AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

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bulletin

Seasonality of death

Highlights

- In Australia, there are more deaths in the winter months of June, July and August, and less deaths in the summer months of December, January and February. In 1999, each day in August averaged 400 deaths, whereas each day in February averaged 316 deaths.
- The very young and the very old are more likely to die in winter.
- Diseases of the circulatory system, pneumonia and influenza and sudden infant death syndrome are all highly seasonal causes of death, occurring more often in winter. Common causes of death among young adults such as from motor vehicle accidents, suicide, drowning and assault are more likely to occur in warmer months.
- Deaths in Australia occur most frequently on Friday or Saturday. However, heart attack and suicide deaths occur most frequently on Monday, whereas motor vehicle traffic accident deaths occur most frequently on weekends.
- Although excess winter deaths predominated for most of the twentieth century, the nineteenth century saw an excess in summer deaths. This excess disappeared in parallel with the decline of infectious and parasitic diseases, and the rise in diseases such as circulatory and respiratory disease, which were more likely to cause death in colder months.

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Deaths tend to occur more often in the winter months of June, July and August…

Introduction

Deaths are predictable to some extent, in that they occur more often for particular causes such as cardiovascular disease or cancers, or at older ages, or within vulnerable population groups. Deaths also tend to occur more often at certain times of the year. In Australia, as in other developed countries, most deaths occur in colder months (Sakamoto-Momiyama 1978, Mackenbach et al. 1992). Deaths attributable to a number of specific causes follow a yearly cycle, peaking in winter and occurring less frequently in summer. Deaths for some causes are also more frequent on certain days of the week, or even at certain times of the day.

This bulletin will examine these patterns of death to see how deaths vary by day, by month and by season, and whether these patterns have changed over time.

Method

Trudeau (1997) examined monthly and daily patterns of death by cause for Canada, using mortality data from 1974 to 1995. The approach used in that research has been adopted here to examine seasonal patterns of death in Australia.

Deaths by day of occurrence from 1 January 1964 to 31 December 1999 were extracted from the Australian Institute of Health and Welfare (AIHW) Mortality Database. Records in this database are derived from data supplied by State and Territory Registrars of Births, Deaths and Marriages and coded by the Australian Bureau of Statistics (ABS).

For each of the years 1964–1999, the daily average number of deaths per month was expressed as a proportion of the daily average for the entire year, thus deriving a measure of seasonality. This measure is expressed as a percentage, and varies around 100%. Greater variation from 100% indicates a more seasonal effect; for example, a seasonal factor of 115% for a certain month indicates that the average number of deaths per day is 15% higher in that month than if there were no seasonality.

A number of causes of death are examined in this bulletin for evidence of seasonal or daily variation. These causes, coded to the Ninth Revision of the International Classification of Diseases (ICD-9), were:

Diseases	ICD-9 codes
Neoplasms	140–239
Diseases of the circulatory system	390–459
Acute myocardial infarction	410
Pneumonia and influenza	480–487
Sudden infant death syndrome	798.0
Motor vehicle accidents	E810–E825
Suicide and self-inflicted injury	E950–E959

