Soc Psychiatry Psychiatr Epidemiol (2000) 35: 341–347

ORIGINAL PAPER

D. Lawrence · A. V. Jablensky · C. D. J. Holman
T. J. Pinder

Mortality in Western Australian psychiatric patients*

Accepted: 10 April 2000

Abstract *Background*: The aim was to examine mortality in psychiatric patients in Western Australia (WA), over a time period of considerable change in the delivery of mental health services. *Methods*: A population-based record linkage analysis was undertaken to quantify mortality among people with mental illness in WA. Mortality rates were calculated in users of mental health services and compared with rates in the whole population of WA. Trends in mortality were also examined using relative survival analysis, and proportional hazards regression. *Results*: The overall mortality rate ratio was 2.57 in males (95% CI: 2.51–2.64), and 2.18 in females (2.12–2.24). The highest cause-specific mortality rate ratio was for deaths due to suicide [RR: 7.37 in males (95% CI: 6.74–8.05) and 8.38 in females (95% CI: 7.11–9.89)], with mortality rate ratios being significantly greater than 1 for all other major causes of death. A relative survival analysis found that the excess mortality risk was concentrated in the first few years after first contact with mental health services. Proportional hazards regression analysis found a slight elevation of mortality rates over time. *Conclusions*: Mortality among psychiatric patients remains high and appears to be increasing. Highest excess mortality rate is associated with suicide, but mortality rates are significantly elevated for all major causes of death.

D. Lawrence (✉)
Centre for Health Services Research,
Department of Public Health,
The University of Western Australia,
Nedlands, W.A. 6907,
Australia
e-mail: davidl@dph.uwa.edu.au
Tel.: +61-8-93801741; Fax: +61-8-93801199

A. V. Jablensky
Department of Psychiatry and Behavioural Science,
The University of Western Australia,
Nedlands, Western Australia, Australia

C. D. J. Holman
Centre for Health Services Research,
Department of Public Health,
The University of Western Australia,
Nedlands, Western Australia, Australia

T. J. Pinder
Health Information Centre,
Health Department of Western Australia,
Perth, Western Australia, Australia

* The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Health Department of Western Australia.

Introduction

A number of studies have reported mortality among people with mental illness to be higher than expected. Record linkage of hospital-based psychiatric case registers with death registers has revealed excess mortality in several different locations [1–3]. One recent study also showed excess mortality in a community-based system of care, although lower than has been reported in hospital-based studies [4]. Some authors have attributed some of the excess mortality in psychiatric patients to long-term inpatient-based care [5, 6]. In Western Australia (WA) there was a significant move away from inpatient-based services in favour of community-based services in the early 1980s. Between 1980 and 1985 there was a 50% reduction in the number of inpatient psychiatric beds. With the significant improvements in general health care, the general increase in life expectancy in Australia, and the major changes in psychiatric service delivery that have occurred, it is relevant to examine the mortality of psychiatric patients.

This study used the recently established WA Health Services Research Linked Database (WA Linked Database), which has linked all available administrative health data within WA [7]. WA is well suited for population-based record linkage studies, with well-maintained comprehensive administrative data collections dating back to 1980, and in many cases much earlier, its relative geographic isolation, its stable population of approximately 1.8 million people, its relatively

centralised psychiatric services, and the cooperative relationship existing between public and private hospitals and the state health department. The availability of this research infrastructure allows a more comprehensive analysis on a larger population to be performed than has been possible in the past.

This study sought to quantify mortality in people with mental illness for an entire population, and to compare this with figures for the general population of WA. The study also sought to identify risk factors associated with highest mortality, and to examine whether mortality among people with mental illness has fallen over time.

Subjects and methods

The WA Linked Database was constructed by means of probabilistic matching, using the Automatch software package [8], as there are no unique identification numbers in use on the core data sets. Name, residential address, date of birth and sex were the principal fields used in the probabilistic matching. The probabilistic matching technique is based on estimating the probability that any two records represent the same person, while allowing for the possibility of errors or changes in the identifying information used for matching. A study of a random sample of links within the WA database has been undertaken, finding a less than 1% error rate [7].

