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Temporal Variation in Irish Suicide Rates

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Using Irish suicide data for the period 1990–1998, the independent effects of month and day adjusting for age, gender, and calendar year effects and distinguishing between holiday and working Mondays were assessed. The male suicide rate was significantly higher on working Mondays (+31%) and Saturdays (+14%), and during April, June, and August (+17%), after adjustment for the other variables. In contrast, female suicide rates were higher only in August (+35%) and exhibited no day effect. Teenage men had a greater elevation of risk on Saturdays, Sundays, and both working and holiday Mondays than any other group. The study findings should be taken into account in the planning of specialized health care services and helplines for suicidal people. Furthermore, the findings provide support for Gabennesch's (1988) broken promise theory and the relationship between dysfunctions of the serotonergic system and suicidal behavior.

Daily and monthly variation in suicide have been described as far back as 1835 and 1879, respectively (Massing & Angermeyer, 1985). Countries from both the northern and southern hemispheres have shown a peak in the number of suicides in late spring/early summer (Chew & McCleary, 1995). Less often, a secondary peak in autumn has been found (Massing & Angermeyer, 1985), primarily among women (Hakko, Rasanen, & Tiihonen, 1998; Meares, Mendelsohn, & Milgrom-Friedman, 1981). More recently, a diminished seasonal effect has been reported for England and Wales (Yip, Chao, & Chiu, 2000), while data from 20 countries indicated that the month with maximum daylight consistently had the peak number of suicides (Petridou, Papadopoulos, Frangakis, Skalkidou, & Trichopoulos, 2002). The vast majority of studies on the distribution of suicide by day of the week have reported the number of suicides to be highest on Mondays and lowest during the weekend (Massing & Angermeyer, 1985). With some exceptions (Phillips & Wils, 1987; Stack, 1995), studies of the temporal variation of suicide have generally focused on either seasonal or daily variation and have not adjusted for the effects of age and calendar year (Hakko, Rasanen, Tiihonen, & Nieminen, 2002). The present study assessed the calendar month and day of the week effects on Irish

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male and female suicide rates over the period 1990 to 1998, adjusting for age and year and distinguishing between working and holiday Mondays.

METHODS

Study Population

The Irish Central Statistics Office (CSO) provided data electronically for every death by suicide (ICD-9 codes E950-959; World Health Organization, 1978) that occurred in the country between 1990 and 1998, inclusively. Undetermined death data (i.e., ICD-9 codes E980-989; World Health Organization, 1978) were not considered. Ireland has a very low rate of undetermined death (on average the annual rate was less than 1 per 100,000 for the study period) because of the "balance of probabilities" approach to the recording of suicide. The suicide data included the age and gender of the individual as well as the date of death. Date of death was used to determine during which calendar month and on which day of the week the person died. Most public holidays in Ireland are on Mondays, so the dates of all holiday Mondays over the study period were identified in order to be able to assess the effects of working and holiday Mondays separately.

Statistical Analysis

Population data, in 5-year age groups for each gender, were obtained from the National Censuses for 1991 and 1996 (Central Statistics Office, 1992, 1997). For non-census years, the CSO's official annual population estimates were used (Central Statistics Office, 1994, 2000). Suicide rates were calculated for men and women by year, age, calendar month, and day of the week. Where relevant, the rates were age-adjusted to the European Standard Population (Waterhouse, Muir, Correa, & Powell, 1976). For all rates, 95% confidence intervals were calculated using standard methods (Breslow & Day, 1987). Where there were no suicides (i.e., a zero rate) in a particular category, the "rule of 3" was used to estimate the standard deviation (Hanley & Lippman-Hand, 1983). These intervals are displayed on all bar charts using error bars.

Poisson regression analysis was used to estimate the independent effect of year, calendar month, day of the week, and age and their potential interaction on the Irish male and female suicide rates. We coded holiday Mondays to enable separate assessment of their effect and that of working Mondays. We modelled the suicide rate as a function of the predictor variables as follows:

$$\log\left(\lambda_{ijkl}/\mu_{ijkl}\right) = \beta_0 + \beta_{Year,i} + \beta_{Age,j} + \beta_{Month,k} + \beta_{Day,l}$$

where:

- λ_{ijkl} = the expected number of suicides in age category j in year i, month k and day l;
- μ_{ijkl} = the population at risk (in person-day units) in age category j, year i, month k, and day l;
- β_0 = log rate of suicide per person-day for the reference year, age group, month, and day;
- $\beta_{Year,i}$ = the effect of year i relative to the reference year;
- $\beta_{Age,j}$ = the effect of age group j relative to the reference age group;
- $\beta_{Month,k}$ = the effect of month k relative to the reference month;
- $\beta_{Day,l}$ = the effect of day type (working Monday, holiday Monday, Midweek, Saturday, Sunday) relative to the reference day.