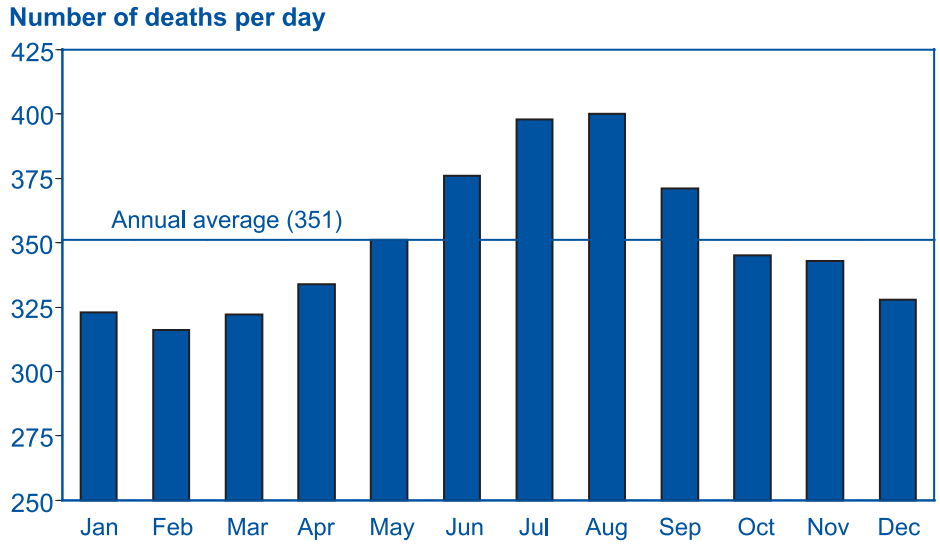
Long-term seasonal trends in mortality are also examined. For the years 1911–1963, data by month of registration were published in *Demography*, the annual bulletin of the (then) Bureau of Census and Statistics. Data for New South Wales, covering the years 1856–1910 were published in *Annual Report from the Registrar General on Vital Statistics*, and data for Victoria for the years 1854–1910 were published in *Statistics of the Colony of Victoria* (ABS 1989).

Note that all data prior to 1964 are based on month of registration of death and not month of occurrence. Legislation required that deaths be registered shortly after occurrence; the period varied between colonies, and was within 30 days in New South Wales, and 7 days in Victoria (McDonald et al. 1987). Most deaths were registered in the same month as their occurrence. A small proportion of deaths may have been registered in the month, months, or even years following occurrence, due to factors such as requirements for a coronial inquest, end-of-year lags or even staff coder shortages (Taylor et al. 1998). These delays might have some effect on monthly calculations, less effect on seasonal (3-monthly) calculations, and less effect still on yearly calculations.

Monthly patterns of death

In Australia during 1999, there were approximately 128,000 deaths—an average of 10,673 for every month, or 351 for every day of the year. Deaths occurred more frequently in some months than others. Each day in February saw an average of 316 deaths, whereas each day in August saw an average of 400 deaths (Figure 1). Deaths tend to occur more often in the winter months of June, July and August and less often in the summer months of December, January and February.

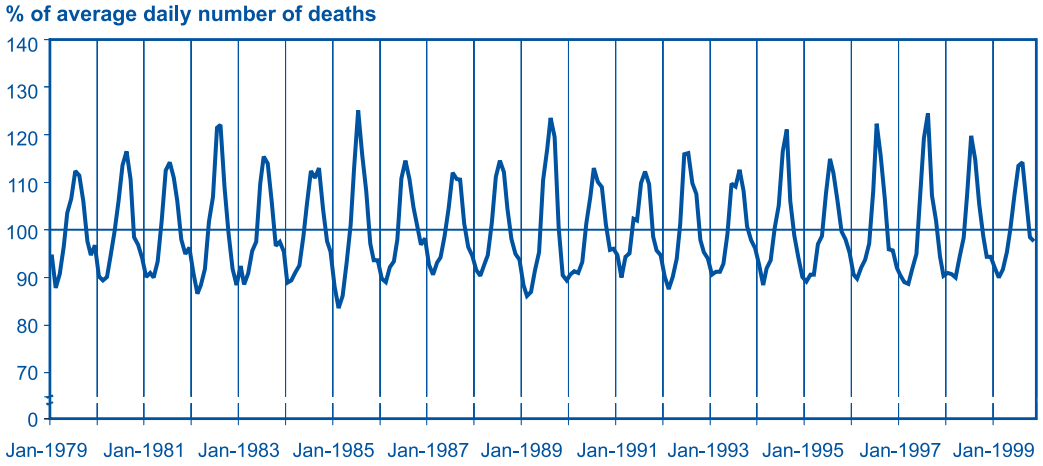
Figure 1: Average daily number of deaths, by month, Australia, 1999