A file was extracted from the WA Linked Database that contained all chains of records for any patient who had contact with mental health services in WA in 1966–1995. This file was extracted on 7 May 1998. The chains link together acute hospital admissions, death records, psychiatric hospital movements and psychiatric outpatient contacts for each patient. The linked death records cover the period 1980–1995, but data on psychiatric service contacts go back to 1966. A second file containing records of all deaths during 1980–1995 was also extracted. The data on mental health services contacts prior to 1980 were used to restrict the study cohort to those patients whose first psychiatric admission occurred in 1980–1995, as death follow-up commenced in 1980. This cleared out the pool of prevalent cases, dating back to 1966. As mortality risk may vary with time after first contact, this removes a potential source of bias from the results. There were 133,105 patients who met these selection criteria.

A principal psychiatric diagnosis was assigned to each patient who had contact with mental health services using the following procedure. The Mental Health Information System (MHIS) records individual movements (admissions, discharges, periods of leave, outpatient contacts, etc). These were grouped together to form episodes of care, and the final diagnosis in each episode of care was used (to allow for revision of preliminary diagnoses during a period of observation or treatment). Diagnoses were coded using ICD-9 [9]. The last occurring informative final diagnosis across the episodes was then assigned as the principal diagnosis according to a hierarchy of diagnoses. So if a final diagnosis for an earlier episode is higher in the hierarchy than that for the last episode, this diagnosis would be taken as the principal diagnosis. The hierarchy used was:

1. *ICD-9 290*, *293–296*: dementia, organic psychotic conditions, schizophrenia and affective psychosis
2. *ICD-9 291–292*, *297–305*, *313–315*: alcohol and drug psychoses, paranoid states, other non-organic psychoses, neurotic disorders, personality disorders, sexual deviations, alcohol and drug dependence, childhood disorders
3. *ICD-9 306–312*, *317–319*: adjustment reaction, reaction to stress, depressive disorders nec, conduct disorders nec, special syndromes nec, mental retardation
4. Non chapter 5 (mental disorders) diagnoses

Preference was also given to diagnoses made in inpatient treatment units over diagnoses made in outpatient clinics or psychiatric residential units. The purpose of the hierarchy was to allow more specific psychiatric diagnoses to take precedence over less specific diagnoses, and to favour an underlying condition rather than a specific symptom or event.

Calculation of rates

Age-sex standardised mortality rates were calculated using direct standardisation. The average population distribution of WA over the period 1980–1995 was used as the standard weights [10]. The start of follow-up was taken as the date of each patient's first contact with mental health services. Patients were then censored at death or 31 December 1995. Rates were calculated by principal diagnosis, by type of care received and by cause of death. The mortality rate was also calculated in the WA population by cause of death and sex. Denominators were taken from estimated resident population counts [10]. Mortality rate ratios were calculated in groups of patients in the study cohort relative to the rate in the WA population.

Relative survival analysis

The mortality of psychiatric patients in WA was compared with the general WA population using the technique of relative survival [11, 12]. In this method, an expected survival curve for the cohort is computed by matching each study subject by age, sex and calender year with a fictional referrant from the general population having the average life expectancy for a person of that age and sex in that year. The analysis was performed using a SAS macro developed by Therneau et al. [13].