The population terms (μ_{ijkl}) were computed from the yearly age distributions of the population by allowing for the varying number of person-days of at-risk time in each of the strata defined by calendar month and day type. While each five-year age group, month, and day were considered separately in the initial model, age, month, and day categories with similar effects, as measured by the incidence rate ratios (IRRs), were combined to

give more parsimonious models in the final analysis. For the analysis of male rates, we used age group 65–74 years, months September–January, and midweek days (Tuesday–Friday) as our reference categories. For the analysis of female rates, we used age group 50–54 years, months June–July, and Sunday as our reference categories. The statistical analysis was done using SPSS version 8.0 and Stata version 6.0 (StataCorp, 1999).

RESULTS

Between 1990 and 1998, there were 3,521 suicides in Ireland, 2,850 (81%) by men and 671 (19%) by women. The European age-standardized Irish suicide rates with 95% confidence interval error bars are presented by sex and calendar year in Figure 1. While the female suicide rate was stable over the period studied, the male rate rose from 16 to 23 per 100,000. In the multivariate Poisson model with year, month, and day, the year effect was well approximated by a linear trend which indicated an annual increase in the male suicide rate of 4.5% since 1990.

Figure 2 presents the suicide rates by 5-year age category. Men in their twenties had the highest rate. The rate dropped thereafter with increasing age, except for secondary peaks in the 55–59 and 75–79 year age groups. The pattern in the Irish female suicide rate was much more regular, rising gradually with age up to 50–54 years and declining thereafter. This pattern was well approximated by a quadratic function in the multivariate Poisson model.

The male suicide rate was highest at 21 per 100,000 during the months of April, June, and August (see Figure 3), over 30% higher than in February, the month with the

