Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

Re: **Mental disorder and early death – a nationwide follow up study, 1981 - 2010.**

'Tomi Ajetunmobi[1], Mark Taylor[2], Diane Stockton[1], and Rachael Wood[1].

	Item No	Recommendation
Title and abstract	1 Done, p1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2 Done – p2	Explain the scientific background and rationale for the investigation being reported
Objectives	3 Done – p2	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4 Done	Present key elements of study design early in the paper
Setting	5 Done	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 Done	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7 Done	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8* Done	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 In method & discussion	Describe any efforts to address potential sources of bias
Study size	10 Done	Explain how the study size was arrived at
Quantitative variables	11 Done	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12 Done	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13* Done	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage

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		(c) Consider use of a flow diagram
Descriptive data	14* Done	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	15* Done	Report numbers of outcome events or summary measures
Main results	16 Done where applicable	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 SMRs and YLL	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18 Done	Summarise key results with reference to study objectives
Limitations	19 Done	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 Done	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21 Commented on	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22 Done	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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Contributors TA and MT conceived the study. TA and DS ascertained the data. All authors analysed the data and drafted the manuscript. RW is the study guarantor.

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Ethical approval not required as this study is covered by existing case linkage protocols. Data sharing agreed in principle.

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Article Focus

- Examines whether those previously hospitalised for mental disorder die earlier than people with no overt serious mental disorder.
- Do multiple psychiatric diagnoses or comorbid disorder exacerbate any premature mortality?
- Is the apparent inequality in mortality rates between those with serious mental disorder and the general population worsening over time?

Key messages

- The average reduction in lifespan in those previously hospitalised for mental disorder compared to the general population is 17 years. People with eating disorders and personality disorder died earliest of all.
- Comorbidity or multiple psychiatric diagnoses exacerbated this effect.
- Cardiovascular and respiratory diseases were the most common causes of death, but suicides led to more years of lost life. No worsening of the 'mortality gap' over three decades was observed.

Strengths and limitations

- A large representative population studied over a long time period, which is important when examining causes of death.
- Innovative use of a diagnostic hierarchy to account for the commonly occurring comorbidity or diagnostic shift seen in psychiatry.
- People with mental disorder who never required in-patient hospital care could not be included in this study.

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Objectives:

To quantify any premature mortality in those previously hospitalised for mental disorder in Scotland; attempt to separately account for the effects of multiple psychiatric diagnoses or comorbidity; and examine any trends in death rates over time.

Design:

Systematic cohort case linkage of hospital discharge and cause of death records.

Setting & participants:

Secondary care sample of all cases previously hospitalised for mental disorder in Scotland, 1986-2010.

Outcomes:

Cases with comorbidity or multiple diagnoses were hierarchically categorised, and contrasted to cases where there was no record of cormorbidity. Causes of death were dichotomised into natural and non-natural causes, and time trends were analysed. Standardised mortality ratios and years of lost life were the primary outcomes.

Results

111504 people were included in the study, and 34243 had died by 31/12/2010. The average reduction in life expectancy for the whole cohort was 17 years, with eating disorders (39 year reduction) and comorbid personality disorders (27.5 year reduction) being worst affected. Non-natural deaths were 11% of the total (SMR=5.2), with these deaths occurring early, whereas physical causes of death were more common (SMR=1.7), particularly cardiovascular disease. Comorbidity elevated the risk of early death, but no worsening over time of these inequalities was observed.

Conclusions

Early death for those hospitalised with mental disorder is common, and represents a significant inequality even in well developed healthcare systems. Prevention of suicide and cardiovascular disease deserve particular attention in the mentally disordered.

Declaration of interest

All authors are employed by NHS Scotland. MT has received fees and / or hospitality from the manufacturers of various antipsychotic medications. TA, DS, and RW have no other conflicts to declare.

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Many of the most disabling medical conditions worldwide are mental illnesses, according to the WHO[1]. As well as adversely affecting day to day function, it has been known for many years that people with mental illness are at increased risk of premature death[2-5] with schizophrenia and bipolar disorder in particular being associated with an early death[6-8]. These inequalities in life expectancy have recently[9] been declared a "scandal", as even the Scandinavian countries[5], Scotland[10] and England[8] , despite relatively high quality and equitably distributed healthcare, have not been able to demonstrate any improvement in this premature mortality for the mentally ill over many years.

Non-natural deaths[11] including suicide and accidents, account for a disproportionate amount of this premature mortality in the mentally ill, particularly affecting young adults. High rates of cardiovascular disease, respiratory disease and other so-called natural causes also contribute[5,12,13] to the elevated relative risk of early death in the mentally ill. Precise estimates of the varying causal contributions to premature mortality in the mentally disordered have been limited by the lack of large representative populations being followed up over a lengthy period, and related studies have usually focussed on schizophrenia and bipolar disorder[8,14] rather than the gamut of mental disorder. Additionally, the effects of comorbidity or multiple diagnoses on this premature mortality have also not been quantified. Concern has also been expressed that those with mental illness have not benefitted from improvements in public health over the last few decades[8,9,13] and that this mortality gap between the general population and the mentally ill is widening in recent years.

Using routinely collected national data, available from 1981, we set out to examine the ages and causes of death in those previously hospitalised with mental disorder in Scotland, and quantify any excess mortality. We also aimed to explore the relative contribution of different causes of death and trends over time.

Methods

Whenever a patient is discharged from a mental ill health hospital/specialty in Scotland, a Scottish Morbidity Record for Mental ill health (SMR04) is returned to the Information Services Division (ISD), NHS National Services Scotland. SMR04 records contain information on patient demographics such as personal identifiers, age, and sex; the diagnosis that necessitated the admission; and aspects of the care given such as the psychiatric subspecialty admitted to. One primary diagnosis and up to five

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further secondary diagnoses can be recorded. Diagnoses are coded according to the International Classification of Diseases (ICD) (version 9 to 1997 and version 10 from 1997 to present). Statutory death records (containing demographic and ICD coded cause of death information) are returned to the National Records of Scotland (NRS) with copies passed to ISD for analytical purposes.

For this study, SMR04 records for adults discharged from mental ill health hospitals/specialities in Scotland between 1981 and 2009 were obtained. Patients aged less than 15 years at the date of first admission and those admitted to the learning disabilities subspecialty were excluded from the sample, in accordance with the aim of studying the ages and causes of death in adults with mental illness and personality disorder. Death records for the period 1986-2010 were also obtained. We created a single patient record for each individual by linking all their hospital admissions and their death record (if died) using a range of patient identifiers and previously developed probabilistic matching algorithms. All patients who had had an admission to a mental ill health specialty between 1981 and 1985 were excluded to give a cohort of patients with (as close as possible to) a **first** inpatient admission between 1986 and 2009 in order to clarify the issue of diagnostic shift or comorbidity.

Diagnostic assignation

We then assigned each individual to a diagnostic category (see table 1) and excluded individuals who did not have any admissions relating to a diagnostic group of interest.

Table 1 here

Patients with a single primary diagnosis and no other or additional diagnoses at any admission were described as 'uncomplicated'. For example, an individual with five hospital admissions which were all coded solely to depression would be described as 'uncomplicated depression'.

In contrast, patients with more than one diagnosis were described as 'complicated'. For patients with more than one diagnosis from the diagnostic groups of interest, a hierarchical approach was used to determine the main diagnosis and hence assign a patient to one group (see table 1) with schizophrenia being assigned the highest rank. For example, a patient diagnosed as having bipolar disorder at their first hospital admission and then admitted for depression at a later date would be assigned to the 'complicated bipolar' group. Conversely, someone who had three hospital admissions for neurosis and then one for neurosis with depression recorded as an additional

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secondary diagnosis would be described as 'complicated depression' and their time at risk in the cohort would be taken from their first neurosis admission.

Patients may also have had other/additional diagnoses not within the diagnostic groups of interest. These included other psychiatric problems (mainly dementia, stress reactions and adjustment disorders); alcohol or drug misuse; or (rarely) physical health problems such as pneumonia. Someone with an admission for personality disorder with drug misuse recorded as an additional secondary diagnosis would therefore be described as 'complicated personality disorder'.

Analysis

A final record was then created for each patient within the mental ill health cohort containing hierarchically defined diagnosis, complication flag, date of first admission, age at first admission, sex, deprivation category at first admission, date of death and (main) cause of death. Deprivation category was determined using Carstairs 1991 area-based deprivation quintiles[15] based on postcode of residence at first admission and corresponding population denominators from the Consistent Areas Through Time (CATTS) classification tables[16] which allows us to create a long time series of deprivation-specific mortality rates.

This linked dataset was used to calculate indirectly standardised mortality ratios (SMRs) for the mental ill health patients using a person-years approach which took account of each individual's time at risk across different age categories and time periods since diagnosis. Years of Life Lost (YLL) were computed by multiplying the number of deaths in the study cohort (in each period of death, sex, age band at death and deprivation quintile) by the corresponding life expectancy at that age. The average YLL (AYLL) was derived by dividing the total YLL by the actual number of deaths within the subgroups of interest. Scottish national mortality rates split by year of death (in time bands), sex, five-year age band and deprivation quintile were used as the reference standard for the SMRs. Life tables were compiled based on these national mortality rates following the Chiang[17] methodology for the YLL analyses. To examine possible trends over time in mortality rates, we chose three time period cohorts each with 10 years of follow up for each cohort to capture a wide range of causes of death.

We looked at overall mortality; mortality by specific cause; and mortality split into natural deaths (cardiovascular, cancer, respiratory, digestive, endocrine, nervous system, infectious disease), non-natural deaths (accidental, suicide/undetermined,

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homicide), and other (all other deaths including those recorded as mental and behavioural).

Results

Over the time period of study (1986-2009) there were 59,028 individuals who had a consistent diagnosis within and between admissions (classified as uncomplicated) and 52,476 individuals who had an unstable diagnosis or additional co-morbidity within and/or between admissions (classified as complicated). Women comprised 55% of the cohort largely due to a higher number of cases of depression in women. Women tended to be older than men at their first included admission, particularly for schizophrenia and neurosis. Complicated diagnoses resulted in significantly higher numbers of hospitalisations and total length of time spent in hospital as would be expected (see Table 2a and 2b).

Increasing deprivation was linked to mental ill health problems for both men and women, with the exception of bi-polar disorder (no clear trend across deprivation groups for either sex) and eating disorder in females (uncomplicated more common in least deprived group; complicated no clear trend across deprivation groups).

Overall, 34,243 individuals in the study cohort had died by the 31 December 2010, around 80% more (SMR=1.8) than expected based on the general population (see table 3). The standardised mortality ratios were generally higher for those with complicated diagnoses, and highest for those with eating disorders (SMR=4.4) and personality disorders complicated by comorbidity (SMR=3.1). Overall life expectancy for the whole cohort of individuals with mental ill health was 17 years less than that for the general population. The largest reduction in life expectancy was seen for individuals with eating disorders (39 years for those with uncomplicated diagnosis) and personality disorders (27.5 years for those with complicated diagnosis) however as most deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

Relative risk of early death

The excess risk of death was extremely high for those in the youngest age group at first included admission, and the excess reduced as age increased (see figure 1). However, total years of life lost told a slightly different story, with a relatively constant YLL for those diagnosed at ages 20-24 through to 75-79 years, with lower YLL for

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those aged 15-19, 80-84 and 85+ years. This reflects the fact that the absolute risk of dying generally increases with age. The same age-related pattern is seen for males and females, although the risk of death is higher for females compared to males at every age (data not shown).

Figure 1 here

Around two thirds of deaths (22,865 deaths) in the mental ill health cohort were from natural causes, 11% (3,909) from non-natural causes and the remaining 21% (7,469) were from "other" deaths not coded as natural or non-natural including 'mental or behavioural disorder' (36% total "other"). The excess risk of death was much higher from non-natural causes (SMR=5.2) compared to natural causes (SMR=1.7) and "other" deaths (SMR=1.6). On average, 31.8 years of life were lost due to every non-natural death compared to 13.3 years due to every natural death and 17.4 years of life lost for each "other" death, reflecting the fact that non-natural deaths tend to occur at younger ages (see Table 4).

There was a significant excess risk of natural, non-natural and "other" deaths for patients in each diagnosis group (except uncomplicated neurotic disorders resulting in "other" deaths (SMR=1.1, ns)). The highest excess risks were seen for eating disorders across death groupings, although the number of deaths from eating disorders was small (see Table 4). Natural deaths accounted for more years of life lost than non-natural deaths in each diagnostic group. Cardiovascular disease accounted for around half of all years of life lost from natural causes, with digestive disorders, cancer, and respiratory disorders accounting for most of the remainder. Suicide accounted for the majority of years of life lost due to non-natural causes in each diagnostic group (data not shown) but Table 5 reveals the proportions of observed and expected deaths for the two main natural causes of death, namely heart disease and cancer, as well as suicide.

Tables 2a; 2b; 3; 4; and 5 here

Mortality trends over time

Looking at individuals whose first admissions were in the periods 1986-90, 1991-95 and 1996-2000 and following each individual in these sub-cohorts up for 10 years from their first admission, the all cause standardised mortality ratios showed no evidence of a narrowing of the mortality excess over time (see Table 6).

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Table 6 here

Discussion

Main findings

This large national study provides an accurate estimate of the risk of early death experienced by adults previously hospitalised for mental disorder. We showed that overall life expectancy for the whole cohort of individuals previously hospitalised due to mental ill health was 17 years less than that for the general population, and that the excess risk of early death is greatest by far in the youngest (15-19 years old) age group but that older individuals experience greater numbers of early deaths. The largest reduction in life expectancy was seen for individuals with eating disorders and personality disorders – namely an alarming 39 years reduction in life expectancy for uncomplicated eating disorders, and 27.5 for those with a complicated personality disorder.

However as the greatest number of deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost. The majority of these deaths in those previously hospitalised for mental disorder are due to 'natural' causes such as cardiovascular and respiratory disorder, which mirrors the results of a similar study from Denmark[7] examining the life expectancy of those with schizophrenia and bipolar disorder. By contrast, although only 11% of deaths in our study population were attributable to 'non-natural' causes such as suicide, accidents, and homicide, we found that these 'non-natural' causes carried a substantially higher comparative excess risk of early death – ranging between 27 years of lost life for depression to a staggering 49.5 years for eating disorders, emphasising that these non-natural deaths occur earlier than the more common natural causes of death. For the whole cohort of mentally ill individuals, those dying from non-natural causes lost, on average, almost 32 years of life, reinforcing the continuing need for national suicide prevention strategies.