Seasonality of death

Deaths vary by 30% or more between low and high months

Figure 2: Seasonality of deaths, January 1979 to December 1999

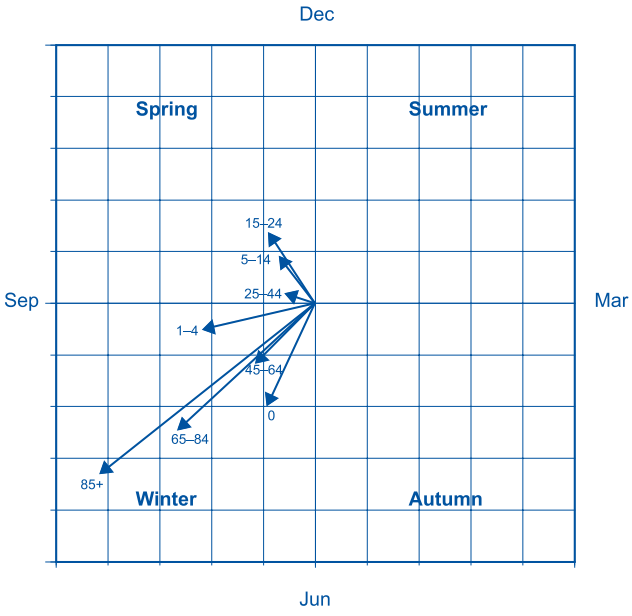


Examination of earlier years shows the same cyclical pattern (Figure 2). Deaths peak in August and trough in February, varying by 30% or more between low and high months. This pattern is quite regular, despite factors such as Australia's comparatively mild climate and year-to-year variations in temperature.

Comparison with a northern hemisphere country such as Canada, not surprisingly, shows a similar but reversed effect, with deaths peaking in January and falling to a minimum in August (Trudeau 1997).

The impact of excess deaths in winter is greatest for the young and the old. In considering the years 1979–1999, although deaths for all age groups peaked in August, the peak for young persons aged 15–24 occurred in the warmer month of November. Figure 3 shows the strength of seasonality for various age groups. If the proportion of deaths in each month is expressed as a series of vectors, these can be

Figure 3: Strength of seasonality of deaths, by age group, 1979–1999



summed to obtain a single vector of seasonality (New Zealand Ministry of Health 1999), with the direction of the vector indicating in which season deaths tend to occur, and the magnitude of the vector indicating the strength of the seasonal effect.

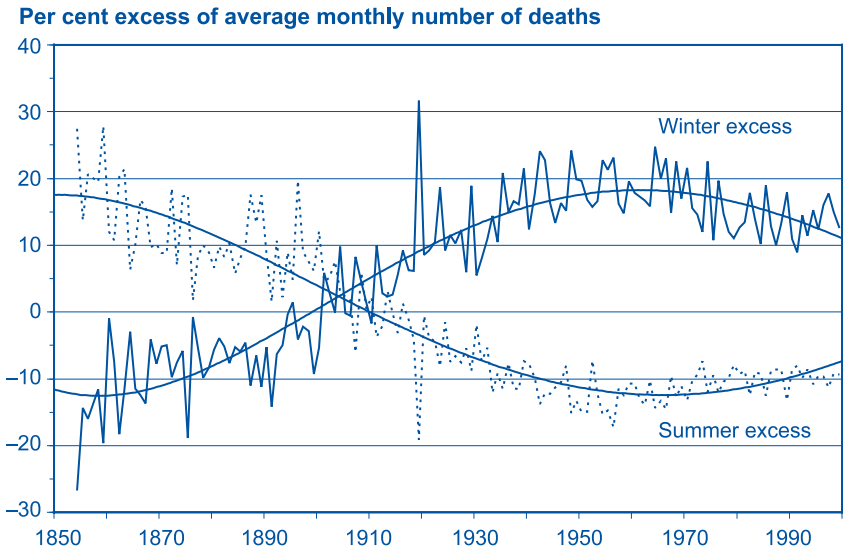
Deaths among infants (aged less than 1 year) and persons aged 45 years and over peak in July and August, the effect being most pronounced among the oldest (persons aged 85 years and over). Deaths for persons aged 25–44 peak in September–October, although the magnitude of the effect is small.