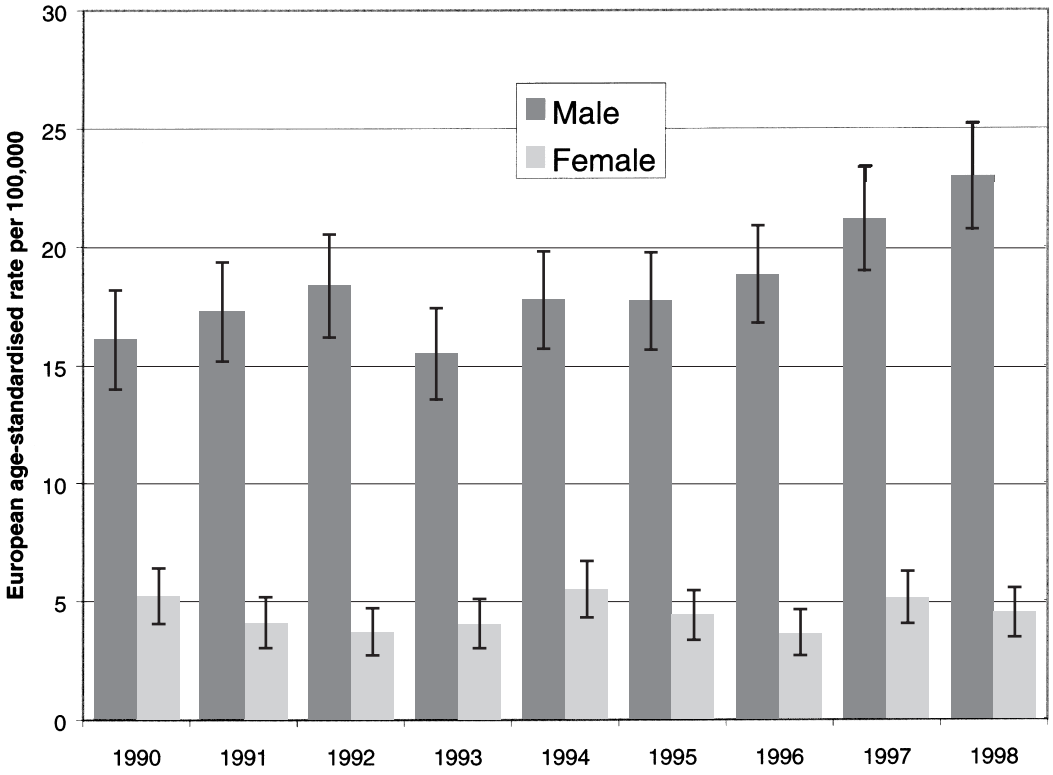

Figure 1. Sex-specific suicide rates in Ireland, 1990–1998.

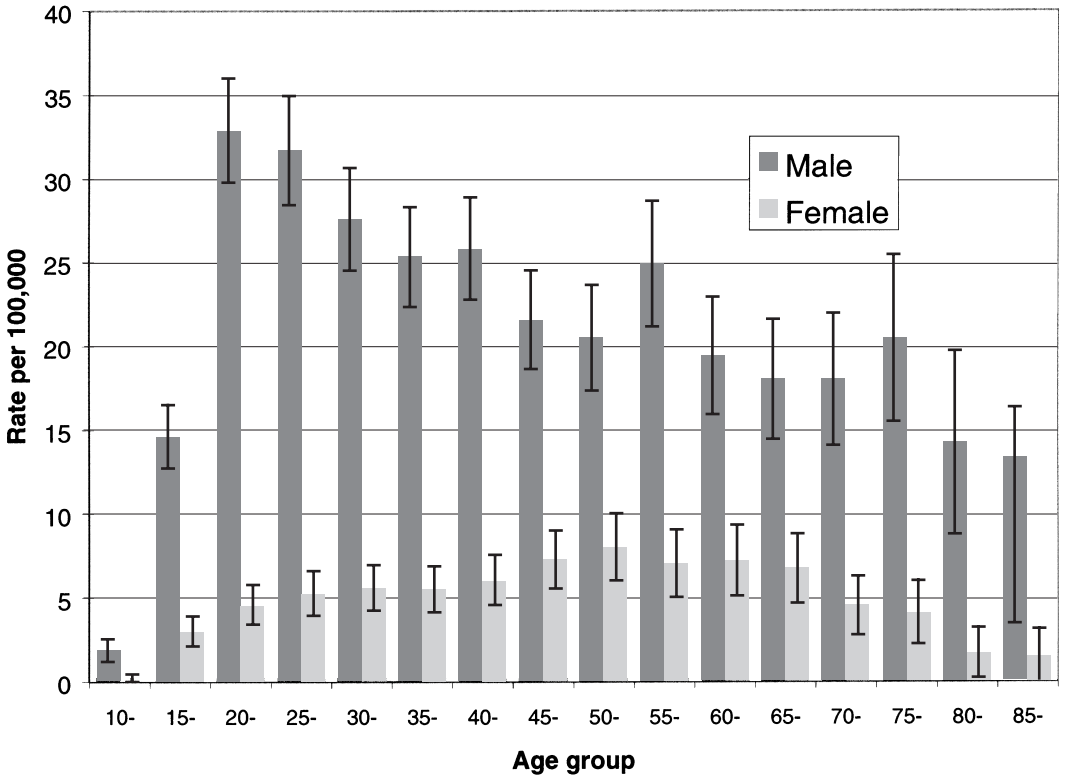

Figure 2. Age-specific male and female suicide rates in Ireland, 1990–1998.

lowest rate. The remaining months had very similar rates, at 17–18 per 100,000. Irish women exhibited less monthly variation with August being the only month when their suicide rate exceeded 5 per 100,000.

The plot of suicide rates by day of the week (see Figure 4) indicates a strong peak on Monday and a secondary peak on Saturday for men, but no apparent trend for women.

The male IRRs from the multivariate Poisson model that assessed the effects of month and day of the week adjusted for calendar year and age are presented in Table 1. April, June, and August had significantly increased suicide rates, about 17% higher than the rate of the reference months (September–January). Saturdays and working Mondays had significantly higher suicide rates than midweek days, while holiday Mondays were comparable to Sundays. A holiday term was not included in the final Poisson model for the Tuesday–Friday weekdays as preliminary analysis showed no evidence of a significant holiday effect on the male suicide rate for these days (IRR = 1.16, $p = 0.42$).