Regression analysis

To examine risk factors associated with highest mortality risk, proportional hazards regression was used [14]. The regression model examined the risk of death from time of first contact with mental health services until death or censoring at the end of follow-up (31 December 1995). Factors included in the model were principal psychiatric diagnosis, sex, marital status, type of care received, cumulative length of inpatient treatment, aboriginality, place of birth, place of residence and socio-economic status. Person attributes that can change (such as address and marital status) were based on information recorded at initial contact with mental health services. The model was also adjusted for age. Type of care received was assigned hierarchically (involuntary inpatient, voluntary inpatient, day-patient, hostel resident, outpatient), so a patient who had both an involuntary inpatient admission and outpatient attendances was classified as an involuntary patient. Socio-economic status was assigned based on residential postcode. These were assigned using the index of relative disadvantage from the Socio-economic Indexes For Areas produced by the Australian Bureau of Statistics [15]. This index gives a relative score for each postcode area based on data collected in the 1996 census.

A second model was fitted to examine possible period trends in mortality among psychiatric patients. The cohort was split into three groups: those patients whose first contact with mental health services was in 1980–1984; those whose first contact was in 1985–1989; and those whose first contact was in 1990–1994 (patients whose first contact was in 1995 were excluded). Follow-up was terminated at 31 December 1984 for the first group, 31 December 1989 for the second group and 31 December 1994 for the third group, so that each group had an average of 2.5 years of follow-up. In addition to all the variables from the previous model, indicators for these three groups were also used in order to test the hypothesis that mortality rates have fallen following the deinstitutionalisation of psychiatric patients.

Results

There were 133,105 patients who were first recorded on the MHIS during 1980–1995. Of these, 14,068 (11%) died during this period. The age-sex standardised mortality rate in the cohort of patients with mental health services contact was 1743 per 100,000 person-years in males (95% CI: 1703–1784) and 1188 per 100,000 person-years in females (1159–1217). This is significantly in excess of the mortality rate in the WA population of 677 per 100,000 person-years in males (95% CI: 673–682) and 545 per 100,000 person-years in females (95% CI: 541–549).

The mortality rate ratio in the cohort of patients with mental health services contact to the WA population overall was significantly greater than 1 for all psychiatric diagnoses in both sexes except in females with a diagnosis of adjustment reaction (Table 1). Cause-specific mortality rate ratios were significantly greater than 1 for all causes of death in both males and females (Table 2). The highest mortality rate ratio occurred for suicide. The mortality rate ratios were greater than 2 for all causes of death except acute myocardial infarction and malignant neoplasms. Mortality rates were similar in people receiving inpatient treatment, day patient treatment and residents of psychiatric hostels, but mortality among patients only receiving outpatient treatment was barely higher than in the general population (Table 3).

Observed and expected mortality among psychiatric patients from the relative survival analysis is shown in Fig. 1. The observed mortality curve deviates strongly from the expected mortality curve during the first several years after first contact with mental health services. After about 7 years, however, the two lines become almost parallel, indicating that the majority of the excess mortality occurs within the first 7 years after initial contact with mental health services. This analysis was repeated for each diagnostic group, and the same essential trend was observed for each diagnosis except schizophrenia. The observed and expected mortality curves for patients with schizophrenia continue to diverge throughout the entire 15 years of follow-up (Fig. 2).

Risk factors for mortality in psychiatric patients were assessed using Cox regression (Table 4). The risk of mortality was almost twice as high in males than in females. Patients with diagnoses of dementia and other

Table 1 Mortality rate ratios (RR) and 95% confidence intervals (CI) in mental health services patients in Western Australia, 1980–1995, by principal psychiatric diagnosis and sex

	Males		Females	
	RR	95% CI	RR	95% CI
Principal psychiatric diagnosis				
Dementia	5.24	(4.00–6.87)	6.56	(3.30–13.1)
Alcohol or drug disorders	2.79	(2.64–2.95)	2.82	(2.55–3.11)
Schizophrenia	1.67	(1.36–2.06)	1.60	(1.27–2.01)
Affective psychoses	1.98	(1.77–2.22)	1.53	(1.38–1.70)
Other psychoses	4.37	(4.03–4.74)	3.59	(3.32–3.90)
Neurotic disorders	1.61	(1.46–1.76)	1.30	(1.21–1.41)
Personality disorders	2.14	(1.68–2.73)	2.25	(1.71–2.94)
Adjustment reaction	1.32	(1.12–1.56)	1.02	(0.86–1.21)
Depressive disorder	2.54	(2.25–2.86)	1.80	(1.64–1.98)
Other mental disorder	1.68	(1.49–1.89)	1.63	(1.43–1.85)
Attempted self-harm	3.04	(2.63–3.50)	2.15	(1.75–2.65)
Non-specific diagnoses	1.28	(1.16–1.41)	1.18	(1.06–1.32)
Total	2.57	(2.51–2.64)	2.18	(2.12–2.24)