A stable 'mortality gap'?

In addition, contrary to results elsewhere[8,13], we did not find any evidence that the difference in risk of death between the general population and the mentally disordered was worsening over time. In fact, we observed that this 'mortality gap' was stable over 25 years for all the common mental disorders, which offers some reassurance to

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claims that the mentally disordered have not benefited from improvements in public health[15,16]. Nevertheless, our data indicates that there continues to be a need for monitoring the physical health of those with mental disorder, and in particular screening for cardiovascular disease.

Strengths and limitations of the study

Strengths of this study include the whole population coverage and the long time series, along with the demonstrable high quality and completeness[20] of the diagnostic coding and cause of death coding. We have also taken care with final diagnosis assignation, using a pragmatic hierarchical approach to account for the diagnostic shift and comorbidities that are commonly seen in day-to-day clinical psychiatric practice. Definitive diagnosis is not always easy initially in mental health. The complicated diagnoses are assigned according to a hierarchy rather than diagnosis at first admission. This approach considerably increases the number of people in the higher categories (eg psychoses). For example, of 17,031 individuals who were first admitted with depression, 71% were assigned to depression, 17% subsequently had schizophrenia and so are assigned to "complicated schizophrenia", and 11% were assigned to "complicated bipolar". For some groups the hierarchy is less intuitive, for example, of the 325 individuals who were first admitted with eating disorders but subsequently had other mental ill health problems, 69% moved out of the eating disorder group into another group higher up the hierarchy (data not shown). This will lead to a conservative SMR for some complicated cases due to time at risk for conditions lower down the hierarchy being assigned to a condition higher up the hierarchy in the person-year analysis.

Comorbidity and early death

Furthermore, we have documented that diagnostic comorbidity, whether it is comorbid substance misuse, mental disorder or physical health problems, significantly elevates risk of premature death and the average years of lost life in those previously hospitalised due to mental illness. This adverse effect of comorbidity has not reported before to our knowledge, and emphasises that comorbidity exacerbates prognosis. Also, our use of the SMR and the 'years of lost life' techniques allows quantification of both the relative and the absolute burden of excess death in this population. However, as this is a secondary care cohort, it will only capture those most severely affected by mental disorder, and hence does not allow comment on, for example, those with depression managed solely in the community. Equally, those hospitalised due to eating disorder are often physically unwell, so it is perhaps no surprise that this diagnostic group had worrying relative and absolute mortality results in this study. Lastly, we

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designed a 'wash in' period of 5 years (1981-1986) in order to capture only first admissions, but it is likely that some patients with psychiatric admissions prior to 1981 were included. The apparently old age at 'diagnosis'/first admission may suggest that these are in fact not all first admissions ie the relatively short wash in period has allowed us to include patients readmitted after more than 5 years as 'first admissions'.

A systematic review by Saha et al[13] found a SMR of 2.5 for risk of death in schizophrenia, which is greater than our figures of 1.8 (uncomplicated) and 2.0 (complicated or comorbid), but the more recent study by Hoang and colleagues from England[8] found similar SMRs for both schizophrenia and bipolar disorder to our own results, albeit with a shorter follow up. Large long term follow up mortality studies comparing common mental disorders have not been reported elsewhere, to our knowledge, and our data provide context for the literature on early death in specific disorders such as schizophrenia and bipolar[8], and depression and anxiety[21]. More detailed analysis of the time trends for individual causes of death in specific diagnostic groups would be valuable in the future.

Implications

In previous studies of all-cause mortality in those with mental illness in Scotland, behavioural risk factors such as heavy smoking and a sedentary lifestyle have been linked to early death, along with social isolation and deprivation[22]. Policy makers in the UK have also highlighted the physical health needs and premature mortality of those with mental health problems which echo the worrying disparities in lifespan we have identified for all the common mental disorders compared to the general population. In particular, we have found that the highest risk of early death is associated with a young age; eating disorders; personality disorders; and in those with multiple diagnoses. A national approach across primary and secondary care tackling the complex mix of factors contributing to early death in the mentally disordered is required, addressing intrinsic disease related factors as well as lifestyle issues; lack of help seeking; and even stigma within the healthcare professions[15,16]. The inequity in life expectancy in the mentally disordered documented here poses a considerable challenge to our healthcare system.

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Table 1: Diagnostic categories of interest (and diagnostic hierarchy)

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Diagnostic group	Definition	Hierarchy
Schizophrenia	Schizophrenia and other psychotic disorders including acute psychosis, persistent delusional disorders, schizotypal and schizoaffective disorder, and drug or alcohol induced psychotic disorder	1
Bipolar disorder	Manic episodes and bipolar disorder	2
Depression	Depressive episodes and recurrent depressive disorder (excluding persistent mood disorders such as cyclothymia)	3
Neurosis	Anxiety disorders and obsessive compulsive disorder	4
Eating disorder	Anorexia and bulimia nervosa	5
Personality disorder	All types of personality disorder	6

Note: ICD9 and ICD10 codes available on request.

Table 2a: Characteristics of the cohort included in the analysis (Males)

	N	%	Median age at first admission	% in most deprived quintile[1]	Admissions	
					Median number	Median total length
Uncomplicated diagnosis group:						
Schizophrenia	8,966	35	33.7	29	1	48
Bipolar disorder	1,680	7	41.1	17	1	36
Depression	12,778	49	47.5	23	1	22
Neurosis	1,129	4	40.7	26	1	14
Eating disorder	49	0	22.1	33	1	48
Personality disorder	1,221	5	30.9	30	1	8
Total uncomplicated	25,823	100	40.9	25	1	28
Complicated (hierarchical) diagnosis group:						
Schizophrenia	10,697	43	31.0	33	4	145
Bipolar disorder	2,159	9	42.4	21	3	115
Depression	9,421	38	40.1	26	2	44
Neurosis	915	4	37.1	24	2	32
Eating disorder	17	0	31.3	29	3	45
Personality disorder	1,580	6	31.3	31	2	21
Total complicated	24,789	100	35.5	28	3	73

Table 2b: Characteristics of the cohort included in the analysis (Females)

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	N	%	Median age at first admission	% in most deprived quintile[1]	Admissions	
					Median number	Median total length
Uncomplicated diagnosis group:						
Schizophrenia	6,999	21	54.0	25	1	47
Bipolar disorder	2,196	7	43.4	18	1	35
Depression	20,383	61	48.5	23	1	28
Neurosis	1,946	6	48.5	26	1	18
Eating disorder	586	2	20.7	16	1	49
Personality disorder	1,095	3	31.2	27	1	9
Total uncomplicated	33,205	100	47.7	23	1	30
Complicated (hierarchical) diagnosis group:						
Schizophrenia	8,230	30	40.6	29	3	162
Bipolar disorder	3,619	13	43.0	22	3	136
Depression	13,390	48	41.1	25	2	64
Neurosis	1,136	4	42.9	21	2	38
Eating disorder	199	1	26.2	18	2	35
Personality disorder	1,113	4	29.5	28	2	27
Total complicated	27,687	100	40.6	26	3	89

1 if there had been no deprivation gradient then around 20% of cases would be in the most deprived quintile

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Table 3: SMRs and years of life lost for all-cause mortality by diagnosis group (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Observed deaths	Expected deaths	SMR[1]	Lower CI	Upper CI	Total YLL	Average YLL
Uncomplicated diagnosis group:							
Schizophrenia	5,060	2,746	1.8	1.8	1.9	78,027	15.2
Bi-polar	883	525.6	1.7	1.6	1.8	14,369	16.1
Depression	11,036	6,831.2	1.6	1.6	1.6	155,582	14.1
Neurotic disorders	838	524.7	1.6	1.5	1.7	12,373	14.9
Eating disorders	51	11.6	4.4	3.3	5.8	2,182	39.0
Personality disorders	449	234.9	1.9	1.7	2.1	10,583	22.8
Complicated (hierarchical) diagnosis group:							
Schizophrenia	5,635	2,876.9	2.0	1.9	2.0	116,775	19.6
Bi-polar	1,706	1,129.5	1.5	1.4	1.6	29,351	16.7
Depression	7,282	3,628.8	2.0	2.0	2.1	146,736	19.0
Neurotic disorders	579	272.8	2.1	2.0	2.3	12,194	19.9
Eating disorders	38	8.7	4.4	3.1	6.0	1,317	31.4
Personality disorders	686	221.9	3.1	2.9	3.3	20,894	27.5
Total	**34,243**	**19,012.4**	**1.8**	**1.8**	**1.8**	600,383	**17.0**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 4: SMRs and years of life lost by diagnosis group and cause of death grouping (natural death, non-natural death, or "other" deaths) (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Natural deaths			Non-natural deaths			Other deaths		
	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL
Uncomplicated diagnosis group:									
Schizophrenia	3,580	1.8 (1.7 - 1.8)	11.8	504	4.4 (4.0 - 4.8)	32.2	976	1.6 (1.5 - 1.7)	16.3
Bi-polar	624	1.7 (1.6 - 1.8)	13.0	97	4.7 (3.8 - 5.8)	32.0	162	1.2 (1.0 - 1.4)	16.4
Depression	7,839	1.6 (1.6 - 1.6)	12.0	1,055	4.9 (4.6 - 5.2)	27.2	2,142	1.2 (1.2 - 1.3)	13.8
Neurotic disorders	622	1.7 (1.6 - 1.9)	13.2	63	3.3 (2.6 - 4.3)	29.4	153	1.1 (0.9 - 1.3)	15.1
Eating disorders	15	2.6 (1.4 - 4.3)	23.8	12	7.2 (3.7 - 12.6)	49.5	24	5.8 (3.7 - 8.7)	39.3
Personality disorders	265	1.7 (1.5 - 1.9)	15.0	96	6.2 (5.0 - 7.6)	37.6	88	1.4 (1.2 - 1.8)	25.6
Complicated (hierarchical) diagnosis group:									
Schizophrenia	3,500	1.7 (1.7 - 1.8)	14.3	767	5.2 (4.8 - 5.5)	35.1	1,368	2.0 (1.9 - 2.1)	20.0
Bi-polar	1,139	1.4 (1.3 - 1.5)	13.7	197	5.1 (4.4 - 5.8)	30.8	370	1.3 (1.1 - 1.4)	15.7
Depression	4,525	1.8 (1.7 - 1.8)	14.8	931	6.5 (6.1 - 7.0)	32.3	1,826	1.9 (1.9 - 2.0)	18.6
Neurotic disorders	379	2.0 (1.8 - 2.3)	16.4	53	4.3 (3.2 - 5.6)	33.6	147	2.0 (1.7 - 2.3)	20.0
Eating disorders	17	3.0 (1.7 - 4.8)	24.4	5	9.0 (2.8 - 21.1)	43.2	16	6.6 (3.7 - 10.7)	32.9
Personality disorders	360	2.5 (2.2 - 2.7)	19.9	129	7.5 (6.2 - 8.9)	39.0	197	3.4 (2.9 - 3.9)	28.8
Total	**22,865**	**1.7 (1.7 - 1.7)**	**13.3**	**3,909**	**5.2 (5.1 - 5.4)**	**31.8**	**7,469**	**1.6 (1.5 - 1.6)**	**17.4**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 5. Observed and expected number of deaths for cardiovascular disease; cancer; and suicide.

	Observed CVS[1] deaths	Expected CVS deaths	Observed Cancer[2] deaths	Expected Cancer deaths	Observed suicide[3] deaths	Expected suicide deaths
Uncomplicated diagnosis group:						
Schizophrenia	2010	1109	650	500	502	110
Bi-polar	335	199	135	105	97	19
Depression	4281	2691	1671	1358	1047	211
Neurotic disorders	313	195	136	102	60	17
Eating disorders	6	3	3	1	12	1
Personality disorders	136	84	55	41	88	14
Complicated diagnosis group						
Schizophrenia	1740	1108	476	543	771	150
Bi-polar	596	425	201	238	198	38
Depression	2219	1368	730	718	932	138
Neurotic disorders	316	99	68	51	53	12
Eating disorders	5	3	3	1	5	0
Personality disorders	129	75	49	44	123	15

[1] All cardiovascular (heart disease) deaths. [2] All cancer, including lung cancer, deaths.
[3] All deaths coded as suicides and accidents by poisoning.

Table 6: SMRs by time period of first admission (1986-2000) and followed up for 10 years from first admission (all diagnosis groups combined)

	Period of first diagnosis	Observed deaths	Expected deaths	SMR[1]	Lower CI	Upper CI
Males	1986-90	3185	1514.1	2.1	2.0	2.2
	1991-95	2878	1328.0	2.2	2.1	2.2
	1996-00	2327	1075.9	2.2	2.1	2.3
Females	1986-90	4808	2669.0	1.8	1.8	1.9
	1991-95	3882	2112.3	1.8	1.8	1.9
	1996-00	2740	1412.6	1.9	1.9	2.0

[1] adjusted for age and deprivation category (Carstairs 1991 decile) at first diagnosis

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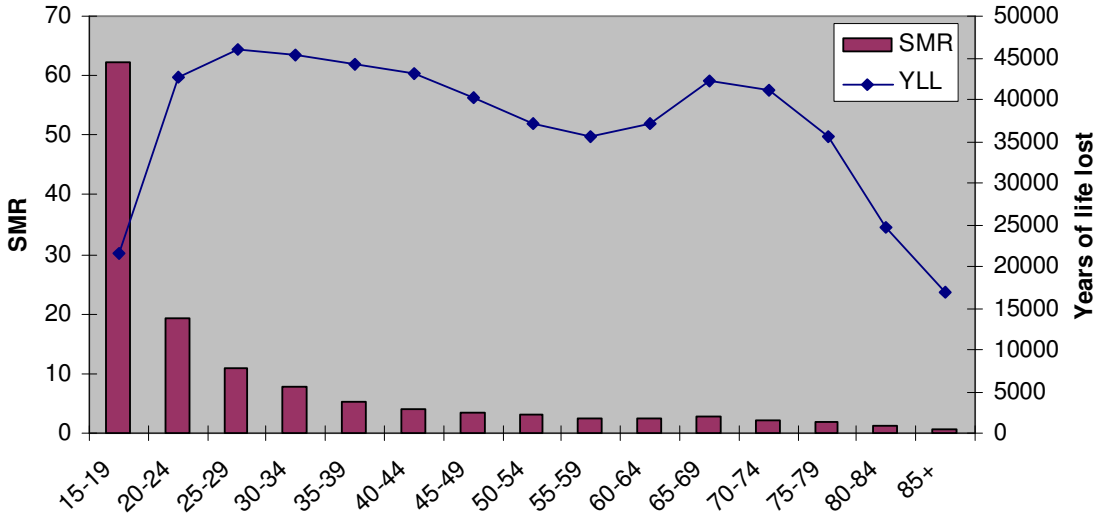
Figure 1: Age-specific all-cause SMRs and overall YLL for all patients diagnosed 1986-2009 and followed up until 31 December 2010



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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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Contributors OA and MT conceived the study. OA and DS ascertained the data. All authors analysed the data and drafted the manuscript. RW is the study guarantor.