The peak in warmer months among young people reflects the seasonal pattern of many of the major causes of death for these ages, such as motor vehicle accidents, suicide, drowning and assault (Feinstein 2002).

Excess summer deaths

The effect of excess deaths in winter has not always been the case. Long-term data show that deaths from at least the middle of the nineteenth century and into the early part of the twentieth century peaked in summer, not winter (Figure 4). In the mid-1850s, deaths during summer months averaged 15–20% higher than for the whole year. This excess decreased progressively until the first decade of the twentieth century, when excess winter deaths began to predominate. Excess summer deaths continued to decline throughout the twentieth century until the 1960s, when the decline levelled. Excess winter deaths peaked in the 1960s, and have declined somewhat since then.

Figure 4: Seasonal excess mortality, 1854–1999



Note: Data to 1910 are for New South Wales and Victoria only; data to 1964 are based on month of registration.

Seasonality of death

The peak in warmer months among young people reflects the seasonal pattern of many of the major causes of death for those ages…

Some researchers believe that rising global temperatures and climate change will lead to a continuing decline in excess winter deaths, and a resurgence in infectious diseases such as malaria, dengue fever and Ross River fever, as well as other harmful health effects through disruption to ecological systems (McMichael 2001).

Some reasons for excess seasonal deaths

Dewdney (1960) examined seasonality of deaths in Australia between 1861 and 1955, and commented on the disappearance of excess summer deaths and the emergence of a new peak in winter. The factors producing these changes include social, geographic and medical reasons, but two factors predominate.

Firstly, there was a decline in mortality from certain diseases which had previously been most severe in the summer months, such as dysentery, gastroenteritis, tuberculosis and other infectious and parasitic diseases. These declines accompanied rising living standards, improved nutrition and food storage, and major public works leading to cleaner water supplies and better sanitation (Taylor et al. 1998).

Secondly, there was an increase in mortality from diseases associated with a high mid-year mortality rate, such as diseases of the circulatory system and respiratory diseases such as pneumonia and influenza (Young 1976). Note, for example, the 1919 peak in Figure 4, which was due to the catastrophic influenza epidemic of that year.