Table 2 Mortality rate ratios in mental health services patients in Western Australia, 1980–1995, by cause of death and sex

	Males		Females	
	RR	95% CI	RR	95% CI
Cause of death				
Malignant neoplasms (140–208)	1.50	(1.41–1.60)	1.33	(1.25–1.42)
Diabetes mellitus (250)	2.99	(2.49–3.58)	2.32	(1.96–2.75)
Acute myocardial infarction (410)	1.59	(1.48–1.71)	1.60	(1.49–1.72)
Other ischaemic heart disease (411–414)	2.18	(1.99–2.37)	2.01	(1.84–2.20)
Cerebrovascular disease (430–438)	3.74	(3.47–4.03)	2.83	(2.66–3.01)
Other circulatory system (other 390–459)	2.76	(2.53–3.00)	2.24	(2.08–2.42)
Pneumonia and influenza (480–487)	4.61	(4.02–5.29)	2.71	(2.30–3.18)
Chronic obstructive pulmonary disease (490–496)	2.71	(2.46–2.99)	2.24	(1.95–2.58)
Accidental (E800–E929)	2.35	(2.13–2.60)	2.48	(2.17–2.84)
Suicide (E950–E959)	7.37	(6.74–8.05)	8.38	(7.11–9.89)
Other causes of death	4.17	(3.96–4.40)	3.13	(2.97–3.31)
Total	2.57	(2.51–2.64)	2.18	(2.12–2.24)

Table 3 Mortality rate ratios in mental health services patients in Western Australia, 1980–1995, by type of care received and sex

	Males		Females	
	RR	95% CI	RR	95% CI
Type of care received				
Involuntary	2.77	(2.55–3.02)	2.70	(2.40–3.04)
Voluntary	3.13	(3.03–3.22)	2.46	(2.38–2.54)
Day patient	2.72	(2.41–3.07)	1.80	(1.53–2.10)
Hostel resident	3.75	(3.31–4.24)	2.93	(2.60–3.30)
Outpatient	1.08	(1.00–1.17)	1.18	(1.09–1.28)
Total	2.57	(2.51–2.64)	2.18	(2.12–2.24)

psychoses were at highest risk across diagnostic groups. There was no significant difference in mortality between involuntary and voluntary inpatients, day patients or hostel residents, although there was a significantly lower mortality risk among outpatients.

Table 4 also shows that cumulative length of stay in inpatient care was only weakly associated with mortality risk. Mortality risk was approximately 25% higher (95% CI: 18–33%) in patients whose cumulative length of stay was between 2 weeks and 3 months compared with patients whose cumulative length of stay was less than 1 week. However, the risk for patients whose length of stay was longer than 3 months was only 12% higher (95% CI: 3–24%). Socio-economic status, marital status, place of residence, and place of birth showed no relationship with mortality risk. Patients of Aboriginal or Torres Strait Islander descent had a 40% higher mortality risk (95% CI: 27–53%).