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Article Focus

- Examines whether those previously hospitalised for mental disorder die earlier than people with no overt serious mental disorder.
- Do individuals with 'complicated' diagnoses (ie additional mental or physical ill health diagnoses in conjunction with their main psychiatric diagnosis) have higher excess mortality than those with 'uncomplicated' diagnoses?
- Is the apparent inequality in mortality rates between those with serious mental disorder and the general population worsening over time?

Key messages

- The average reduction in lifespan in those previously hospitalised for mental disorder compared to the general population is 17 years. People with eating disorders and personality disorder died earliest of all.
- In general, patients with 'complicated' diagnoses experience higher excess mortality than those without.
- Cardiovascular and respiratory diseases were the most common causes of death and accounted for a high proportion of the total burden of years of life lost, but suicides led to more years of lost life at the individual level due to predominantly affecting younger adults. No worsening of the 'mortality gap' over three decades was observed.

Strengths and limitations

- A large representative population studied over a long time period, which is important when examining causes of death.
- Innovative use of a diagnostic hierarchy to determine individuals' main psychiatric diagnosis.
- People with mental disorder who never required in-patient hospital care could not be included in this study.

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Objectives:

To compare the mortality in those previously hospitalised for mental disorder in Scotland to that experienced by the general population.

Design:

Population based historical cohort study using routinely available psychiatric hospital discharge and death records.

Setting & participants:

Individuals with a first hospital admission for mental disorder in Scotland, 1986-2009.

Outcomes:

The main outcome measure was death from any cause, 1986-2010. Excess mortality in individuals with previous psychiatric admission was presented as standardised mortality ratios (SMR) and years of life lost (YLL). Excess mortality was assessed overall and by age, sex, main psychiatric diagnosis, whether the psychiatric diagnosis was 'complicated' (ie additional mental or physical ill health diagnoses present), cause of death, and time period of first admission.

Results

111504 people were included in the study, and 34243 had died by 31/12/2010. The average reduction in life expectancy for the whole cohort was 17 years, with eating disorders (39 year reduction) and 'complicated' personality disorders (27.5 year reduction) being worst affected. 'Natural' causes of death such as cardiovascular disease showed modestly elevated relative risk (SMR1.7) but accounted for a high proportion of all deaths (67%) and of the total burden of years of life lost (54%). Non-natural deaths such as suicide showed higher relative risk (SMR5.2) and tended to occur at a younger age but were less common overall (11% of all deaths and 22% of all YLL). Having a 'complicated' diagnosis tended to elevate the risk of early death. No worsening of the overall excess mortality experienced by individuals with previous psychiatric admission over time was observed.

Conclusions

Early death for those hospitalised with mental disorder is common, and represents a significant inequality even in well developed healthcare systems. Prevention of suicide and cardiovascular disease deserve particular attention in the mentally disordered.

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Declaration of interest

All authors are employed by NHS Scotland. MT has received fees and / or hospitality from the manufacturers of various antipsychotic medications. TA, DS, and RW have no other conflicts to declare.

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Many of the most disabling medical conditions worldwide are mental illnesses, according to the WHO[1]. As well as adversely affecting day to day function, it has been known for many years that people with mental illness are at increased risk of premature death[2-5] with schizophrenia and bipolar disorder in particular being associated with an early death[6-8]. These inequalities in life expectancy have recently[9] been declared a "scandal", as even the Scandinavian countries[5], Scotland[10] and England[8] , despite relatively high quality and equitably distributed healthcare, have not been able to demonstrate any improvement in this premature mortality for the mentally ill over many years.

Non-natural deaths[11] including suicide and accidents, account for a disproportionate amount of this premature mortality in the mentally ill, particularly affecting young adults. High rates of cardiovascular disease, respiratory disease and other so-called natural causes also contribute[5,12,13] to the elevated relative risk of early death in the mentally ill. Precise estimates of the varying causal contributions to premature mortality in the mentally disordered have been limited by the lack of large representative populations being followed up over a lengthy period, and related studies have usually focussed on schizophrenia and bipolar disorder[8,14] rather than the gamut of mental disorder. Additionally, the effects of comorbidity or multiple diagnoses on this premature mortality have also not been quantified. Concern has also been expressed that those with mental illness have not benefitted from improvements in public health over the last few decades[8,9,13] and that this mortality gap between the general population and the mentally ill is widening in recent years.

Using routinely collected national data, available from 1981, we set out to examine the ages and causes of death in those previously hospitalised with mental disorder in Scotland, and quantify any excess mortality. We also aimed to explore the relative contribution of different causes of death and trends over time.

Methods

Whenever a patient is discharged from a mental ill health hospital/specialty in Scotland, a Scottish Morbidity Record for Mental ill health (SMR04) is returned to the NHS National Services Scotland Information Services Division (ISD).. SMR04 records contain information on patient demographics such as personal identifiers, age, and sex; the diagnosis that necessitated the admission; and aspects of the care given such as the psychiatric subspecialty admitted to. One primary diagnosis and up to five

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further secondary diagnoses can be recorded. Diagnoses are coded according to the International Classification of Diseases (ICD) (version 9 to 1997 and version 10 from 1997 to present). Statutory death records (containing demographic and ICD coded cause of death information) are returned to the National Records of Scotland (NRS) with copies passed to ISD for analytical purposes.

For this study, SMR04 records for adults discharged from mental ill health hospitals/specialities in Scotland between 1981 and 2009 were obtained. Patients aged less than 15 years at the date of first admission and those admitted to the learning disabilities subspecialty were excluded from the sample, in accordance with the aim of studying the ages and causes of death in adults with mental illness and personality disorder. Death records for the period 1986-2010 were also obtained. We created a single patient record for each individual by linking all their hospital discharge records and their death record (if died) using a range of patient identifiers and previously developed probabilistic matching algorithms. All patients who had had an admission to a mental ill health specialty between 1981 and 1985 were excluded to give a cohort of patients with (as close as possible to) a **first** inpatient admission between 1986 and 2009 in order to clarify the issue of diagnostic shift or comorbidity.

All patient level data used in this study were held and analysed within ISD. Only aggregate results, from which individual patients could not be identified, were shared with members of the study team not based within ISD (MT). ISD operates strict procedures to maintain patient privacy and confidentiality and no specific additional permissions were required for this study. In particular, permission for linkage of previously unlinked health datasets held by ISD is required from the Privacy Advisory Committee. PAC approval was not required for this study however as SMR04 and death records have been routinely linked within ISD for decades for purposes such as monitoring patient outcomes.

Diagnostic assignation

We then assigned each individual to a main psychiatric diagnosis category (see table 1) and excluded individuals who did not have any admissions relating to a diagnostic group of interest. The diagnostic groups of interest included were schizophrenia, bipolar disorder, depression, neurosis, eating disorder, and personality disorder.

Table 1 here

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Patients with a single primary psychiatric diagnosis of interest recorded on all their psychiatric discharge records over the period of study, and no other or additional diagnoses at any admission, were described as 'uncomplicated'. For example, an individual with five hospital admissions which were all coded solely to depression would be described as 'uncomplicated depression'.

In contrast, patients with more than one diagnosis recorded were described as 'complicated'. For patients with more than one diagnosis from the diagnostic groups of interest, a hierarchical approach was used to determine the main diagnosis and hence assign a patient to one group (see table 1) with schizophrenia being assigned the highest rank. For example, a patient diagnosed as having bipolar disorder at their first hospital admission and then admitted for neurosis at a later date would be assigned to the 'complicated bipolar' group. Conversely, someone who had three hospital admissions for neurosis and then one for neurosis with depression recorded as an additional secondary diagnosis would be described as 'complicated depression' and their time at risk in the cohort would be taken from their first neurosis admission.

Patients may also have had other/additional diagnoses not within the diagnostic groups of interest. These included other psychiatric problems (mainly dementia, stress reactions and adjustment disorders); alcohol or drug misuse; or (rarely) physical health problems such as pneumonia. Someone with an admission for personality disorder with drug misuse recorded as an additional secondary diagnosis would therefore be described as 'complicated personality disorder'.

Analysis

A final record was then created for each patient within the mental ill health cohort containing hierarchically defined main psychiatric diagnosis, a flag indicating whether the main diagnosis was 'complicated' or not, date of first admission, age at first admission, sex, deprivation category at first admission, date of death and (main) cause of death. Deprivation category was determined using Carstairs 1991 area-based deprivation quintiles[15] based on postcode of residence at first admission and corresponding population denominators from the Consistent Areas Through Time (CATTS) classification tables[16] which allows us to create a long time series of deprivation-specific mortality rates.

This linked dataset was used to calculate indirectly standardised mortality ratios (SMRs) for the mental ill health patients using a person-years approach which took account of each individual's time at risk (from time of first admission) across different

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age categories and time periods since diagnosis. Years of Life Lost (YLL) were computed by multiplying the number of deaths in the study cohort (in each period of death, sex, age band at death and deprivation quintile) by the corresponding life expectancy at that age. The average YLL (AYLL) was derived by dividing the total YLL by the actual number of deaths within the subgroups of interest. Scottish national mortality rates split by year of death (in time bands), sex, five-year age band and deprivation quintile were used as the reference standard for the SMRs. Life tables were compiled based on these national mortality rates following the Chiang[17] methodology for the YLL analyses. To examine possible trends over time in the excess mortality experienced by individuals with previous psychiatric admission, we chose three time period cohorts each with 10 years of follow up for each cohort to capture a wide range of causes of death.

We looked at overall mortality; mortality by specific cause; and mortality split into natural deaths (cardiovascular, cancer, respiratory, digestive, endocrine, nervous system, infectious disease), non-natural deaths (accidental, suicide/undetermined, homicide), and other (all other deaths including those recorded as mental and behavioural).

Results

Over the time period of study (1986-2009) there were 59,028 individuals who had a consistent diagnosis within and between admissions (classified as uncomplicated) and 52,476 individuals who had an unstable diagnosis or additional co-morbidity within and/or between admissions (classified as complicated). Women comprised 55% of the cohort largely due to a higher number of cases of depression in women. Women tended to be older than men at their first included admission, particularly for schizophrenia and neurosis. Complicated diagnoses resulted in higher numbers of hospitalisations and total length of time spent in hospital as would be expected (see Table 2a and 2b).

Increasing deprivation was linked to mental ill health problems for both men and women, with the exception of bi-polar disorder (no clear trend across deprivation groups for either sex) and eating disorder in females (uncomplicated more common in least deprived group; complicated no clear trend across deprivation groups) (Table 2 and additional analyses available on request).

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Overall, 34,243 individuals in the study cohort had died by the 31 December 2010, around 80% more (SMR=1.8) than expected based on the general population (see table 3). The standardised mortality ratios tended to be higher for those with complicated diagnoses, and overall were highest for those with eating disorders (SMR=4.4) and complicated personality disorders (SMR=3.1). Overall life expectancy for the whole cohort of individuals with mental ill health was 17 years less than that for the general population. The largest reduction in life expectancy was seen for individuals with eating disorders (39 years of life lost for those with uncomplicated diagnosis) and personality disorders (27.5 YLL for those with complicated diagnosis) however as most deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

Relative risk of early death

The excess risk of death was extremely high for those in the youngest age group at first included admission, and the excess reduced as age increased (see figure 1). However, total years of life lost told a slightly different story, with a relatively constant YLL for those diagnosed at ages 20-24 through to 75-79 years, with lower YLL for those aged 15-19, 80-84 and 85+ years. This reflects the fact that the absolute risk of dying generally increases with age. The same age-related pattern is seen for males and females, although the excess risk of death is higher for females compared to males at every age (data not shown).

Figure 1 here

Around two thirds of deaths (22,865 deaths) in the mental ill health cohort were from natural causes, 11% (3,909) from non-natural causes and the remaining 21% (7,469) were from "other" deaths not coded as natural or non-natural including 'mental or behavioural disorder' (36% total "other"). The excess risk of death was much higher from non-natural causes (SMR=5.2) compared to natural causes (SMR=1.7) and "other" deaths (SMR=1.6). On average, 31.8 years of life were lost due to every non-natural death compared to 13.3 years due to every natural death and 17.4 years of life lost for each "other" death, reflecting the fact that non-natural deaths tend to occur at younger ages (see Table 4).

There was a significant excess risk of natural, non-natural and "other" deaths for patients in each diagnosis group (except uncomplicated neurotic disorders resulting in "other" deaths (SMR=1.1, ns)). The highest excess risks were seen for eating disorders across death groupings, although the number of deaths in individuals with

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eating disorders was small (see Table 4). Natural deaths accounted for more years of life lost than non-natural deaths in each diagnostic group. Cardiovascular disease accounted for around half of all years of life lost from natural causes, with digestive disorders, cancer, and respiratory disorders accounting for most of the remainder. Suicide accounted for the majority of years of life lost due to non-natural causes in each diagnostic group (data not shown). Table 5 reveals the proportions of observed and expected deaths for the two main natural causes of death, namely heart disease and cancer, as well as suicide.

Tables 2a; 2b; 3; 4; and 5 here

Mortality trends over time

Looking at individuals whose first admissions were in the periods 1986-90, 1991-95 and 1996-2000 and following each individual in these sub-cohorts up for 10 years from their first admission, the all cause standardised mortality ratios showed no evidence of a narrowing of the mortality excess over time (see Table 6).