Given that, in Ireland, school examinations take place in June and end-of-school examination results are released in August, it may be hypothesized that the high male suicide rates in these months are a reflection of raised rates in the school-going age categories. Further analyses in young males (aged 15–34 years) indicated that the suicide rates of young men of school-going, college, and working age did not differ in these high-incidence months. Men aged 15–19 years did, however, contribute a disproportionately high number of suicides to the May rate. In addition, men in this age group had the greatest elevation of risk on Saturdays (IRR = 1.52, $p < 0.05$), Sundays (IRR = 1.96, $p < 0.05$), and working Mondays (IRR = 2.11, $p < 0.05$). Uniquely, they had a very elevated and highly

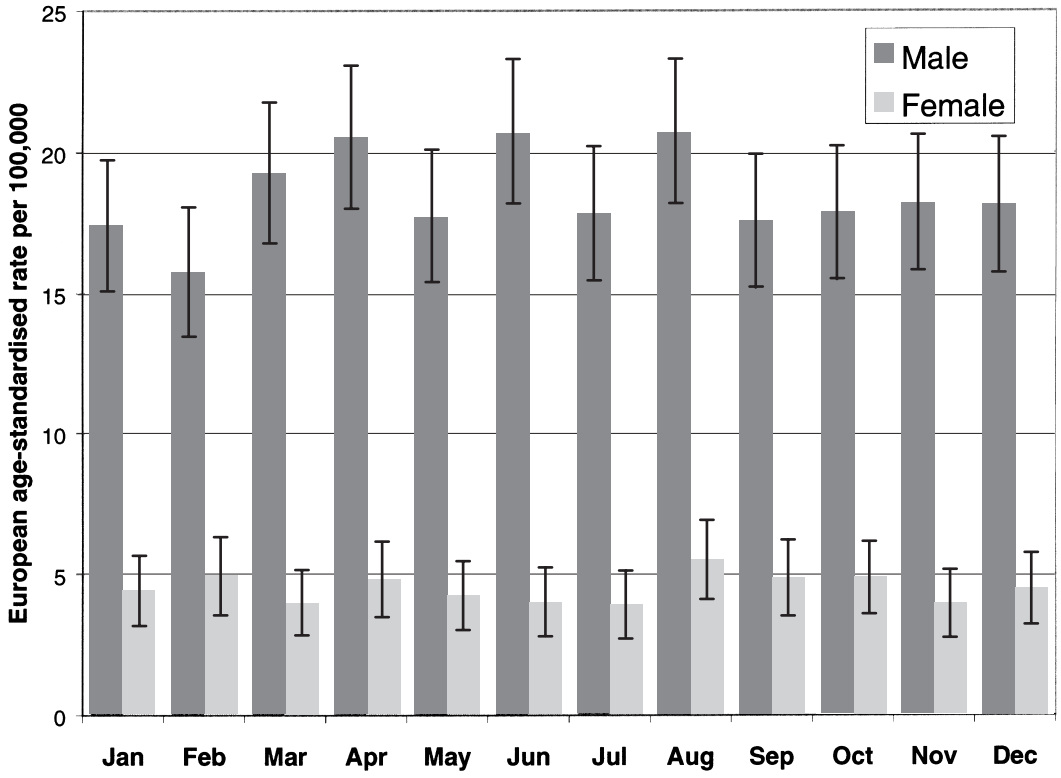

Figure 3. Male and female suicide rates in Ireland by calendar month, 1990–1998.

significant rate (IRR = 3.44, $p < 0.001$) on holiday Mondays.

The female IRRs, adjusted for age and calendar year, are presented in Table 2. August is the only month with an elevated rate but this just failed to reach statistical significance (IRR = 1.35, $p = 0.056$). There was no evidence of a day effect, although the Sunday rate was somewhat lower than other days. As for the male data, a holiday term was not included in the final Poisson model for the Tuesday–Friday weekdays as preliminary analysis showed no evidence of a significant holiday effect on the female suicide rate for these days (IRR = 0.74, $p = 0.50$).