The same model was fitted separately for each diagnostic group and for each major cause of death. For patients with schizophrenia, being married was a protective factor. Compared with married patients, single patients were at 75% higher risk of mortality (95% CI: 14–167%), and divorced, widowed or separated patients

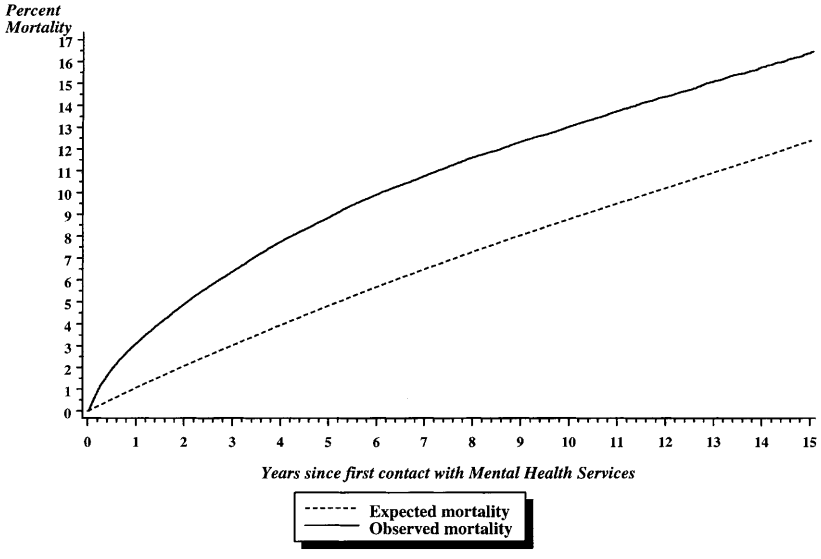

Fig. 1 Observed and expected mortality of Western Australian psychiatric patients