Table 6 here

Discussion

Main findings

This large national study provides an accurate estimate of the risk of early death experienced by adults previously hospitalised for mental disorder. We showed that overall life expectancy for the whole cohort of individuals previously hospitalised due to mental ill health was 17 years less than that for the general population, and that the excess risk of early death is greatest by far in the youngest (15-19 years old) age group but that older individuals experience greater numbers of early deaths. The largest reduction in life expectancy was seen for individuals with eating disorders and personality disorders – namely an alarming 39 years reduction in life expectancy for uncomplicated eating disorders, and 27.5 for those with a complicated personality disorder.

However as the greatest number of deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost. The majority of these deaths in those previously hospitalised for mental disorder

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are due to 'natural' causes such as cardiovascular and respiratory disorder, which mirrors the results of a similar study from Denmark[7] examining the life expectancy of those with schizophrenia and bipolar disorder. By contrast, although only 11% of deaths in our study population were attributable to 'non-natural' causes such as suicide, accidents, and homicide, we found that these 'non-natural' causes carried a substantially higher comparative excess risk of early death – ranging between 27 years of lost life for depression to a staggering 49.5 years for eating disorders, emphasising that these non-natural deaths occur earlier than the more common natural causes of death. For the whole cohort of mentally ill individuals, those dying from non-natural causes lost, on average, almost 32 years of life, reinforcing the continuing need for national suicide prevention strategies.

A stable 'mortality gap'?

In addition, contrary to results elsewhere[8,13], we did not find any evidence that the difference in risk of death between the general population and the mentally disordered was worsening over time. In fact, we observed that this 'mortality gap' was stable over 25 years for all the common mental disorders, which offers some reassurance to claims that the mentally disordered have not benefited from improvements in public health[15,16]. Nevertheless, our data indicates that there continues to be a need for monitoring the physical health of those with mental disorder, and in particular screening for cardiovascular disease.

Strengths and limitations of the study

Strengths of this study include the whole population coverage and the long time series, along with the demonstrable high quality and completeness[20] of the diagnostic coding and cause of death coding. We have also taken care with main psychiatric diagnosis assignation, using a pragmatic hierarchical approach to account for the diagnostic shift and co-morbidities that are commonly seen in day-to-day clinical psychiatric practice. Definitive diagnosis is not always easy initially in mental health. Main psychiatric diagnosis has therefore been assigned using a hierarchical approach and taking into account all diagnoses recorded on an individual's psychiatric discharge records over the period of study rather than simply diagnosis at first admission. This approach considerably increases the number of people in the higher categories (eg psychoses). For example, of 17,031 individuals who were first admitted with depression, 71% were assigned to depression, 17% subsequently had schizophrenia recorded on a discharge record and so were assigned to "complicated schizophrenia", and 11% were assigned to "complicated bipolar". For some groups the hierarchy is less intuitive, for example, of the 325 individuals who were first admitted with eating

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disorders but subsequently had other mental ill health problems, 69% moved out of the eating disorder group into another group higher up the hierarchy (data not shown). This will lead to a conservative SMR for some complicated cases due to time at risk for conditions lower down the hierarchy being assigned to a condition higher up the hierarchy in the person-year analysis.

Comorbidity and early death

Furthermore, we have documented that diagnostic 'complexity' (indicated by further recording of other mental disorders in addition to the main psychiatric diagnosis, substance misuse, or physical health problems), tends to increase the risk of premature death and the average years of lost life in those previously hospitalised due to mental illness. This adverse effect of complexity has not reported before to our knowledge, and emphasises that comorbidity exacerbates prognosis. Also, our use of the SMR and the 'years of lost life' techniques allows quantification of both the relative and the absolute burden of excess death in this population. However, as this is a secondary care cohort, it will only capture those most severely affected by mental disorder, and hence does not allow comment on, for example, those with depression managed solely in the community. Equally, those hospitalised due to eating disorder are often physically unwell, so it is perhaps no surprise that this diagnostic group had worrying relative and absolute mortality results in this study. Lastly, we designed a 'wash in' period of 5 years (1981-1986) in order to capture only first admissions, but it is likely that some patients with psychiatric admissions prior to 1981 were included. The apparently old age at 'diagnosis'/first admission may suggest that these are in fact not all first admissions ie the relatively short wash in period has allowed us to include patients readmitted after more than 5 years as 'first admissions'.

A systematic review by Saha et al[13] found a SMR of 2.5 for risk of death in schizophrenia, which is greater than our figures of 1.8 (uncomplicated) and 2.0 (complicated), but the more recent study by Hoang and colleagues from England[8] found similar SMRs for both schizophrenia and bipolar disorder to our own results, albeit with a shorter follow up. Large long term follow up mortality studies comparing common mental disorders have not been reported elsewhere, to our knowledge, and our data provide context for the literature on early death in specific disorders such as schizophrenia and bipolar disorder[8], and depression and anxiety[21]. More detailed analysis of the time trends for individual causes of death in specific diagnostic groups would be valuable in the future.

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Implications

In previous studies of all-cause mortality in those with mental illness in Scotland, behavioural risk factors such as heavy smoking and a sedentary lifestyle have been linked to early death, along with social isolation and deprivation[22]. Policy makers in the UK have also highlighted the physical health needs and premature mortality of those with mental health problems which echo the worrying disparities in lifespan we have identified for all the common mental disorders compared to the general population. In particular, we have found that the highest risk of early death is associated with a young age; eating disorders; personality disorders; and in those with multiple diagnoses. A national approach across primary and secondary care tackling the complex mix of factors contributing to early death in the mentally disordered is required, addressing intrinsic disease related factors as well as lifestyle issues; lack of help seeking; and even stigma within the healthcare professions[15,16]. The inequity in life expectancy in the mentally disordered documented here poses a considerable challenge to our healthcare system.

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Table 1: Main psychiatric diagnosis categories of interest (and diagnostic hierarchy)

Main psychiatric diagnosis category	Definition	Hierarchy
Schizophrenia	Schizophrenia and other psychotic disorders including acute psychosis, persistent delusional disorders, schizotypal and schizoaffective disorder, and drug or alcohol induced psychotic disorder	1
Bipolar disorder	Manic episodes and bipolar disorder	2
Depression	Depressive episodes and recurrent depressive disorder (excluding persistent mood disorders such as cyclothymia)	3
Neurosis	Anxiety disorders and obsessive compulsive disorder	4
Eating disorder	Anorexia and bulimia nervosa	5
Personality disorder	All types of personality disorder	6

Note: ICD9 and ICD10 codes available on request.

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Table 2a: Characteristics of the cohort included in the analysis (Males)

	N	%	Median age at first admission (25th – 75th percentiles)	% in most deprived quintile[1]	Median number (25th – 75th percentiles)	Median total length (days) (25th – 75th percentiles)
Uncomplicated diagnosis group:						
Schizophrenia	8,966	35	33.7 (24.6 -50.2)	29	1.0 (1.0 -2.0)	48.0 (16.0 -161.0)
Bipolar disorder	1,680	7	41.0 (28.4 -56.2)	17	1.0 (1.0 -2.0)	36.0 (17.0 -72.0)
Depression	12,778	49	47.5 (34.2 -66.0)	23	1.0 (1.0 -1.0)	22.0 (7.0 -53.0)
Neurosis	1,129	4	40.7 (29.8 -58.5)	26	1.0 (1.0 -1.0)	14.0 (5.0 -35.0)
Eating disorder	49	<1	22.1 (19.0 -28.8)	33	1.0 (1.0 -1.0)	48.0 (12.0 -89.0)
Personality disorder	1,221	5	30.9 (23.8 -41.7)	30	1.0 (1.0 -1.0)	8.0 (3.0 -24.0)
Total uncomplicated	25,823	100	40.9 (28.4 -59.6)	25	1.0 (1.0 -2.0)	28.0 (9.0 -74.0)
Complicated (hierarchical) diagnosis group:						
Schizophrenia	10,697	43	31.0 (23.3 -44.0)	33	4.0 (2.0 -6.0)	145.0 (52.0 -429.0)
Bipolar disorder	2,159	9	42.4 (30.5 -56.6)	21	3.0 (2.0 -5.0)	115.0 (51.0 -257.0)
Depression	9,421	38	40.1 (30.0 -54.9)	26	2.0 (1.0 -4.0)	44.0 (18.0 -105.0)
Neurosis	915	4	37.0 (27.4 -48.1)	24	2.0 (1.0 -3.0)	32.0 (14.0 -71.0)
Eating disorder	17	<1	31.3 (23.5 -48.5)	29	3.0 (2.0 -4.0)	45.0 (21.0 -148.0)
Personality disorder	1,580	6	31.3 (23.8 -41.6)	31	2.0 (1.0 -3.0)	21.0 (8.0 -49.0)
Total complicated	24,789	100	35.5 (26.0-49.9)	28	3.0(2.0-5.0)	73.0(26.0 -214.0)

Table 2b: Characteristics of the cohort included in the analysis (Females)

	N	%	Median age at first admission (25th – 75th percentiles)	% in most deprived quintile[1]	Median number (25th -75th percentiles)	Median total length (days) (25th – 75th percentiles)
Uncomplicated diagnosis group:						
Schizophrenia	6,999	21	53.9 (34.5 -76.0)	25	1.0 (1.0 -2.0)	47.0 (19.0 -122.0)
Bipolar disorder	2,196	7	43.4 (30.5 -61.0)	18	1.0 (1.0 -2.0)	35.0 (17.0 -74.0)
Depression	20,383	61	48.5 (33.8 -69.1)	23	1.0 (1.0 -1.0)	28.0 (10.0 -65.0)
Neurosis	1,946	6	48.5 (33.7 -68.7)	26	1.0 (1.0 -1.0)	18.0 (7.0 -39.0)
Eating disorder	586	2	20.7 (17.5 -26.5)	16	1.0 (1.0 -1.0)	49.0 (13.0 -126.0)
Personality disorder	1,095	3	31.1 (23.0 -43.5)	27	1.0 (1.0 -1.0)	9.0 (3.0 -25.0)
Total uncomplicated	33,205	100	47.6 (32.5-69.5)	23	1.0 (1.0 -1.0)	30.0 (11.0 -73.0)
Complicated (hierarchical) diagnosis group[2]:						
Schizophrenia	8,230	30	40.6 (27.7 -66.0)	29	3.0 (2.0 -6.0)	162.0 (68.0 -410.0)
Bipolar disorder	3,619	13	43.0 (31.2 -59.8)	22	3.0 (2.0 -5.0)	136.0 (60.0 -313.0)
Depression	13,390	48	41.1 (29.8 -61.8)	25	2.0 (2.0 -4.0)	64.0 (25.0 -163.0)
Neurosis	1,136	4	42.9 (31.2 -63.6)	21	2.0 (1.0 -3.0)	38.0 (17.0 -91.5)
Eating disorder	199	1	26.2 (20.7 -34.3)	18	2.0 (1.0 -3.0)	35.0 (10.0 -103.0)
Personality disorder	1,113	4	29.5 (22.5 -40.3)	28	2.0 (1.0 -3.0)	27.0 (10.0 -60.0)
Total complicated	27,687	100	40.6 (28.8 -61.9)	26	3.0 (2.0 -5.0)	89.0 (33.0 -237.0)

1 if there had been no deprivation gradient then around 20% of cases would be in the most deprived quintile

2 . For individuals with a complicated mental health diagnosis (hierarchical) , the age at first admission refers to the first 'ever' admission event.

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Table 3: SMRs and years of life lost for all-cause mortality by diagnosis group (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Observed deaths	Expected deaths	SMR[1]	Lower CI	Upper CI	Total YLL	Average YLL
Uncomplicated diagnosis group:							
Schizophrenia	5,060	2,746	1.8	1.8	1.9	78,027	15.2
Bi-polar	883	525.6	1.7	1.6	1.8	14,369	16.1
Depression	11,036	6,831.2	1.6	1.6	1.6	155,582	14.1
Neurotic disorders	838	524.7	1.6	1.5	1.7	12,373	14.9
Eating disorders	51	11.6	4.4	3.3	5.8	2,182	39.0
Personality disorders	449	234.9	1.9	1.7	2.1	10,583	22.8
Complicated (hierarchical) diagnosis group:							
Schizophrenia	5,635	2,876.9	2.0	1.9	2.0	116,775	19.6
Bi-polar	1,706	1,129.5	1.5	1.4	1.6	29,351	16.7
Depression	7,282	3,628.8	2.0	2.0	2.1	146,736	19.0
Neurotic disorders	579	272.8	2.1	2.0	2.3	12,194	19.9
Eating disorders	38	8.7	4.4	3.1	6.0	1,317	31.4
Personality disorders	686	221.9	3.1	2.9	3.3	20,894	27.5
Total	**34,243**	**19,012.4**	**1.8**	**1.8**	**1.8**	600,383	**17.0**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 4: SMRs and years of life lost by diagnosis group and cause of death grouping (natural death, non-natural death, or "other" deaths) (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Natural deaths			Non-natural deaths			Other deaths		
	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL
Uncomplicated diagnosis group:									
Schizophrenia	3,580	1.8 (1.7 - 1.8)	11.8	504	4.4 (4.0 - 4.8)	32.2	976	1.6 (1.5 - 1.7)	16.3
Bi-polar	624	1.7 (1.6 - 1.8)	13.0	97	4.7 (3.8 - 5.8)	32.0	162	1.2 (1.0 - 1.4)	16.4
Depression	7,839	1.6 (1.6 - 1.6)	12.0	1,055	4.9 (4.6 - 5.2)	27.2	2,142	1.2 (1.2 - 1.3)	13.8
Neurotic disorders	622	1.7 (1.6 - 1.9)	13.2	63	3.3 (2.6 - 4.3)	29.4	153	1.1 (0.9 - 1.3)	15.1
Eating disorders	15	2.6 (1.4 - 4.3)	23.8	12	7.2 (3.7 - 12.6)	49.5	24	5.8 (3.7 - 8.7)	39.3
Personality disorders	265	1.7 (1.5 - 1.9)	15.0	96	6.2 (5.0 - 7.6)	37.6	88	1.4 (1.2 - 1.8)	25.6
Complicated (hierarchical) diagnosis group:									
Schizophrenia	3,500	1.7 (1.7 - 1.8)	14.3	767	5.2 (4.8 - 5.5)	35.1	1,368	2.0 (1.9 - 2.1)	20.0
Bi-polar	1,139	1.4 (1.3 - 1.5)	13.7	197	5.1 (4.4 - 5.8)	30.8	370	1.3 (1.1 - 1.4)	15.7
Depression	4,525	1.8 (1.7 - 1.8)	14.8	931	6.5 (6.1 - 7.0)	32.3	1,826	1.9 (1.9 - 2.0)	18.6
Neurotic disorders	379	2.0 (1.8 - 2.3)	16.4	53	4.3 (3.2 - 5.6)	33.6	147	2.0 (1.7 - 2.3)	20.0
Eating disorders	17	3.0 (1.7 - 4.8)	24.4	5	9.0 (2.8 - 21.1)	43.2	16	6.6 (3.7 - 10.7)	32.9
Personality disorders	360	2.5 (2.2 - 2.7)	19.9	129	7.5 (6.2 - 8.9)	39.0	197	3.4 (2.9 - 3.9)	28.8
Total	**22,865**	**1.7 (1.7 - 1.7)**	**13.3**	**3,909**	**5.2 (5.1 - 5.4)**	**31.8**	**7,469**	**1.6 (1.5 - 1.6)**	**17.4**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 5. Observed and expected number of deaths for cardiovascular disease; cancer; and suicide.