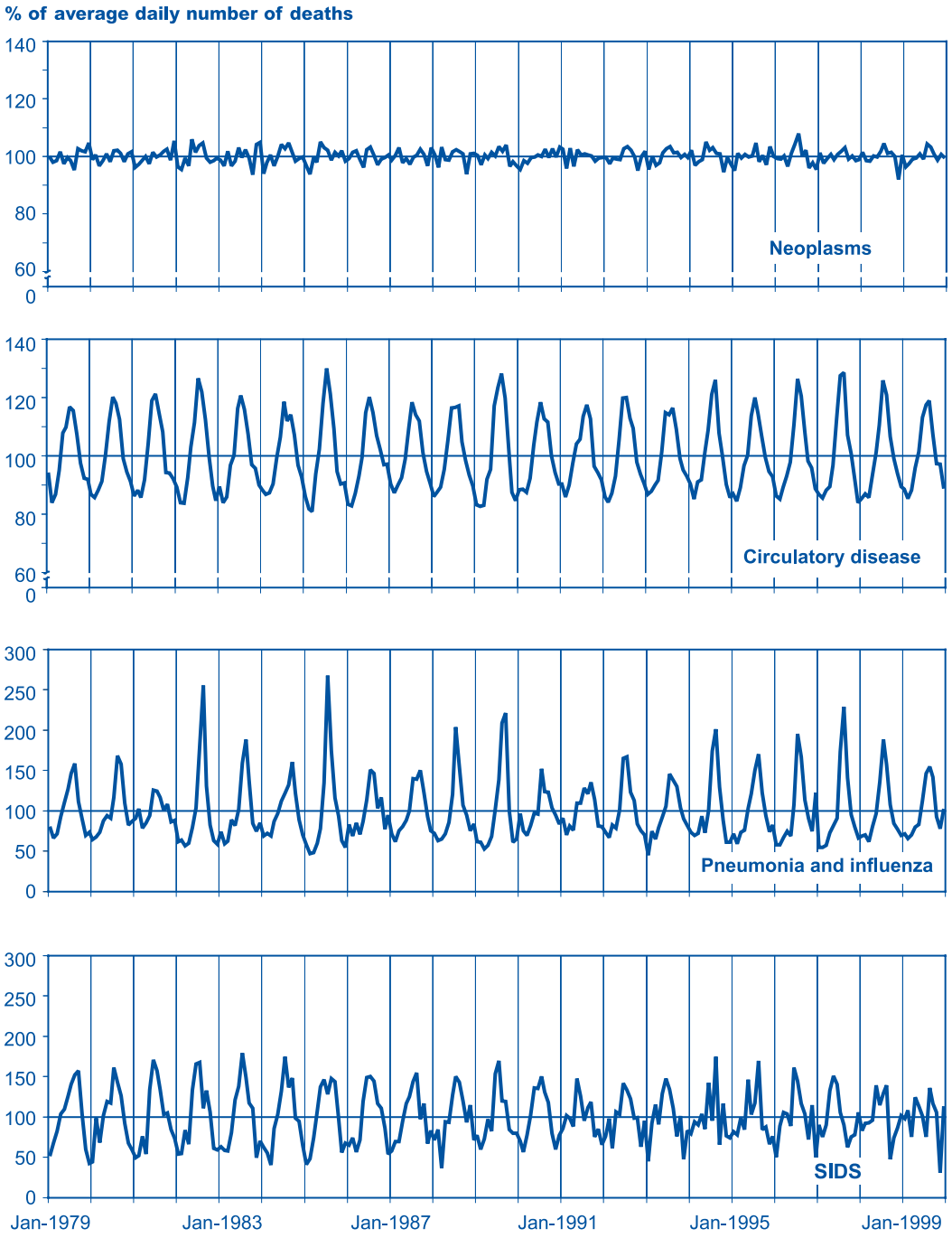
The recent decline in excess winter deaths is a phenomenon observed in Australia and other countries, and has been explored by researchers. For example, Kunst et al. (1990) attributed the reduction in the Netherlands since the 1950s to declines in cardiovascular and respiratory diseases. The role of the introduction of central heating in houses, proposed by some researchers as a factor leading to declines in these diseases, was found to be minimal. Instead, factors related to socioeconomic progress, such as increased prosperity and social welfare, were found to be important determinants of the decline (Kunst et al. 1990).

Seasonality among causes of death

The seasonal effect differs for various causes of death—some causes are highly seasonal whereas other causes show little evidence of seasonality. Deaths attributable to cancer, for example, which comprised 28% of all deaths in Australia in 1999, exhibit almost no variation from month to month (Figure 5). This implies that seasonality of death is not inevitable for all persons who happen to be ill during winter. Instead, the mechanisms for increased seasonal mortality are specific to particular causes of death (Mackenbach et al. 1992).

In contrast, deaths from circulatory diseases, especially heart attack, show large winter peaks. These diseases contributed 40% of all deaths in Australia in 1999, and so have a large impact on the overall seasonality of deaths. For the period 1979–1999, deaths due to circulatory disease averaged a 20% higher peak in the winter months and 15% lower trough in the summer months.

Figure 5: Seasonality of deaths from neoplasms, circulatory disease, pneumonia and influenza and SIDS



Note: Scales on y-axes differ.

Seasonality of death

A number of specific causes of death show different daily variation…

It has been known for some time that cold temperature acts as a trigger for coronary events (Seretakis et al. 1997). It is unclear whether low temperature per se (perhaps affecting thrombosis), or other socioeconomic and cultural factors occurring during winter (such as time spent indoors, recreational pursuits, diet or nutritional habits), are responsible for the observed increase in circulatory disease.