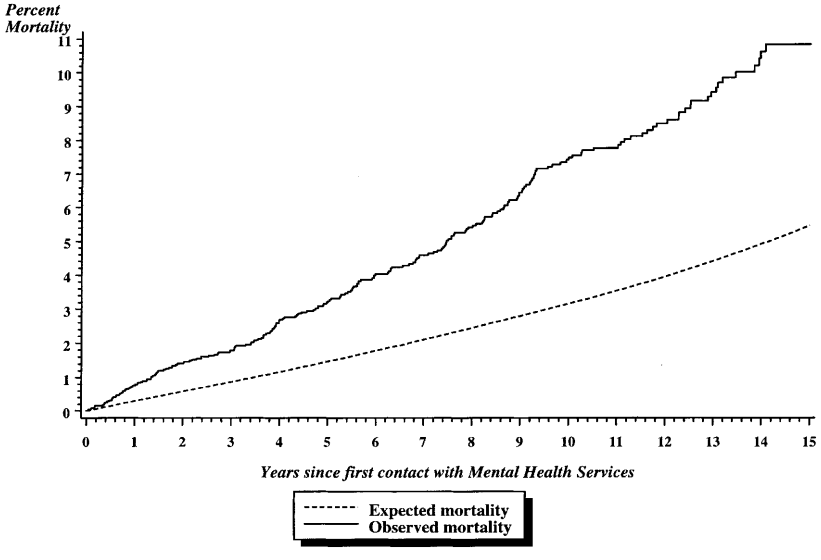

Fig. 2 Observed and expected mortality of patients with schizophrenia

Table 4 Mortality risk factors

	RR	95% CI
Principal psychiatric diagnosis		
Dementia	1.64	(1.50–1.81)
Alcohol/drug disorders	1.55	(1.40–1.71)
Schizophrenia	1.14	(0.97–1.34)
Affective psychoses	0.91	(0.81–1.01)
Other psychoses	1.67	(1.51–1.84)
Neurotic disorders	0.88	(0.80–0.97)
Personality disorders	1.26	(1.06–1.50)
Adjustment reaction	0.90	(0.79–1.03)
Depressive disorder	1.06	(0.95–1.19)
Other mental disorders	0.85	(0.76–0.96)
Attempted self-harm	1.46	(1.27–1.68)
Non-specific diagnoses	1.00	
Sex		
Male	1.00	
Female	0.57	(0.55–0.60)
Place of residence		
Perth metropolitan area	1.00	
Country	0.97	(0.93–1.02)
Socio-economic status		
Lowest quartile	1.01	(0.96–1.06)
2nd quartile	0.98	(0.93–1.03)
3rd quartile	0.99	(0.95–1.04)
Highest quartile	1.00	
Race		
Aboriginal/Torres Strait Islander	1.41	(1.27–1.53)
Other	1.00	
Marital status		
Single	1.04	(0.99–1.10)
Married	1.00	
Separated/widowed/divorced	0.96	(0.93–1.00)
Length of stay in inpatient care		
0–7 days	1.00	
8–14 days	1.14	(1.08–1.21)
15–28 days	1.24	(1.17–1.32)
29–90 days	1.26	(1.19–1.34)
>90 days	1.12	(1.03–1.24)
Patient type		
Involuntary	1.00	
Voluntary	1.06	(0.98–1.15)
Day patient	1.03	(0.91–1.16)
Hostel resident	1.08	(0.99–1.19)
Outpatient	0.57	(0.51–0.63)
Place of birth		
Australia	1.00	
Overseas	0.99	(0.95–1.02)

were at 69% higher risk (95% CI: 8–163%). For deaths due to diabetes, patients of Aboriginal or Torres Strait Islander descent were at significantly higher risk [RR 4.88 (95% CI: 3.07–7.75)]. For accidental deaths, patients with a diagnosis of alcohol/drug disorder were at highest risk of mortality, and single patients were at higher risk than married patients [RR 1.39 (95% CI: 1.13–1.70)]. No other significant differences were observed compared with the main model.

When the cohort was split into three groups based on period of first contact, and follow-up was restricted to a maximum of 5 years, a very similar pattern of risks was found compared with the main model. Additional factors were fitted for time of first contact with mental health services. For those patients with first contact in 1985–1989 the risk ratio was 1.09 (95% CI: 1.03–1.14) compared with those with first contact in 1980–1984. For those whose first contact was in 1990–1994 the risk ratio was 1.03 (95% CI: 0.93–1.09) compared with those whose first contact was in 1980–1984.

Discussion

The prevalence of diagnosable psychiatric disorder in the Western Australian population has been estimated at 19% in the National Survey of Mental Health and Wellbeing of Adults [16]. The survey, which was part of the National Mental Health Strategy, included a sample of 4400 adult West Australians. The Composite International Diagnostic Interview (CIDI) was used as the basis for the diagnostic component of the survey [17].

The results of this present study show that psychiatric disorders are associated with high mortality risk. The high prevalence of disorder together with the high risk indicate that this issue is one of significant public health importance. Not all people with diagnosable mental illness seek any form of treatment. An estimated 61.4% seek no treatment at all [16]. At any one time, the MHIS covers approximately 7.5% of the WA population. We would expect, but cannot prove, that diagnosed cases on the MHIS would represent the more serious cases. Even so, the high mortality rate among people on the MHIS is a cause for concern.

These results are consistent with findings from other studies. A recent meta-analysis based on studies mainly from the US, Scandinavia and the UK calculated an overall standardized mortality ratio of 234 for males and 262 for females, and findings by psychiatric disorder comparable with our results from WA [18].

There have been significant changes in the treatment of mental illness this century. The availability of new treatments for mental illness, higher general standards of care and the move to community-based care have significantly altered the lifestyle of people with mental illness. While one might expect that these changes would reduce exposure to some mortality risks, particularly infectious diseases, and allow people with mental illness to pursue more normal lives, we have found that there remains significant excess mortality across all major causes of death. While the highest mortality rate ratio was observed for deaths due to suicide, in absolute terms deaths due to suicide represent only 9% of excess deaths among the study cohort. There is significant excess mortality due to physical health problems, particularly heart disease.