	Observed CVS[1] deaths	Expected CVS deaths	Observed Cancer[2] deaths	Expected Cancer deaths	Observed suicide[3] deaths	Expected suicide deaths
Uncomplicated diagnosis group:						
Schizophrenia	2010	1109	650	500	502	110
Bi-polar	335	199	135	105	97	19
Depression	4281	2691	1671	1358	1047	211
Neurotic disorders	313	195	136	102	60	17
Eating disorders	6	3	3	1	12	1
Personality disorders	136	84	55	41	88	14
Complicated diagnosis group						
Schizophrenia	1740	1108	476	543	771	150
Bi-polar	596	425	201	238	198	38
Depression	2219	1368	730	718	932	138
Neurotic disorders	316	99	68	51	53	12
Eating disorders	5	3	3	1	5	0
Personality disorders	129	75	49	44	123	15

[1] All cardiovascular (heart disease) deaths. [2] All cancer, including lung cancer, deaths.
[3] All deaths coded as suicides and accidents by poisoning.

Table 6: SMRs by time period of first admission (1986-2000) and followed up for 10 years from first admission (all diagnosis groups combined)

	Period of first diagnosis	Observed deaths	Expected deaths	SMR[1]	Lower CI	Upper CI
Males	1986-90	3185	1514.1	2.1	2.0	2.2
	1991-95	2878	1328.0	2.2	2.1	2.2
	1996-00	2327	1075.9	2.2	2.1	2.3
Females	1986-90	4808	2669.0	1.8	1.8	1.9
	1991-95	3882	2112.3	1.8	1.8	1.9
	1996-00	2740	1412.6	1.9	1.9	2.0

[1] adjusted for age and deprivation category (Carstairs 1991 decile) at first diagnosis

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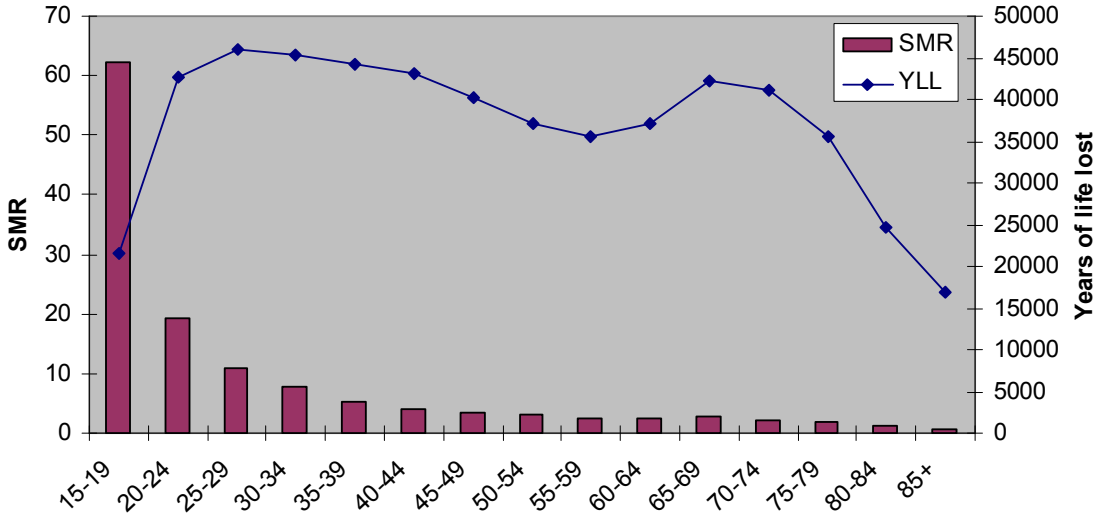
Figure 1: Age-specific all-cause SMRs and overall YLL for all patients diagnosed 1986-2009 and followed up until 31 December 2010



* The SMR for the above chart was produced from the table in Appendix A (below)

Appendix A: Age Specific all cause SMRs for all patients admitted to mental health speciality 1986 – 2009 followed up to 31st December 2010.

Age	Observed	Expected	RR	LCI	UCI
15-19	427	6.9	62.2	56.4	68.4
20-24	918	47.3	19.4	18.2	20.7
25-29	1112	101.0	11.0	10.4	11.7
30-34	1232	157.7	7.8	7.4	8.3
35-39	1357	251.4	5.4	5.1	5.7
40-44	1529	379.2	4.0	3.8	4.2
45-49	1690	515.3	3.3	3.1	3.4
50-54	1849	594.6	3.1	3.0	3.3
55-59	2162	822.4	2.6	2.5	2.7
60-64	2718	1055.7	2.6	2.5	2.7
65-69	3670	1340.3	2.7	2.7	2.8
70-74	4243	1882.2	2.3	2.2	2.3
75-79	4487	2509.9	1.8	1.7	1.8
80-84	3836	3182.7	1.2	1.2	1.2
85+	3013	6165.9	0.5	0.5	0.

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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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Contributors OA and MT conceived the study. OA and DS ascertained the data. All authors analysed the data and drafted the manuscript. RW is the study guarantor.

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Neither NHS e~~Ethical approval not required as this study is covered by existing case linkage protocols. Data sharing agreed in principle.~~thical approval nor Privacy Advisory Committee approval was required for this study as no patient identifiable data were released outwith NHS National Services Scotland and no new data linkages were undertaken.

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Article Focus

- Examines whether those previously hospitalised for mental disorder die earlier than people with no overt serious mental disorder.
- Do individuals with 'complicated' diagnoses (ie additional mental or physical ill health diagnoses in conjunction with their main psychiatric diagnosis) have higher excess mortality than those with 'uncomplicated' diagnoses? ~~multiple psychiatric diagnoses or comorbid disorder exacerbate any premature mortality?~~
- Is the apparent inequality in mortality rates between those with serious mental disorder and the general population worsening over time?

Key messages

- The average reduction in lifespan in those previously hospitalised for mental disorder compared to the general population is 17 years. People with eating disorders and personality disorder died earliest of all.
- ~~Comorbidity or multiple psychiatric diagnoses exacerbated this effect~~In general, patients with 'complicated' diagnoses experience higher excess mortality than those without.
- Cardiovascular and respiratory diseases were the most common causes of death and accounted for a high proportion of the total burden of years of life lost, but suicides led to more years of lost life at the individual level due to predominantly affecting younger adults. No worsening of the 'mortality gap' over three decades was observed.

Strengths and limitations

- A large representative population studied over a long time period, which is important when examining causes of death.
- Innovative use of a diagnostic hierarchy to ~~account for the commonly occurring comorbidity or diagnostic shift seen in psychiatry~~determine individuals' main psychiatric diagnosis.
- People with mental disorder who never required in-patient hospital care could not be included in this study.

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Objectives:

To ~~quantify any premature~~ compare the mortality in those previously hospitalised for mental disorder in Scotland to that experienced by the general population~~; attempt to separately account for the effects of multiple psychiatric diagnoses or comorbidity; and examine any trends in death rates over time.~~ .

Design:

~~Systematic cohort case linkage of hospital discharge and cause of death records~~Population based historical cohort study using routinely available psychiatric hospital discharge and death records.

Setting & participants:

~~Secondary care sample of all cases previously hospitalised~~Individuals with a first hospital admission for mental disorder in Scotland, 1986-2009~~10~~.

Outcomes:

The main outcome measure was death from any cause, 1986-2010. Excess mortality in individuals with previous psychiatric admission was presented as standardised mortality ratios (SMR) and years of life lost (YLL). Excess mortality was assessed overall and by age, sex, main psychiatric diagnosis, whether the psychiatric diagnosis was 'complicated' (ie additional mental or physical ill health diagnoses present), cause of death, and time period of first admission.

~~Cases with comorbidity or multiple diagnoses were hierarchically categorised, and contrasted to cases where there was no record of cormorbidity. Causes of death were dichotomised into natural and non-natural causes, and time trends were analysed. Standardised mortality ratios and years of lost life were the primary outcomes.~~

Results

111504 people were included in the study, and 34243 had died by 31/12/2010. The average reduction in life expectancy for the whole cohort was 17 years, with eating disorders (39 year reduction) and '~~comorbid~~ complicated' personality disorders (27.5 year reduction) being worst affected. 'Natural' causes of death such as cardiovascular disease showed modestly elevated relative risk (SMR1.7) but accounted for a high proportion of all deaths (67%) and of the total burden of years of life lost (54%). Non-natural deaths such as suicide showed higher relative risk (SMR5.2) and tended to occur at a younger age but were less common overall (11% of all deaths and 22% of all YLL). ~~were 11% of the total (SMR=5.2), with these deaths occurring early, whereas physical causes of death were more common (SMR=1.7), particularly cardiovascular~~

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disease. Comorbidity Having a 'complicated' diagnosis tended to elevated the risk of early death. No , but no worsening over time of these inequalities of the overall excess mortality experienced by individuals with previous psychiatric admission over time was observed.

Conclusions

Early death for those hospitalised with mental disorder is common, and represents a significant inequality even in well developed healthcare systems. Prevention of suicide and cardiovascular disease deserve particular attention in the mentally disordered.

Declaration of interest

All authors are employed by NHS Scotland. MT has received fees and / or hospitality from the manufacturers of various antipsychotic medications. TA, DS, and RW have no other conflicts to declare.

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Many of the most disabling medical conditions worldwide are mental illnesses, according to the WHO[1]. As well as adversely affecting day to day function, it has been known for many years that people with mental illness are at increased risk of premature death[2-5] with schizophrenia and bipolar disorder in particular being associated with an early death[6-8]. These inequalities in life expectancy have recently[9] been declared a "scandal", as even the Scandinavian countries[5], Scotland[10] and England[8] , despite relatively high quality and equitably distributed healthcare, have not been able to demonstrate any improvement in this premature mortality for the mentally ill over many years.

Non-natural deaths[11] including suicide and accidents, account for a disproportionate amount of this premature mortality in the mentally ill, particularly affecting young adults. High rates of cardiovascular disease, respiratory disease and other so-called natural causes also contribute[5,12,13] to the elevated relative risk of early death in the mentally ill. Precise estimates of the varying causal contributions to premature mortality in the mentally disordered have been limited by the lack of large representative populations being followed up over a lengthy period, and related studies have usually focussed on schizophrenia and bipolar disorder[8,14] rather than the gamut of mental disorder. Additionally, the effects of comorbidity or multiple diagnoses on this premature mortality have also not been quantified. Concern has also been expressed that those with mental illness have not benefitted from improvements in public health over the last few decades[8,9,13] and that this mortality gap between the general population and the mentally ill is widening in recent years.

Using routinely collected national data, available from 1981, we set out to examine the ages and causes of death in those previously hospitalised with mental disorder in Scotland, and quantify any excess mortality. We also aimed to explore the relative contribution of different causes of death and trends over time.

Methods

Whenever a patient is discharged from a mental ill health hospital/specialty in Scotland, a Scottish Morbidity Record for Mental ill health (SMR04) is returned to the NHS National Services Scotland Information Services Division (ISD)~~, NHS National Services Scotland~~. SMR04 records contain information on patient demographics such as personal identifiers, age, and sex; the diagnosis that necessitated the admission; and aspects of the care given such as the psychiatric subspecialty admitted to. One

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primary diagnosis and up to five further secondary diagnoses can be recorded. Diagnoses are coded according to the International Classification of Diseases (ICD) (version 9 to 1997 and version 10 from 1997 to present). Statutory death records (containing demographic and ICD coded cause of death information) are returned to the National Records of Scotland (NRS) with copies passed to ISD for analytical purposes.

For this study, SMR04 records for adults discharged from mental ill health hospitals/specialities in Scotland between 1981 and 2009 were obtained. Patients aged less than 15 years at the date of first admission and those admitted to the learning disabilities subspecialty were excluded from the sample, in accordance with the aim of studying the ages and causes of death in adults with mental illness and personality disorder. Death records for the period 1986-2010 were also obtained. We created a single patient record for each individual by linking all their hospital ~~admissions~~ discharge records and their death record (if died) using a range of patient identifiers and previously developed probabilistic matching algorithms. All patients who had had an admission to a mental ill health specialty between 1981 and 1985 were excluded to give a cohort of patients with (as close as possible to) a **first** inpatient admission between 1986 and 2009 in order to clarify the issue of diagnostic shift or comorbidity.

All patient level data used in this study were held and analysed within ISD. Only aggregate results, from which individual patients could not be identified, were shared with members of the study team not based within ISD (MT). ISD operates strict procedures to maintain patient privacy and confidentiality and no specific additional permissions were required for this study. In particular, permission for linkage of previously unlinked health datasets held by ISD is required from the Privacy Advisory Committee. PAC approval was not required for this study however as SMR04 and death records have been routinely linked within ISD for decades for purposes such as monitoring patient outcomes.

Diagnostic assignation

We then assigned each individual to a ~~diagnostic~~ main psychiatric diagnosis category (see table 1) and excluded individuals who did not have any admissions relating to a diagnostic group of interest. The diagnostic groups of interest included were schizophrenia, bipolar disorder, depression, neurosis, eating disorder, and personality disorder.

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Table 1 here

Patients with a single primary psychiatric diagnosis of interest recorded on all their psychiatric discharge records over the period of study, and no other or additional diagnoses at any admission, were described as 'uncomplicated'. For example, an individual with five hospital admissions which were all coded solely to depression would be described as 'uncomplicated depression'.