Mortality due to pneumonia and influenza is more clear cut. Although pneumonia and influenza were primary causes of death for less than 2% of Australians in 1999, they are often associated with other causes of death, especially cardiovascular and respiratory diseases, and especially among older persons. Deaths peak in winter (Figure 5), in parallel to outbreaks of influenza and other respiratory infections. Transmission of viruses responsible for these diseases is facilitated by the amount of time spent indoors in winter in close contact with other persons (Trudeau 1997).

Sudden infant death syndrome (SIDS), or cot death, is the sudden and unexpected death of an infant where the cause of death remains unexplained, even after complete post-mortem investigation. It was the main cause of death for infants for three decades prior to the early 1990s, when the National SIDS Council of Australia introduced a successful public health education campaign (Dwyer et al. 1995). In 2000, 81 male and 48 female SIDS deaths were recorded, comprising 10% of all infant deaths. Deaths from SIDS are also highly seasonal, peaking in winter (Figure 5), although these peaks have declined since the mid-1990s. The cause or causes of SIDS remain largely unknown. Researchers believe that the increase in SIDS during winter months may be attributable to the greater risk of bacterial infection infants face during the colder months, and perhaps to the overbundling and overheating of infants. Excess bedding and clothing, heated rooms and recent illness have all been shown to increase the risk of SIDS in infants sleeping in a prone position (Ponsonby et al. 1993, Mitchell 2000).

Numerous other causes of death such as diabetes and chronic liver disease also display seasonal patterns, peaking in winter. Other causes such as motor vehicle traffic accidents, suicide, drowning and assault tend to occur more often in warmer months (Trudeau 1997, Mackenbach et al. 1992).

Days of the week

Deaths occur more often on certain days of the week (Figure 6). For the period 1979 to 1999, death was more likely to occur on Friday or Saturday, and least likely to occur on Tuesday or Wednesday.

Table 1 outlines the days during this period for which the most and least number of deaths were recorded. Upward of 470 deaths per day occurred on selected Fridays and

Saturdays in the winter months of July and August. Less than 230 deaths occurred on selected days in the warmer months of November and January.

Although not evident in Table 1, major traumatic events, such as the Ash Wednesday bushfires (Wednesday, 16 February 1983), Granville rail disaster (Tuesday, 18 January 1977) and Cyclone Tracy (Wednesday, 25 December 1974) will influence daily frequency of death.

Table 1: Most and least frequent days of death, 1979–1999

Most frequent		Least frequent	
Day	Number of deaths	Day	Number of deaths
Friday, 8 August 1997	489	Friday, 26 January 1979	210
Saturday, 26 August 1989	484	Thursday, 3 January 1980	219
Friday, 15 August 1997	484	Wednesday, 7 January 1981	220
Friday, 29 July 1994	477	Thursday, 29 November 1979	223
Saturday, 13 August 1994	476	Monday, 7 April 1980	225

Source: AIHW National Mortality Database.