Infectious diseases, such as tuberculosis, were once a major cause of death in psychiatric patients [19]. Infectious diseases are no longer a major cause of death, with only 90 deaths in mental health patients coded to ICD-9 chapter 1 illnesses (infectious and parasitic diseases) in the study period (less than 1% of all deaths). There was insufficient power to detect whether this was different from the expected number of deaths.

The period from 1980–1985 represented a time of significant transition in the delivery of mental health services in WA. During this time there was a shift from long-term inpatient care to community-based treatment, with the number of inpatient beds decreasing by half over the period [20, 21]. There has been little change in the number of available inpatient beds since that time. Also, in 1984, mental health services were integrated into mainstream health services with the administration of both physical and mental institutions being combined into one government department [22]. The results of this study suggest that the mortality experience of psychiatric patients has not improved and may have worsened since that time.

One possible contributing factor to the excess mortality in psychiatric patients is cigarette smoking. The Low Prevalence (Psychotic Disorders) Study found that 73.2% of male patients with psychotic disorders (principally schizophrenia and schizoaffective disorder) and 56.3% of females were current smokers [24]. The Low Prevalence Study, which was part of the National Mental Health Strategy, was a census of 3800 Australians with psychotic disorders drawn from four catchment areas, one of which was in WA. Unpublished data from the National Mental Health Survey found 42.9% of Western Australians with a diagnosable mental health condition were current smokers, compared to 24.4% among people without a mental disorder. Smoking is a high risk factor for heart disease, respiratory disease and some forms of cancer [25, 26]. Also, life expectancy in the general population has increased over 1980–1995, with reduced mortality from circulatory disease a major factor [27]. It may well be that psychiatric patients have not benefitted from the public health effort that has gone into promoting avoidance of cardiovascular risk factors. People with mental illness may benefit from specifically targetted health promotion activities.

The mortality rate for Aboriginal and Torres Strait Islanders is 3.75 times higher than the mortality rate in the general community [28]. Among users of mental health services, there was a 40% elevated mortality rate among patients of Aboriginal or Torres Strait Islander descent. Overall, psychiatric patients have significantly higher mortality than the general community, and Aboriginal and Torres Strait Islanders also have significantly higher mortality, but the effect is not multiplicative.

The pattern of the relative survival curve implies that, except in the case of patients with schizophrenia, the greatest risk of excess mortality is in the period following first contact with mental health services, and that risk declines with time. Patients who survive 7 years from initial contact may have come through the main period of excess risk. The risk of excess mortality does not seem to abate with time for patients with schizophrenia.

The WA linked database has not been linked with the national death index, and we have not been able to identify people who may have migrated out of WA. This could lead to undercounting of deaths. Migration out of WA is relatively low, around 1.7% per annum [29]. We have no information as to whether users of mental health services are any more or less likely to migrate out of WA than non-service users.

Note that the reference population in calculating rate ratios was the entire WA population, which includes mental health services users (approximately 7.5% of the population). Had we calculated rate ratios relative to the WA population excluding those known to mental health services, the resulting rate ratios would have been slightly higher: for all cause mortality, 2.91 for males and 2.37 for females. Excluding users of mental health services would not create a reference population free of mental illness, as over half of people with a diagnosable disorder do not receive any treatment from mental health services.

The continuing excess mortality in psychiatric patients, from both natural and unnatural causes, and across most diagnostic groups, shows this is a continuing problem. Regular monitoring of mortality rates among psychiatric patients should continue.

Acknowledgements This study was supported by a project grant from the National Health and Medical Research Council. The initial construction of the WA Health Services Research Linked Database was funded by the Western Australian Lotteries Commission.