In contrast, patients with more than one diagnosis recorded were described as 'complicated'. For patients with more than one diagnosis from the diagnostic groups of interest, a hierarchical approach was used to determine the main diagnosis and hence assign a patient to one group (see table 1) with schizophrenia being assigned the highest rank. For example, a patient diagnosed as having bipolar disorder at their first hospital admission and then admitted for ~~depression~~ neurosis at a later date would be assigned to the 'complicated bipolar' group. Conversely, someone who had three hospital admissions for neurosis and then one for neurosis with depression recorded as an additional secondary diagnosis would be described as 'complicated depression' and their time at risk in the cohort would be taken from their first neurosis admission.

Patients may also have had other/additional diagnoses not within the diagnostic groups of interest. These included other psychiatric problems (mainly dementia, stress reactions and adjustment disorders); alcohol or drug misuse; or (rarely) physical health problems such as pneumonia. Someone with an admission for personality disorder with drug misuse recorded as an additional secondary diagnosis would therefore be described as 'complicated personality disorder'.

Analysis

A final record was then created for each patient within the mental ill health cohort containing hierarchically defined main psychiatric diagnosis, ~~complication~~ a flag indicating whether the main diagnosis was 'complicated' or not, date of first admission, age at first admission, sex, deprivation category at first admission, date of death and (main) cause of death. Deprivation category was determined using Carstairs 1991 area-based deprivation quintiles[15] based on postcode of residence at first admission and corresponding population denominators from the Consistent Areas Through Time (CATTS) classification tables[16] which allows us to create a long time series of deprivation-specific mortality rates.

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This linked dataset was used to calculate indirectly standardised mortality ratios (SMRs) for the mental ill health patients using a person-years approach which took account of each individual's time at risk (from time of first admission) across different age categories and time periods since diagnosis. Years of Life Lost (YLL) were computed by multiplying the number of deaths in the study cohort (in each period of death, sex, age band at death and deprivation quintile) by the corresponding life expectancy at that age. The average YLL (AYLL) was derived by dividing the total YLL by the actual number of deaths within the subgroups of interest. Scottish national mortality rates split by year of death (in time bands), sex, five-year age band and deprivation quintile were used as the reference standard for the SMRs. Life tables were compiled based on these national mortality rates following the Chiang[17] methodology for the YLL analyses. To examine possible trends over time in ~~mortality rates~~the excess mortality experienced by individuals with previous psychiatric admission, we chose three time period cohorts each with 10 years of follow up for each cohort to capture a wide range of causes of death.

We looked at overall mortality; mortality by specific cause; and mortality split into natural deaths (cardiovascular, cancer, respiratory, digestive, endocrine, nervous system, infectious disease), non-natural deaths (accidental, suicide/undetermined, homicide), and other (all other deaths including those recorded as mental and behavioural).

Results

Over the time period of study (1986-2009) there were 59,028 individuals who had a consistent diagnosis within and between admissions (classified as uncomplicated) and 52,476 individuals who had an unstable diagnosis or additional co-morbidity within and/or between admissions (classified as complicated). Women comprised 55% of the cohort largely due to a higher number of cases of depression in women. Women tended to be older than men at their first included admission, particularly for schizophrenia and neurosis. Complicated diagnoses resulted in ~~significantly~~ higher numbers of hospitalisations and total length of time spent in hospital as would be expected (see Table 2a and 2b).

Increasing deprivation was linked to mental ill health problems for both men and women, with the exception of bi-polar disorder (no clear trend across deprivation groups for either sex) and eating disorder in females (uncomplicated more common in

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least deprived group; complicated no clear trend across deprivation groups) (Table 2 and additional analyses available on request).

Overall, 34,243 individuals in the study cohort had died by the 31 December 2010, around 80% more (SMR=1.8) than expected based on the general population (see table 3). The standardised mortality ratios ~~were generally~~tended to be higher for those with complicated diagnoses, and overall were highest for those with eating disorders (SMR=4.4) and complicated personality disorders ~~complicated by comorbidity~~ (SMR=3.1). Overall life expectancy for the whole cohort of individuals with mental ill health was 17 years less than that for the general population. The largest reduction in life expectancy was seen for individuals with eating disorders (39 years of life lost for those with uncomplicated diagnosis) and personality disorders (27.5 ~~years~~ YLL for those with complicated diagnosis) however as most deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

Relative risk of early death

The excess risk of death was extremely high for those in the youngest age group at first included admission, and the excess reduced as age increased (see figure 1). However, total years of life lost told a slightly different story, with a relatively constant YLL for those diagnosed at ages 20-24 through to 75-79 years, with lower YLL for those aged 15-19, 80-84 and 85+ years. This reflects the fact that the absolute risk of dying generally increases with age. The same age-related pattern is seen for males and females, although the excess risk of death is higher for females compared to males at every age (data not shown).

Figure 1 here

Around two thirds of deaths (22,865 deaths) in the mental ill health cohort were from natural causes, 11% (3,909) from non-natural causes and the remaining 21% (7,469) were from "other" deaths not coded as natural or non-natural including 'mental or behavioural disorder' (36% total "other"). The excess risk of death was much higher from non-natural causes (SMR=5.2) compared to natural causes (SMR=1.7) and "other" deaths (SMR=1.6). On average, 31.8 years of life were lost due to every non-natural death compared to 13.3 years due to every natural death and 17.4 years of life lost for each "other" death, reflecting the fact that non-natural deaths tend to occur at younger ages (see Table 4).

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There was a significant excess risk of natural, non-natural and "other" deaths for patients in each diagnosis group (except uncomplicated neurotic disorders resulting in "other" deaths (SMR=1.1, ns)). The highest excess risks were seen for eating disorders across death groupings, although the number of deaths ~~from~~ in individuals with eating disorders was small (see Table 4). Natural deaths accounted for more years of life lost than non-natural deaths in each diagnostic group. Cardiovascular disease accounted for around half of all years of life lost from natural causes, with digestive disorders, cancer, and respiratory disorders accounting for most of the remainder. Suicide accounted for the majority of years of life lost due to non-natural causes in each diagnostic group (data not shown). T~~but T~~able 5 reveals the proportions of observed and expected deaths for the two main natural causes of death, namely heart disease and cancer, as well as suicide.

Tables 2a; 2b; 3; 4; and 5 here

Mortality trends over time

Looking at individuals whose first admissions were in the periods 1986-90, 1991-95 and 1996-2000 and following each individual in these sub-cohorts up for 10 years from their first admission, the all cause standardised mortality ratios showed no evidence of a narrowing of the mortality excess over time (see Table 6).

Table 6 here

Discussion

Main findings

This large national study provides an accurate estimate of the risk of early death experienced by adults previously hospitalised for mental disorder. We showed that overall life expectancy for the whole cohort of individuals previously hospitalised due to mental ill health was 17 years less than that for the general population, and that the excess risk of early death is greatest by far in the youngest (15-19 years old) age group but that older individuals experience greater numbers of early deaths. The largest reduction in life expectancy was seen for individuals with eating disorders and personality disorders – namely an alarming 39 years reduction in life expectancy for uncomplicated eating disorders, and 27.5 for those with a complicated personality disorder.

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However as the greatest number of deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost. The majority of these deaths in those previously hospitalised for mental disorder are due to 'natural' causes such as cardiovascular and respiratory disorder, which mirrors the results of a similar study from Denmark[7] examining the life expectancy of those with schizophrenia and bipolar disorder. By contrast, although only 11% of deaths in our study population were attributable to 'non-natural' causes such as suicide, accidents, and homicide, we found that these 'non-natural' causes carried a substantially higher comparative excess risk of early death – ranging between 27 years of lost life for depression to a staggering 49.5 years for eating disorders, emphasising that these non-natural deaths occur earlier than the more common natural causes of death. For the whole cohort of mentally ill individuals, those dying from non-natural causes lost, on average, almost 32 years of life, reinforcing the continuing need for national suicide prevention strategies.

A stable 'mortality gap'?

In addition, contrary to results elsewhere[8,13], we did not find any evidence that the difference in risk of death between the general population and the mentally disordered was worsening over time. In fact, we observed that this 'mortality gap' was stable over 25 years for all the common mental disorders, which offers some reassurance to claims that the mentally disordered have not benefited from improvements in public health[15,16]. Nevertheless, our data indicates that there continues to be a need for monitoring the physical health of those with mental disorder, and in particular screening for cardiovascular disease.

Strengths and limitations of the study

Strengths of this study include the whole population coverage and the long time series, along with the demonstrable high quality and completeness[20] of the diagnostic coding and cause of death coding. We have also taken care with ~~final~~ main psychiatric diagnosis assignation, using a pragmatic hierarchical approach to account for the diagnostic shift and co-morbidities that are commonly seen in day-to-day clinical psychiatric practice. Definitive diagnosis is not always easy initially in mental health. ~~The complicated diagnoses are~~Main psychiatric diagnosis has therefore been assigned ~~according to a hiera~~ using a hierarchical approach and taking into account all diagnoses recorded on an individual's psychiatric discharge records over the period of study ~~rchy~~ rather than simply diagnosis at first admission. This approach considerably increases the number of people in the higher categories (eg psychoses). For example,

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of 17,031 individuals who were first admitted with depression, 71% were assigned to depression, 17% subsequently had schizophrenia recorded on a discharge record and so ~~are~~ were assigned to "complicated schizophrenia", and 11% were assigned to "complicated bipolar". For some groups the hierarchy is less intuitive, for example, of the 325 individuals who were first admitted with eating disorders but subsequently had other mental ill health problems, 69% moved out of the eating disorder group into another group higher up the hierarchy (data not shown). This will lead to a conservative SMR for some complicated cases due to time at risk for conditions lower down the hierarchy being assigned to a condition higher up the hierarchy in the person-year analysis.

Comorbidity and early death

Furthermore, we have documented that diagnostic ~~comorbidity~~'complexity' (indicated by further recording of other mental disorders in addition to the main psychiatric diagnosis, ~~, whether it is comorbid~~ substance misuse, ~~mental disorder~~ or physical health problems), ~~significantly elevates~~tends to increase the risk of premature death and the average years of lost life in those previously hospitalised due to mental illness. This adverse effect of ~~comorbidity~~ complexity has not reported before to our knowledge, and emphasises that comorbidity exacerbates prognosis. Also, our use of the SMR and the 'years of lost life' techniques allows quantification of both the relative and the absolute burden of excess death in this population. However, as this is a secondary care cohort, it will only capture those most severely affected by mental disorder, and hence does not allow comment on, for example, those with depression managed solely in the community. Equally, those hospitalised due to eating disorder are often physically unwell, so it is perhaps no surprise that this diagnostic group had worrying relative and absolute mortality results in this study. Lastly, we designed a 'wash in' period of 5 years (1981-1986) in order to capture only first admissions, but it is likely that some patients with psychiatric admissions prior to 1981 were included. The apparently old age at 'diagnosis'/first admission may suggest that these are in fact not all first admissions ie the relatively short wash in period has allowed us to include patients readmitted after more than 5 years as 'first admissions'.

A systematic review by Saha et al[13] found a SMR of 2.5 for risk of death in schizophrenia, which is greater than our figures of 1.8 (uncomplicated) and 2.0 (complicated ~~or comorbid~~), but the more recent study by Hoang and colleagues from England[8] found similar SMRs for both schizophrenia and bipolar disorder to our own results, albeit with a shorter follow up. Large long term follow up mortality studies comparing common mental disorders have not been reported elsewhere, to our

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knowledge, and our data provide context for the literature on early death in specific disorders such as schizophrenia and bipolar disorder[8], and depression and anxiety[21]. More detailed analysis of the time trends for individual causes of death in specific diagnostic groups would be valuable in the future.

Implications

In previous studies of all-cause mortality in those with mental illness in Scotland, behavioural risk factors such as heavy smoking and a sedentary lifestyle have been linked to early death, along with social isolation and deprivation[22]. Policy makers in the UK have also highlighted the physical health needs and premature mortality of those with mental health problems which echo the worrying disparities in lifespan we have identified for all the common mental disorders compared to the general population. In particular, we have found that the highest risk of early death is associated with a young age; eating disorders; personality disorders; and in those with multiple diagnoses. A national approach across primary and secondary care tackling the complex mix of factors contributing to early death in the mentally disordered is required, addressing intrinsic disease related factors as well as lifestyle issues; lack of help seeking; and even stigma within the healthcare professions[15,16]. The inequity in life expectancy in the mentally disordered documented here poses a considerable challenge to our healthcare system.

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Table 1: ~~Diagnostic~~ Main psychiatric diagnosis categories of interest (and diagnostic hierarchy)

~~Diagnostic group~~Main psychiatric diagnosis category	Definition	Hierarchy
Schizophrenia	Schizophrenia and other psychotic disorders including acute psychosis, persistent delusional disorders, schizotypal and schizoaffective disorder, and drug or alcohol induced psychotic disorder	1
Bipolar disorder	Manic episodes and bipolar disorder	2
Depression	Depressive episodes and recurrent depressive disorder (excluding persistent mood disorders such as cyclothymia)	3
Neurosis	Anxiety disorders and obsessive compulsive disorder	4
Eating disorder	Anorexia and bulimia nervosa	5
Personality disorder	All types of personality disorder	6

Note: ICD9 and ICD10 codes available on request.