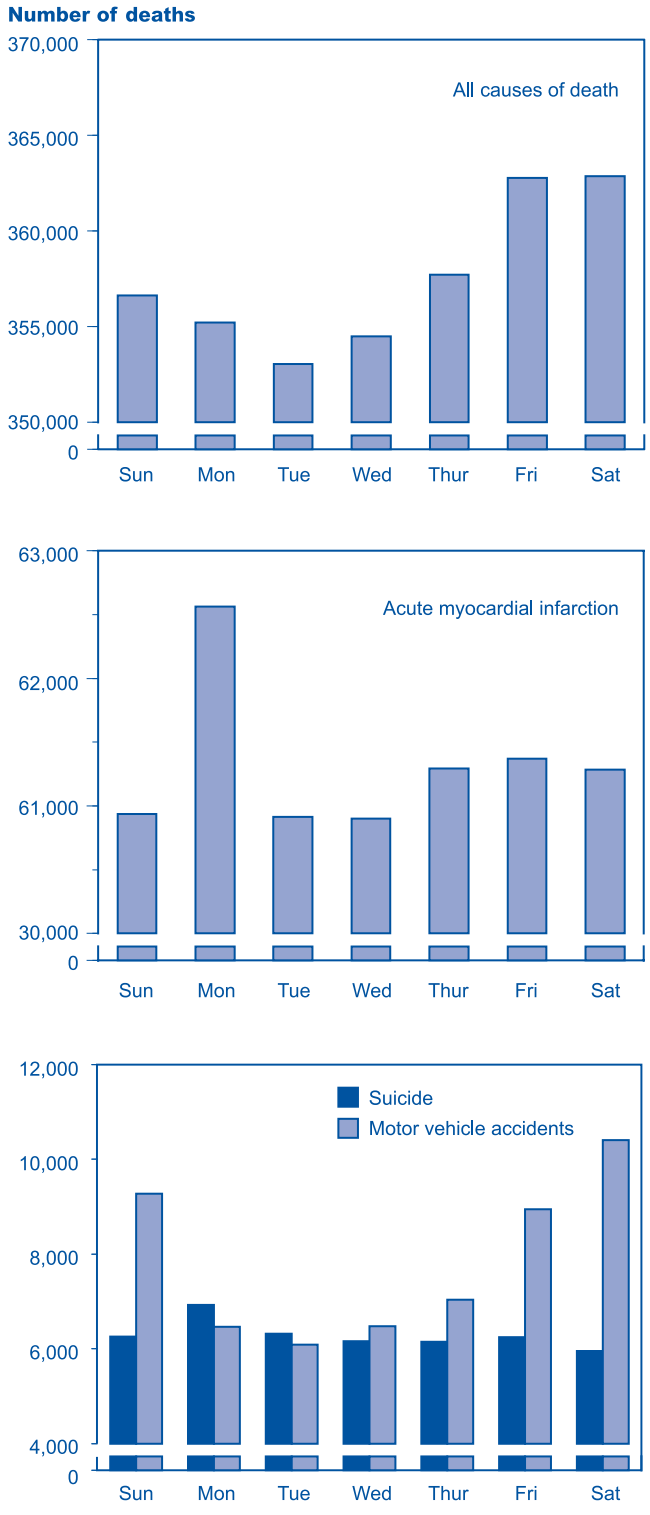
A number of specific causes of death show different daily variation. Acute myocardial infarction, or heart attack, occurs more often on Monday (Figure 6). This suggests that there are factors triggering heart attack that can be identified, and which may improve prevention of the disease, especially in the working population (Willich et al. 1994). Research is concentrating on the effect of physiological changes within population groups during key periods of the day, due to factors such as climate, occupation, stress, and patterns of activities.

Motor vehicle accidents are more likely to occur with the onset of the weekend, beginning to rise on Thursday, peaking on Saturday and Sunday, and falling away on Monday. The weekend rise in motor vehicle deaths can also be observed in many other developed countries, such as Canada (Trudeau 1997).

Suicide also occurs slightly more often on Monday, followed by Tuesday, with Saturday having the lowest average (Figure 6). Monday peaks for suicide were also found in the United States, among both males and females, and for most age groups (Maldonado & Kraus 1991). Explanations for this phenomenon lean toward social, rather than biological or climatic factors. The frequency and intensity of social interactions across the week, and their disequilibrium due to work, employment and family, may contribute to daily variations in the incidence of suicide (Hassan 1995, 1996).

Seasonality of death

Figure 6: Deaths by day of the week and cause, 1979 to 1999 combined



Time of day

Although not examined closely here, research has found that some causes of death also occur more often at certain times of the day. This 'circadian rhythm', as it is known, has been associated with particular causes of death such as suicide, which tends to occur least often in the early morning hours, and cardiovascular diseases such as heart attack, sudden cardiac death and stroke, which tend to occur more often in the morning hours from 8 a.m. to 12 noon (Maldonado & Kraus 1991; Elliott 1998).