DISCUSSION

This, the first study to investigate the daily variation of suicide in Ireland, found that Irish men had their highest rate of suicide on working Mondays while Irish women did not show a daily pattern. The number of suicides in other countries has been consistently found to be highest on Mondays and lowest during the weekend (Massing & Angermeyer, 1985). Thus, the present paper confirms the excess of suicides on Monday for men but not for women. It clarifies that this excess of suicides by Irish men did not generally occur on holiday Mondays, which were comparable to Sundays. Contrary to the reported weekend trough, Irish male suicide rates were also increased on Saturdays but to a lesser extent than on Mondays.

Independent of the daily variation, peaks of similar magnitude (+17%) occurred in the male suicide rate during the months of April, June, and August, whereas women only had an increased rate in August. This would indicate that the spring peak in male and fe-

male suicides that has been frequently found (Chew & McCleary, 1995) is exhibited only by Irish men. The Irish male data also supports, to some extent, the finding that the month with maximum daylight (June) has the peak number of suicides (Petridou et al., 2002). The lesser secondary peak in suicide that has been found to occur in autumn (Massing & Angermeyer, 1985) was exhibited by both men and women in Ireland.

Suicide Trends

The male suicide rate in Ireland increased by almost 50% between 1990 and 1998 while the female rate remained stable. Extending our year-month-day model to accommodate interactions between age and calendar year, the male increase was found to be largely due to men aged 20–44 years. The trend in male suicide has been associated primarily with the rapid social change that has occurred in Ireland and, to a lesser extent, with a reduction in the underreporting of suicide (Kelleher, Corcoran, & Keeley, 1997). Across all ages, the suicide rate for men far exceeded that of women. Young adult males were at highest risk and the rate diminished with increasing age. This pattern of male suicide is similar to that in the United Kingdom but different from that in most European countries where the elderly have the highest rates (World Health Organization, 2002).

Monthly Variation in Suicide

Irish men exhibited greater monthly variation in suicide than their female counterparts as has been previously indicated (Chew & McCleary, 1995). Several studies have found the seasonal variation in suicide to be largely due to variation in the number of vio-

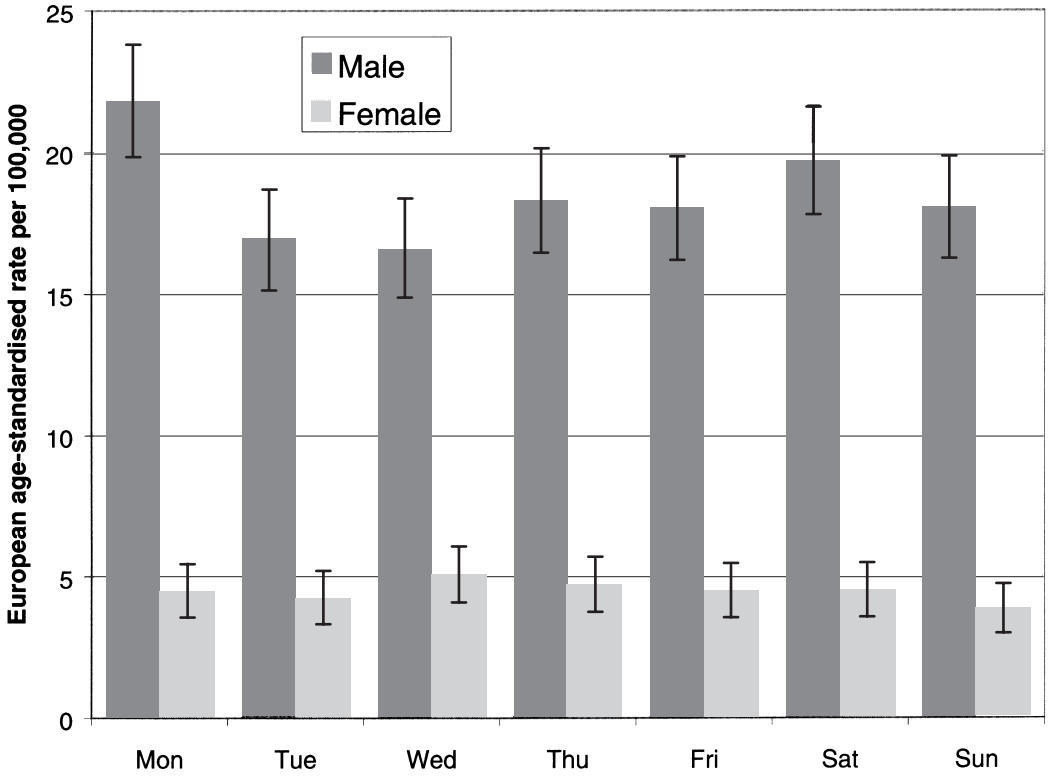

Figure 4. Male and female suicide rates in Ireland by day of the week, 1990–1998.