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Table 2a: Characteristics of the cohort included in the analysis (Males)

	N	%	Median age at first admission (25th – 75th percentiles)	% in most deprived quintile[1]	Median number (25th – 75th percentiles)	Median total length (days) (25th – 75th percentiles)
Uncomplicated diagnosis group:						
Schizophrenia	8,966	35	33.7 (24.6 -50.2)	29	1.0 (1.0 -2.0)	48.0 (16.0 -161.0)
Bipolar disorder	1,680	7	41.0 (28.4 -56.2)	17	1.0 (1.0 -2.0)	36.0 (17.0 -72.0)
Depression	12,778	49	47.5 (34.2 -66.0)	23	1.0 (1.0 -1.0)	22.0 (7.0 -53.0)
Neurosis	1,129	4	40.7 (29.8 -58.5)	26	1.0 (1.0 -1.0)	14.0 (5.0 -35.0)
Eating disorder	49	<1	22.1 (19.0 -28.8)	33	1.0 (1.0 -1.0)	48.0 (12.0 -89.0)
Personality disorder	1,221	5	30.9 (23.8 -41.7)	30	1.0 (1.0 -1.0)	8.0 (3.0 -24.0)
Total uncomplicated	25,823	100	40.9 (28.4 -59.6)	25	1.0 (1.0 -2.0)	28.0 (9.0 -74.0)
Complicated (hierarchical) diagnosis group:						
Schizophrenia	10,697	43	31.0 (23.3 -44.0)	33	4.0 (2.0 -6.0)	145.0 (52.0 -429.0)
Bipolar disorder	2,159	9	42.4 (30.5 -56.6)	21	3.0 (2.0 -5.0)	115.0 (51.0 -257.0)
Depression	9,421	38	40.1 (30.0 -54.9)	26	2.0 (1.0 -4.0)	44.0 (18.0 -105.0)
Neurosis	915	4	37.0 (27.4 -48.1)	24	2.0 (1.0 -3.0)	32.0 (14.0 -71.0)
Eating disorder	17	<1	31.3 (23.5 -48.5)	29	3.0 (2.0 -4.0)	45.0 (21.0 -148.0)
Personality disorder	1,580	6	31.3 (23.8 -41.6)	31	2.0 (1.0 -3.0)	21.0 (8.0 -49.0)
Total complicated	24,789	100	35.5 (26.0-49.9)	28	3.0(2.0-5.0)	73.0(26.0 -214.0)

Table 2b: Characteristics of the cohort included in the analysis (Females)

	N	%	Median age at first admission (25th – 75th percentiles)	% in most deprived quintile[1]	Median number (25th -75th percentiles)	Median total length (days) (25th – 75th percentiles)
Uncomplicated diagnosis group:						
Schizophrenia	6,999	21	53.9 (34.5 -76.0)	25	1.0 (1.0 -2.0)	47.0 (19.0 -122.0)
Bipolar disorder	2,196	7	43.4 (30.5 -61.0)	18	1.0 (1.0 -2.0)	35.0 (17.0 -74.0)
Depression	20,383	61	48.5 (33.8 -69.1)	23	1.0 (1.0 -1.0)	28.0 (10.0 -65.0)
Neurosis	1,946	6	48.5 (33.7 -68.7)	26	1.0 (1.0 -1.0)	18.0 (7.0 -39.0)
Eating disorder	586	2	20.7 (17.5 -26.5)	16	1.0 (1.0 -1.0)	49.0 (13.0 -126.0)
Personality disorder	1,095	3	31.1 (23.0 -43.5)	27	1.0 (1.0 -1.0)	9.0 (3.0 -25.0)
Total uncomplicated	33,205	100	47.6 (32.5-69.5)	23	1.0 (1.0 -1.0)	30.0 (11.0 -73.0)
Complicated (hierarchical) diagnosis group[2]:						
Schizophrenia	8,230	30	40.6 (27.7 -66.0)	29	3.0 (2.0 -6.0)	162.0 (68.0 -410.0)
Bipolar disorder	3,619	13	43.0 (31.2 -59.8)	22	3.0 (2.0 -5.0)	136.0 (60.0 -313.0)
Depression	13,390	48	41.1 (29.8 -61.8)	25	2.0 (2.0 -4.0)	64.0 (25.0 -163.0)
Neurosis	1,136	4	42.9 (31.2 -63.6)	21	2.0 (1.0 -3.0)	38.0 (17.0 -91.5)
Eating disorder	199	1	26.2 (20.7 -34.3)	18	2.0 (1.0 -3.0)	35.0 (10.0 -103.0)
Personality disorder	1,113	4	29.5 (22.5 -40.3)	28	2.0 (1.0 -3.0)	27.0 (10.0 -60.0)
Total complicated	27,687	100	40.6 (28.8 -61.9)	26	3.0 (2.0 -5.0)	89.0 (33.0 -237.0)

1 if there had been no deprivation gradient then around 20% of cases would be in the most deprived quintile

2 . For individuals with a complicated mental health diagnosis (hierarchical) , the age at first admission refers to the first 'ever' admission event.

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Table 3: SMRs and years of life lost for all-cause mortality by diagnosis group (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Observed deaths	Expected deaths	SMR[1]	Lower CI	Upper CI	Total YLL	Average YLL
Uncomplicated diagnosis group:							
Schizophrenia	5,060	2,746	1.8	1.8	1.9	78,027	15.2
Bi-polar	883	525.6	1.7	1.6	1.8	14,369	16.1
Depression	11,036	6,831.2	1.6	1.6	1.6	155,582	14.1
Neurotic disorders	838	524.7	1.6	1.5	1.7	12,373	14.9
Eating disorders	51	11.6	4.4	3.3	5.8	2,182	39.0
Personality disorders	449	234.9	1.9	1.7	2.1	10,583	22.8
Complicated (hierarchical) diagnosis group:							
Schizophrenia	5,635	2,876.9	2.0	1.9	2.0	116,775	19.6
Bi-polar	1,706	1,129.5	1.5	1.4	1.6	29,351	16.7
Depression	7,282	3,628.8	2.0	2.0	2.1	146,736	19.0
Neurotic disorders	579	272.8	2.1	2.0	2.3	12,194	19.9
Eating disorders	38	8.7	4.4	3.1	6.0	1,317	31.4
Personality disorders	686	221.9	3.1	2.9	3.3	20,894	27.5
Total	**34,243**	**19,012.4**	**1.8**	**1.8**	**1.8**	600,383	**17.0**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 4: SMRs and years of life lost by diagnosis group and cause of death grouping (natural death, non-natural death, or "other" deaths) (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

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	Natural deaths			Non-natural deaths			Other deaths		
	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL
Uncomplicated diagnosis group:									
Schizophrenia	3,580	1.8 (1.7 - 1.8)	11.8	504	4.4 (4.0 - 4.8)	32.2	976	1.6 (1.5 - 1.7)	16.3
Bi-polar	624	1.7 (1.6 - 1.8)	13.0	97	4.7 (3.8 - 5.8)	32.0	162	1.2 (1.0 - 1.4)	16.4
Depression	7,839	1.6 (1.6 - 1.6)	12.0	1,055	4.9 (4.6 - 5.2)	27.2	2,142	1.2 (1.2 - 1.3)	13.8
Neurotic disorders	622	1.7 (1.6 - 1.9)	13.2	63	3.3 (2.6 - 4.3)	29.4	153	1.1 (0.9 - 1.3)	15.1
Eating disorders	15	2.6 (1.4 - 4.3)	23.8	12	7.2 (3.7 - 12.6)	49.5	24	5.8 (3.7 - 8.7)	39.3
Personality disorders	265	1.7 (1.5 - 1.9)	15.0	96	6.2 (5.0 - 7.6)	37.6	88	1.4 (1.2 - 1.8)	25.6
Complicated (hierarchical) diagnosis group:									
Schizophrenia	3,500	1.7 (1.7 - 1.8)	14.3	767	5.2 (4.8 - 5.5)	35.1	1,368	2.0 (1.9 - 2.1)	20.0
Bi-polar	1,139	1.4 (1.3 - 1.5)	13.7	197	5.1 (4.4 - 5.8)	30.8	370	1.3 (1.1 - 1.4)	15.7
Depression	4,525	1.8 (1.7 - 1.8)	14.8	931	6.5 (6.1 - 7.0)	32.3	1,826	1.9 (1.9 - 2.0)	18.6
Neurotic disorders	379	2.0 (1.8 - 2.3)	16.4	53	4.3 (3.2 - 5.6)	33.6	147	2.0 (1.7 - 2.3)	20.0
Eating disorders	17	3.0 (1.7 - 4.8)	24.4	5	9.0 (2.8 - 21.1)	43.2	16	6.6 (3.7 - 10.7)	32.9
Personality disorders	360	2.5 (2.2 - 2.7)	19.9	129	7.5 (6.2 - 8.9)	39.0	197	3.4 (2.9 - 3.9)	28.8
Total	**22,865**	**1.7 (1.7 - 1.7)**	**13.3**	**3,909**	**5.2 (5.1 - 5.4)**	**31.8**	**7,469**	**1.6 (1.5 - 1.6)**	**17.4**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 5. Observed and expected number of deaths for cardiovascular disease; cancer; and suicide.

	Observed CVS[1] deaths	Expected CVS deaths	Observed Cancer[2] deaths	Expected Cancer deaths	Observed suicide[3] deaths	Expected suicide deaths
Uncomplicated diagnosis group:						
Schizophrenia	2010	1109	650	500	502	110
Bi-polar	335	199	135	105	97	19
Depression	4281	2691	1671	1358	1047	211
Neurotic disorders	313	195	136	102	60	17
Eating disorders	6	3	3	1	12	1
Personality disorders	136	84	55	41	88	14
Complicated diagnosis group						
Schizophrenia	1740	1108	476	543	771	150
Bi-polar	596	425	201	238	198	38
Depression	2219	1368	730	718	932	138
Neurotic disorders	316	99	68	51	53	12
Eating disorders	5	3	3	1	5	0
Personality disorders	129	75	49	44	123	15

[1] All cardiovascular (heart disease) deaths. [2] All cancer, including lung cancer, deaths.
[3] All deaths coded as suicides and accidents by poisoning.

Table 6: SMRs by time period of first admission (1986-2000) and followed up for 10 years from first admission (all diagnosis groups combined)

	Period of first diagnosis	Observed deaths	Expected deaths	SMR[1]	Lower CI	Upper CI
Males	1986-90	3185	1514.1	2.1	2.0	2.2
	1991-95	2878	1328.0	2.2	2.1	2.2
	1996-00	2327	1075.9	2.2	2.1	2.3
Females	1986-90	4808	2669.0	1.8	1.8	1.9
	1991-95	3882	2112.3	1.8	1.8	1.9
	1996-00	2740	1412.6	1.9	1.9	2.0

[1] adjusted for age and deprivation category (Carstairs 1991 decile) at first diagnosis

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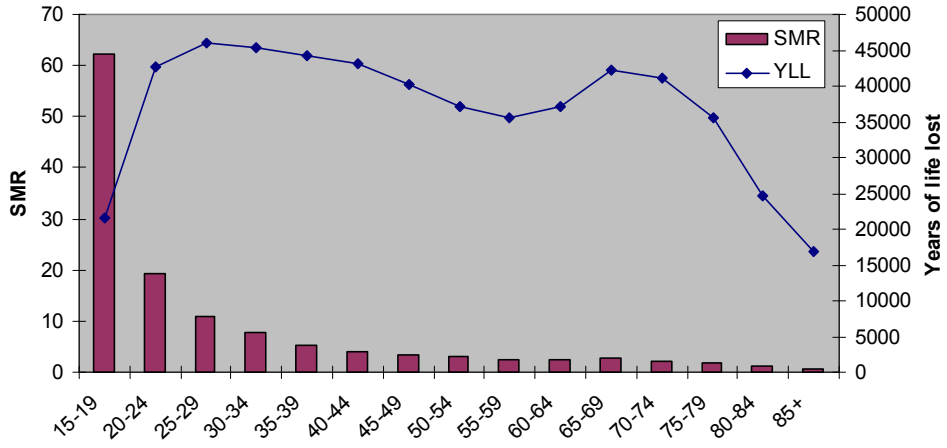
Figure 1: Age-specific all-cause SMRs and overall YLL for all patients diagnosed 1986-2009 and followed up until 31 December 2010



* The SMR for the above chart was produced from the table in Appendix A (below)

Appendix A: Age Specific all cause SMRs for all patients admitted to mental health speciality 1986 – 2009 followed up to 31st December 2010.

Age	Observed	Expected	RR	LCI	UCI
15-19	427	6.9	62.2	56.4	68.4
20-24	918	47.3	19.4	18.2	20.7
25-29	1112	101.0	11.0	10.4	11.7
30-34	1232	157.7	7.8	7.4	8.3
35-39	1357	251.4	5.4	5.1	5.7
40-44	1529	379.2	4.0	3.8	4.2
45-49	1690	515.3	3.3	3.1	3.4
50-54	1849	594.6	3.1	3.0	3.3
55-59	2162	822.4	2.6	2.5	2.7
60-64	2718	1055.7	2.6	2.5	2.7
65-69	3670	1340.3	2.7	2.7	2.8
70-74	4243	1882.2	2.3	2.2	2.3
75-79	4487	2509.9	1.8	1.7	1.8
80-84	3836	3182.7	1.2	1.2	1.2
85+	3013	6165.9	0.5	0.5	0.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

Re: **Mental disorder and early death – a nationwide follow up study, 1981 - 2010.**

'Tomi Ajetunmobi[1], Mark Taylor[2], Diane Stockton[1], and Rachael Wood[1].

	Item No	Recommendation
Title and abstract	1 Done, p1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2 Done – p2	Explain the scientific background and rationale for the investigation being reported
Objectives	3 Done – p2	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4 Done	Present key elements of study design early in the paper
Setting	5 Done	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 Done	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7 Done	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8* Done	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 In method & discussion	Describe any efforts to address potential sources of bias
Study size	10 Done	Explain how the study size was arrived at
Quantitative variables	11 Done	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12 Done	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13* Done	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage

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		(c) Consider use of a flow diagram
Descriptive data	14* Done	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	15* Done	Report numbers of outcome events or summary measures
Main results	16 Done where applicable	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 SMRs and YLL	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18 Done	Summarise key results with reference to study objectives
Limitations	19 Done	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 Done	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21 Commented on	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22 Done	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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Complete List of Authors:	Ajetunmobi, 'Tomi; ISD Scotland, Taylor, Mark; NHS Lothian, Stockton, Diane; ISD Scotland, Wood, Rachael; ISD Scotland,
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Secondary Subject Heading:	Epidemiology, Public health
Keywords:	MENTAL HEALTH, Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH

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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

Omotomilola Ajetunmobi[1], Mark Taylor[2], Diane Stockton[1], and Rachael Wood[1].

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Contributors OA and MT conceived the study. OA and DS ascertained the data. All authors analysed the data and drafted the manuscript. RW is the study guarantor.

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Neither NHS ethical approval nor Privacy Advisory Committee approval was required for this study as no patient identifiable data were released outwith NHS National Services Scotland and no new data linkages were undertaken.

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Article Focus

- Examines whether those previously hospitalised for mental disorder die earlier than people with no overt serious mental disorder.
- Do individuals with 'complicated' diagnoses (ie additional mental or physical ill health diagnoses in conjunction with their main psychiatric diagnosis) have higher excess mortality than those with 'uncomplicated' diagnoses?
- Is the apparent inequality in mortality rates between those with serious mental disorder and the general population worsening over time?

