explanations for the observed effects require clarification to inform suicide prevention activities.

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## CLINICAL IMPLICATIONS

- Successive post-war generations of men appear to have an increased risk of suicide which they carry with them into middle age.
- If present trends continue, the post-war downturn in the suicide rates of older men could reverse and have an unfavourable impact on overall national suicide rates.
- Explanations for the observed patterns require elucidation if current trends are to be reversed.

## LIMITATIONS

- We did not control for some possible period effects, such as economic recession, and were only able to control crudely for the period effects of changes in the lethality of popular suicide methods.
- Because the birth cohorts who have experienced the most rapid rise in post-war suicide rates are still relatively young, the longer-term impact of their changing risk of suicide remains uncertain.
- Because of the linear relationship between age, period and cohort, distinguishing the relative importance of each of these factors separately is problematic.

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