References

1. Baxter DN (1996) The mortality experience of individuals on the Salford psychiatric case register. Br J Psychiatry 168: 772–779
2. Black DW, Warrack G, Winokur G (1985) Excess mortality among psychiatric patients: the Iowa record-linkage study. JAMA 253: 58–61
3. Hansen V, Arnesen E, Jacobsen BK (1997) Total mortality in people admitted to a psychiatric hospital. Br J Psychiatry 170: 186–190
4. Amaddeo F, Bisoffi G, Bonizzato P, Micciolo R, Tansella M (1995) Mortality among patients with psychiatric illness: a ten-year case register study in an area with a community-based system of care. Br J Psychiatry 166: 783–788
5. Craig TJ, Lin SP (1981) Death and deinstitutionalization. Am J Psychiatry 138: 224–227
6. Casadebaig F, Quemala N (1991) Changes in mortality among psychiatric patients 1969–1982. Soc Psychiatry Psychiatr Epidemiol 26: 78–82
7. Holman CDJ, Bass AJ, Rouse IL, Hobbs MST (1999) Population-based linkage of health records in Western Australia: development of a health services research linked database. Aust N Z J Public Health 23: 453–459
8. Jaro MA (1995) Probabilistic linkage of large public health data files. Stat Med 14: 491–498
9. World Health Organisation (1977) Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death. WHO, Geneva
10. Population by age and sex Western Australia. Australian Bureau of Statistics Cat. 3235.5. Canberra
11. Hakulinen T (1982) Cancer survival corrected for heterogeneity in patient withdrawal. Biometrics 38: 933
12. Hakulinen T, Abeywickrama KH (1985) A computer program package for relative survival analysis. Comput Programs Biomed 19: 197–207
13. Therneau T, Sicks J, Bergstralh E, Offord J (1994) Expected survival based on hazard rates. Mayo clinic section of Biostatistics technical report no. 52. Rochester

14. Cox DR (1972) Regression models and life tables (with discussion). J R Stat Soc Ser B 34: 187–220
15. Socio-economic Indexes For Areas 96 (1998) Australian Bureau of Statistics Cat. 2033.0.30.001, Canberra
16. Mental Health and Wellbeing: profile of adults Western Australia 1997–98. (1999) Australian Bureau of Statistics Cat. 4326.5, Canberra
17. World Health Organisation (1994) Composite International Diagnostic Interview (CIDI) Researcher's Manual. WHO, Geneva
18. Harris EC, Barraclough B (1998) Excess mortality of mental disorder. Br J Psychiatry 173: 11–53
19. Alstrom CH (1942) Mortality in mental hospitals with especial regard to tuberculosis. Acta Psychiatr Neurol Scand [Suppl] 24: 1–423
20. Hills N (1996) Asylum to mainstream: replacing a psychiatric hospital for the elderly. An account of the closure and replacement of Swanbourne hospital. Shenton Park Psychiatric Services to the Elderly, Perth, Western Australia
21. Ellis AS (1984) Eloquent testimony: the story of the mental health services in Western Australia 1830–1975. University of Western Australia Press, Perth
22. Smith G, McCavanagh D, Williams T, Lipscombe P (1996) Making a commitment: the mental health plan for Western Australia. Health Department of Western Australia, Perth
23. Jablensky A, McGrath J, Herrman H, Castle D, Gureje O, Morgan V (1999) National survey of mental health and wellbeing. Report 4. People living with psychotic illness: an Australian study. Commonwealth Department of Health and Aged Care, Canberra
24. Kendrick T (1996) Cardiovascular and respiratory risk factors and symptoms among general practice patients with long-term mental illness. Br J Psychiatry 169: 733–739
25. Hymowitz N, Jaffe FE, Gupta A, Feuerman M (1997) Cigarette smoking among patients with mental retardation and mental illness. Psychiatr Serv 48: 100–102
26. Deaths Australia 1997 (1998) Australian Bureau of Statistics Cat. 3302.0, Canberra
27. Anderson P, Bhatia K, Cunningham J (1996) Occasional Paper. Mortality of indigenous Australians. Australian Bureau of Statistics & Australian Institute of Health and Welfare, ABS Cat. 3315.0, Canberra
28. Migration Australia 1993–1994 (1995) Australian Bureau of Statistics Cat. 3412.0, Canberra