TABLE 1
Incidence Rate Ratios for Male Suicide Rates Adjusted for Year and Age Effects

	IRR	95% CI
Months		
September–January	1.000	–
February	0.887	0.750–1.024
March	1.066	0.919–1.213
April	1.178	1.019–1.337
May	1.025	0.882–1.168
June	1.172	1.013–1.331
July	0.999	0.858–1.140
August	1.174	1.017–1.331
Days		
Midweek	1.000	–
Saturday	1.135	1.013–1.257
Sunday	1.084	0.964–1.204
Working Monday	1.313	1.172–1.454
Holiday Monday	1.099	0.789–1.409

lent suicides (Lester, 1999; Maes, Cosyns, Meltzer, De Meyer, & Peeters, 1993; Massing & Angermeyer, 1985). While we did not analyze the data by method, the greater seasonality for Irish men may be a reflection of their more frequent use of violent methods (Kelleher, Keohane, Corcoran, Keeley, & Neilson, 2000).

TABLE 2
Incidence Rate Ratios for Male Suicide Rates Adjusted for Year and Age Effects

	IRR	95% CI
Months		
December–January	1.093	0.797–1.389
February	1.224	0.822–1.626
March	1.014	0.671–1.357
April	1.191	0.805–1.577
May	1.093	0.732–1.454
June–July	1.000	–
August	1.352	0.935–1.769
September–October	1.222	0.897–1.547
November	1.027	0.678–1.376
Days		
Sunday	1.000	–
Non-Sunday	1.173	0.903–1.443

Meteorological factors, particularly temperature change, were mentioned in 1879 by Morselli in the first explanation ever given for the seasonal variation of suicide (Massing & Angermeyer, 1985). There is evidence that countries with temperate climates and defined seasons display more seasonality in the distribution of suicides than countries, like Ireland, without clear seasonal climate patterns (Chew & McCleary, 1995). In contrast, Durkheim postulated that the extended duration of daylight offers "wider latitude to collective life," which would lead to increased suicide (Massing & Angermeyer, 1985). This is supported by the recent cross-national study which not only showed that the highest number of suicides consistently occurred in the month with maximum daylight but that the seasonal amplitude of suicide was positively associated with the number of hours of sunshine in the country (Petridou et al., 2002). These authors call for further research in the field of sunshine-regulated hormones, particularly melatonin (Petridou et al., 2002), which is associated with increased suicide risk (Bunney, Garland-Bunney, & Patel, 1986). Alcohol may also be implicated in the seasonality of suicide. An Australian study reported that a registered blood alcohol count was most likely to be found in spring suicides (Cantor, Hickey, & De Leo, 2000). Other biological factors associated with suicidal behavior, such as the central neurotransmitter serotonin (also affected by alcohol), have been found to exhibit a seasonal variation similar to that for suicide (Maes et al., 1995; Swade & Coppen, 1980).

The stress of end-of-school examinations receives much attention in Ireland around the time they take place (June) and when the results are released (August). In an analysis confined to men aged 15–34 years, the effect of these high-incidence months was found to be similar for men of school-going, college and working age. This would undermine the hypothesis that the increased suicide rate is due to either the timing of the examinations or the release of their results. Teenage men did contribute a disproportionately high number of suicides to the May

rate. This may be related to the attendant stress of examinations given that college examinations begin in May and that it is the month preceding school examinations; however, further research is required to clarify this relationship.

Daily Variation in Suicide

Since the daily variation in suicide was first examined, the usual finding of a peak on Mondays and a trough during the weekend has been explained in social terms. The weekend is the time for rest from work and recreation whereas Monday signals the beginning of another working week (Massing & Angermeyer, 1985). It is reasonable to consider that some people may have difficulty returning to a more structured, routine lifestyle after the weekend. Alternatively, or in addition, they may be in unsatisfying employment or unemployed, in which case Monday may make them acutely aware of their situation in contrast with that of their employed peers. This would also explain the absence of a higher rate of male suicide on holiday Mondays reported in the present paper. The "broken promise effect" also provides an attractive explanation for the Monday peak and weekend trough whereby the weekend is seen as a positive period of the week which, for some, promises more than it delivers (Gabennesch, 1988).