It has been noted that acute cardiac events such as heart attack can be triggered by the daily activities of the subject, and that many risk factors for the cardiovascular disease process are also periodic.

Implications

Excess seasonal disease and death have a significant effect on the Australian health care system. Extra demands are placed on health care professionals, hospitals and other accident and emergency facilities in winter months, especially for respiratory and cardiovascular conditions.

Since winter increases are predictable for specific causes of death, preventative steps may be able to reduce excess seasonal deaths. Public health measures such as influenza vaccinations, especially for vulnerable populations such as older persons, might play a part.

References

ABS 1989. Catalogue of Australian statistical publications 1804 to 1901. ABS Cat. No. 1115.0. Canberra: ABS.

Dewdney JCH 1960. A note on the seasonal swings in mortality in Australia, 1861–1955. Australian Journal of Statistics 2: 84–90.

Dwyer T, Ponsonby A, Blizzard L, Newman NM & Cochrane JA 1995. The contribution of changes in the prevalence of prone sleeping position to the decline in sudden infant death syndrome in Tasmania. Journal of the American Medical Association 273: 783–9.

Elliott WJ 1998. Circadian variation in the timing of stroke onset: a meta-analysis. Stroke 29: 992–6.

Feinstein CA 2002. Seasonality of deaths in the US by age and cause. Demographic Research 6: Article 17. Available online: www.demographic-research.org

Hassan R 1995. Suicide explained: the Australian experience. Carlton South: Melbourne University Press.

Hassan R 1996. Social factors in suicide in Australia. Trends and Issues in Crime and Criminal Justice No. 52. Canberra: Australian Institute of Criminology.

Kunst AE, Looman CWN & Mackenbach JP 1990. The decline in winter excess mortality in the Netherlands. International Journal of Epidemiology 20: 971–7.

Mackenbach JP, Kunst AE & Looman CWN 1992. Seasonal variation in mortality in the Netherlands. Journal of Epidemiology and Community Health 46: 261–5.

Maldonado G & Kraus JF 1991. Variation in suicide occurrence by time of day, day of week, month, and lunar phase. Suicide and Life Threatening Behaviour 21: 174–87.

McDonald P, Ruzicka L & Pyne P 1987. Marriage, fertility and mortality. In: Vamplew W (ed.). Australians: historical statistics. Sydney: Fairfax, Syme & Weldon Associates.

McMichael T 2001. Human frontiers, environments and disease: past patterns, uncertain futures. Cambridge: Cambridge University Press.

Mitchell EA 2000. SIDS: facts and controversies. Medical Journal of Australia 173: 175–6.

New Zealand Ministry of Health 1999. Our health, our future: the health of New Zealanders 1999. Wellington: Ministry of Health.

Ponsonby A, Dwyer T, Gibbons LE, Cochrane JA & Wang Y 1993. Factors potentiating the risk of sudden infant death syndrome associated with the prone position. New England Journal of Medicine 329: 377–82.

Sakamoto-Momiyama M 1978. Changes in the seasonality of human mortality: a medico-geographical study. Social Science & Medicine 12: 29–42.

Seretakis D, Lagiou P, Lipworth L, Signorello LB, Rothman KJ & Trichopoulos D 1997. Changing seasonality of mortality from coronary heart disease. Journal of the American Medical Association 278: 1012–14.

Taylor R, Lewis M & Powles J 1998. The Australian mortality decline: all-cause mortality 1788–1990. Australian and New Zealand Journal of Public Health 22: 27–36.

Trudeau R 1997. Monthly and daily patterns of death. Statistics Canada. Health Reports 9: 43–50.

Willich SN, Lowel H, Lewis M, Hormann A, Arntz HR & Keil U 1994. Weekly variation of acute myocardial infarction. Increased Monday risk in the working population. Circulation 90: 87–93.

Young CM 1976. Mortality patterns and trends in Australia. National Population Inquiry, Research Report No. 5. Canberra: AGPS.

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