While we found that Irish men were at highest risk of suicide on working Mondays, they also had an elevated rate on Saturdays. During the weekend, work, study, and daily routines are no longer preoccupations and social interactions take priority. While traditionally seen as a positive change and used to explain the trough in suicide at the weekend, increased socialization does provide greater scope for interpersonal problems which are the most common precipitants cited in relation to suicidal behavior (Bancroft, Skrimshire, Casson, Harvard-Watts, & Reynolds, 1977). Additionally, there is the increased consumption of alcohol and other drugs at the weekend (Jackson, 1997). Alcohol, partially mediated by serotonin, reduces impulse control thereby increasing the risk of aggressive and self-destructive behavior (Gorwood, 2001). In addition, intoxication with alcohol and/or illicit drugs can be accompanied by temporary but severe depressive symptoms (McIntosh & Ritson, 2001).

According to a stress-diathesis model (Mann, Waternaux, Haas, & Malone, 1999), dysfunctions of the serotonergic system are linked to both suicidal and aggressive behavior. Evidence for the existence of different pathways to lethal aggression, either suicide or homicide, is also supported by sociological studies (Unnithan, Corzine, Whitt, & Huff-Corzine, 1994). From the sociological perspective, the current of lethal aggression is more internalized in Ireland, with its high rate of suicide relative to homicide, than in the United States. Thus, increased consumption of alcohol at the weekends would be more likely to trigger suicide in Ireland and homicide in the United States.

Substance misuse is less common in women (Castilla, Barrio, Belza, & de la Fuente, 1999; Jackson, 1997). They are also more likely than men to cope positively with relationship difficulties by networking with friends and confidantes (Hobfoll, Dunahoo, Ben-Porath, & Monnier, 1994), which may go some way to explaining why Irish women did not show significant daily variation in suicide rates. However, the study had the limitation that the statistical power of the analysis of the female data was reduced due to the relatively limited number of female suicides over the study period (671 for women compared to 2,850 for men).

Alcohol consumption has been associated with increased risk-taking behavior in the young and particularly in young men (Castilla et al., 1999; Mongrain & Standing, 1989). We found that during weekends and on both working and holiday Mondays, Irish teenage men exhibited a greater rise in suicide rate than any other group. The prevalence of alcohol intoxication/binge drinking in Irish teenagers (male and female) has increased and is among the highest in Europe (Plant, 2001). If this trend continues, it might contribute to further increases in the suicide

rate of Irish teenagers of both genders, and particularly so at the weekend.

As mentioned above, the study had the limitation of reduced statistical power in the analysis of the female data. The lack of specific data regarding biological and socioeconomic factors and alcohol consumption meant we could not empirically determine correlations with temporal variations in suicide. Where possible, such investigations should be incorporated into future studies of temporal variations in suicide rates. There may also be a limitation to how generalizable the study findings are to settings where the culture and/or suicide trends differ.

Yet clarifying the temporal variation of suicide, as we have done for Ireland, advances our understanding of the phenomenom. It provides further evidence of the multifactorial nature of the problem. Despite a large number of research studies, implications for improved suicide prevention have generally been absent or vague. The seasonal covariance of serotonin and suicide (Maes et al., 1995; Swade & Coppen, 1980) would indicate to us the need to establish whether serotonin's natural seasonality continues for those on medication that affects the serotonergic system. If so, this might inform decisions relating to the management of such medication. Irish men, particularly teenage men, are at highest risk of suicide during and just after the weekend. The provision of support services such as helplines and mental health liaison staff should reflect this pattern, especially if it were also found for nonfatal suicidal behavior. In the United States, it has been found that month and day variations in the frequency of third-party suicide calls to a crisis intervention center paralleled variations in completed suicides (Noble, 1996). At the individual level, clinical decisions (e.g., weekend discharges) should be informed by knowledge of temporal patterns, particularly where a male patient has a history of alcohol misuse, relationship difficulties, or suicidal behavior.

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