Key messages

- The average reduction in lifespan in those previously hospitalised for mental disorder compared to the general population is 17 years. People with eating disorders and personality disorder died earliest of all.
- In general, patients with 'complicated' diagnoses experience higher excess mortality than those without.
- Cardiovascular and respiratory diseases were the most common causes of death and accounted for a high proportion of the total burden of years of life lost, but suicides led to more years of lost life at the individual level due to predominantly affecting younger adults. No worsening of the 'mortality gap' over three decades was observed.

Strengths and limitations

- A large representative population studied over a long time period, which is important when examining causes of death.
- Innovative use of a diagnostic hierarchy to determine individuals' main psychiatric diagnosis.
- People with mental disorder who never required in-patient hospital care could not be included in this study.

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Objectives:

To compare the mortality in those previously hospitalised for mental disorder in Scotland to that experienced by the general population.

Design:

Population based historical cohort study using routinely available psychiatric hospital discharge and death records.

Setting & participants:

Individuals with a first hospital admission for mental disorder in Scotland, 1986-2009.

Outcomes:

The main outcome measure was death from any cause, 1986-2010. Excess mortality in individuals with previous psychiatric admission was presented as standardised mortality ratios (SMR) and years of life lost (YLL). Excess mortality was assessed overall and by age, sex, main psychiatric diagnosis, whether the psychiatric diagnosis was 'complicated' (ie additional mental or physical ill health diagnoses present), cause of death, and time period of first admission.

Results

111504 people were included in the study, and 34243 had died by 31/12/2010. The average reduction in life expectancy for the whole cohort was 17 years, with eating disorders (39 year reduction) and 'complicated' personality disorders (27.5 year reduction) being worst affected. 'Natural' causes of death such as cardiovascular disease showed modestly elevated relative risk (SMR1.7) but accounted for a high proportion of all deaths (67%) and of the total burden of years of life lost (54%). Non-natural deaths such as suicide showed higher relative risk (SMR5.2) and tended to occur at a younger age but were less common overall (11% of all deaths and 22% of all YLL). Having a 'complicated' diagnosis tended to elevate the risk of early death. No worsening of the overall excess mortality experienced by individuals with previous psychiatric admission over time was observed.

Conclusions

Early death for those hospitalised with mental disorder is common, and represents a significant inequality even in well developed healthcare systems. Prevention of suicide and cardiovascular disease deserve particular attention in the mentally disordered.

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Declaration of interest

All authors are employed by NHS Scotland. MT has received fees and / or hospitality from the manufacturers of various antipsychotic medications. TA, DS, and RW have no other conflicts to declare.

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Many of the most disabling medical conditions worldwide are mental illnesses, according to the WHO[1]. As well as adversely affecting day to day function, it has been known for many years that people with mental illness are at increased risk of premature death[2-5] with schizophrenia and bipolar disorder in particular being associated with an early death[6-8]. These inequalities in life expectancy have recently[9] been declared a "scandal", as even the Scandinavian countries[5], Scotland[10] and England[8,11] , despite relatively high quality and equitably distributed healthcare, have not been able to demonstrate any improvement in this premature mortality for the mentally ill over many years.

Non-natural deaths[12] including suicide and accidents, account for a disproportionate amount of this premature mortality in the mentally ill, particularly affecting young adults. High rates of cardiovascular disease, respiratory disease and other so-called natural causes also contribute[5,13,14] to the elevated relative risk of early death in the mentally ill. Precise estimates of the varying causal contributions to premature mortality in the mentally disordered have been limited by the lack of large representative populations being followed up over a lengthy period, and related studies have usually focussed on schizophrenia and bipolar disorder[8,15] rather than all major mental disorders. Additionally, the effects of comorbidity or multiple diagnoses on this premature mortality have also not been quantified. Concern has also been expressed that those with mental illness have not benefitted from improvements in public health over the last few decades[9,14] and that this mortality gap between the general population and the mentally ill is widening in recent years.

Using routinely collected national data, available from 1981, we set out to examine the ages and causes of death in those previously hospitalised with mental disorder in Scotland, and quantify any excess mortality. We also aimed to explore the relative contribution of different causes of death and trends over time.

Methods

Whenever a patient is discharged from a mental ill health hospital/specialty in Scotland, a Scottish Morbidity Record for Mental ill health (SMR04) is returned to the NHS National Services Scotland Information Services Division (ISD). SMR04 records contain information on patient demographics such as personal identifiers, age, and sex; the diagnosis that necessitated the admission; and aspects of the care given such as the psychiatric subspecialty admitted to. One primary diagnosis and up to five

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further secondary diagnoses can be recorded. Diagnoses are coded according to the International Classification of Diseases (ICD) (version 9 to 1997 and version 10 from 1997 to present). Statutory death records (containing demographic and ICD coded cause of death information) are returned to the National Records of Scotland (NRS) with copies passed to ISD for analytical purposes.

For this study, SMR04 records for adults discharged from mental ill health hospitals/specialities in Scotland between 1981 and 2009 were obtained. Patients aged less than 15 years at the date of first admission and those admitted to the learning disabilities subspecialty were excluded from the sample, in accordance with the aim of studying the ages and causes of death in adults with mental illness and personality disorder. Death records for the period 1986-2010 were also obtained. We created a single patient record for each individual by linking all their hospital discharge records and their death record (if died) using a range of patient identifiers and previously developed probabilistic matching algorithms. These methods have been described previously[16, 17]. All patients who had had an admission to a mental ill health specialty between 1981 and 1985 were excluded to give a cohort of patients with (as close as possible to) a first inpatient admission between 1986 and 2009 in order to clarify the issue of diagnostic shift or comorbidity.

All patient level data used in this study were held and analysed within ISD. Only aggregate results, from which individual patients could not be identified, were shared with members of the study team not based within ISD (MT). ISD operates strict procedures to maintain patient privacy and confidentiality and no specific additional permissions were required for this study. In particular, permission for linkage of previously unlinked health datasets held by ISD is required from the Privacy Advisory Committee. PAC approval was not required for this study however as SMR04 and death records have been routinely linked within ISD for decades for purposes such as monitoring patient outcomes.

Diagnostic assignation

We then assigned each individual to a main psychiatric diagnosis category (see table 1) and excluded individuals who did not have any admissions relating to a diagnostic group of interest. The diagnostic groups of interest included were schizophrenia, bipolar disorder, depression, neurosis, eating disorder, and personality disorder.

Table 1 here

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Patients with a single primary psychiatric diagnosis of interest recorded on all their psychiatric discharge records over the period of study, and no other or additional diagnoses at any admission, were described as 'uncomplicated'. For example, an individual with five hospital admissions which were all coded solely to depression would be described as 'uncomplicated depression'.

In contrast, patients with more than one diagnosis recorded were described as 'complicated'. For patients with more than one diagnosis from the diagnostic groups of interest, a hierarchical approach was used to determine the main diagnosis and hence assign a patient to one group (see table 1) with schizophrenia being assigned the highest rank. For example, a patient diagnosed as having bipolar disorder at their first hospital admission and then admitted for neurosis at a later date would be assigned to the 'complicated bipolar' group. Conversely, someone who had three hospital admissions for neurosis and then one for neurosis with depression recorded as an additional secondary diagnosis would be described as 'complicated depression' and their time at risk in the cohort would be taken from their first neurosis admission.

Patients may also have had other/additional diagnoses not within the diagnostic groups of interest. These included other psychiatric problems (mainly dementia, stress reactions and adjustment disorders); alcohol or drug misuse; or (rarely) physical health problems such as pneumonia. Someone with an admission for personality disorder with drug misuse recorded as an additional secondary diagnosis would therefore be described as 'complicated personality disorder'.

Analysis

A final record was then created for each patient within the mental ill health cohort containing hierarchically defined main psychiatric diagnosis, a flag indicating whether the main diagnosis was 'complicated' or not, date of first admission, age at first admission, sex, deprivation category at first admission, date of death and (main) cause of death. Deprivation category was determined using Carstairs 1991 area-based deprivation deciles[18] based on postcode of residence at first admission and corresponding population denominators from the Consistent Areas Through Time (CATTS) classification tables[19] which allows us to create a long time series of deprivation-specific mortality rates.

This linked dataset was used to calculate indirectly standardised mortality ratios (SMRs) for the mental ill health patients using a person-years approach which took

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account of each individual's time at risk (from time of first admission) across different age categories, time periods, sex and deprivation decile since diagnosis. All analyses were carried out using Stata 11.0 (Stata Corp, College Station, Texas) using the stsplit command to split age (in days) across the time periods. Age was defined in days from birth date to diagnosis date, and study exit was defined in days from diagnosis date to end of follow-up interval or death, whichever came first.

Years of Life Lost (YLL) were computed by multiplying the number of deaths in the study cohort (in each period of death, sex, age band at death and deprivation decile) by the corresponding life expectancy at that age. The average YLL (AYLL) was derived by dividing the total YLL by the actual number of deaths within the subgroups of interest. Scottish national mortality rates split by year of death (in time bands), sex, five-year age band and deprivation decile were used as the reference standard for the SMRs. Life tables were compiled based on these national mortality rates following the Chiang[20] methodology for the YLL analyses. To examine possible trends over time in the excess mortality experienced by individuals with previous psychiatric admission, we chose three time period cohorts each with 10 years of follow up for each cohort to capture a wide range of causes of death.

We looked at overall mortality; mortality by specific cause; and mortality split into natural deaths (cardiovascular, cancer, respiratory, digestive, endocrine, nervous system, infectious disease), non-natural deaths (accidental, suicide/undetermined, homicide), and other (all other deaths including those recorded as mental and behavioural).

Results

Over the time period of study (1986-2009) there were 59,028 individuals who had a consistent diagnosis within and between admissions (classified as uncomplicated) and 52,476 individuals who had an unstable diagnosis or additional co-morbidity within and/or between admissions (classified as complicated). Women comprised 55% of the cohort largely due to a higher number of cases of depression in women. Women tended to be older than men at their first included admission, particularly for schizophrenia and neurosis. Complicated diagnoses resulted in higher numbers of hospitalisations and total length of time spent in hospital as would be expected (see Table 2a and 2b).

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Increasing deprivation was linked to mental ill health problems for both men and women, with the exception of bi-polar disorder (no clear trend across deprivation groups for either sex) and eating disorder in females (uncomplicated more common in least deprived group; complicated no clear trend across deprivation groups) (Table 2 and additional analyses available on request).

Overall, 34,243 individuals in the study cohort had died by the 31 December 2010, around 80% more (SMR=1.8) than expected based on the general population (see table 3). The standardised mortality ratios tended to be higher for those with complicated diagnoses, and overall were highest for those with eating disorders (SMR=4.4) and complicated personality disorders (SMR=3.1). Overall life expectancy for the whole cohort of individuals with mental ill health was 17 years less than that for the general population. The largest reduction in life expectancy was seen for individuals with eating disorders (39 years of life lost for those with uncomplicated diagnosis) and personality disorders (27.5 YLL for those with complicated diagnosis) however as most deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

Relative risk of early death

The excess risk of death was extremely high for those in the youngest age group at first included admission, and the excess reduced as age at first admission increased (see figure 1). However, total years of life lost told a slightly different story, with a relatively constant YLL for those diagnosed at ages 20-24 through to 75-79 years, with lower YLL for those aged 15-19, 80-84 and 85+ years. This reflects the fact that the absolute risk of dying generally increases with age. The same age-related pattern is seen for males and females, although the excess risk of death is higher for females compared to males at every age (data not shown).

Figure 1 here

Around two thirds of deaths (22,865 deaths) in the mental ill health cohort were from natural causes, 11% (3,909) from non-natural causes and the remaining 21% (7,469) were from "other" deaths not coded as natural or non-natural including 'mental or behavioural disorder' (36% of "other" causes of death). The excess risk of death was much higher from non-natural causes (SMR=5.2) compared to natural causes (SMR=1.7) and "other" deaths (SMR=1.6). On average, 31.8 years of life were lost due to every non-natural death compared to 13.3 years due to every natural death

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and 17.4 years of life lost for each "other" death, reflecting the fact that non-natural deaths tend to occur at younger ages (see Table 4).

There was a significant excess risk of natural, non-natural and "other" deaths for patients in each diagnosis group (except uncomplicated neurotic disorders resulting in "other" deaths (SMR=1.1, ns). The highest excess risks were seen for eating disorders across death groupings, although the number of deaths in individuals with eating disorders was small (see Table 4). Natural deaths accounted for more years of life lost than non-natural deaths in each diagnostic group. Cardiovascular disease accounted for around half of all years of life lost from natural causes, with digestive disorders, cancer, and respiratory disorders accounting for most of the remainder. Suicide accounted for the majority of years of life lost due to non-natural causes in each diagnostic group (data not shown). Table 5 reveals the proportions of observed ~~and expected~~ deaths for the two main natural causes of death, namely heart disease and cancer, as well as suicide, the main causes of unnatural death.

Tables 2a; 2b; 3; 4; and 5 here

Mortality trends over time

Looking at individuals whose first admissions were in the periods 1986-90, 1991-95 and 1996-2000 and following each individual in these sub-cohorts up for 10 years from their first admission, the all cause standardised mortality ratios showed no evidence of a narrowing of the mortality excess over time (see Table 6).

Table 6 here

Discussion

Main findings

This large national study provides an accurate estimate of the risk of early death experienced by adults previously hospitalised for mental disorder. We showed that overall life expectancy for the whole cohort of individuals previously hospitalised due to mental ill health was 17 years less than that for the general population. The excess risk of early death was greatest for patients first admitted at the youngest age (15-19 years old) but individuals first admitted at older ages experienced greater numbers of early deaths. The largest reduction in life expectancy was seen for individuals with

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eating disorders and personality disorders – namely an alarming 39 years reduction in life expectancy for uncomplicated eating disorders, and 27.5 for those with a complicated personality disorder. However as the greatest number of deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

The majority of deaths in those previously hospitalised for mental disorder are due to 'natural' causes such as cardiovascular and respiratory disorder, which mirrors the results of a similar study from Denmark[7] examining the life expectancy of those with schizophrenia and bipolar disorder. By contrast, although only 11% of deaths in our study population were attributable to 'non-natural' causes such as suicide, accidents, and homicide, we found that these 'non-natural' causes carried a substantially higher comparative excess risk of early death – ranging between 27 years of lost life for depression to a staggering 49.5 years for eating disorders, emphasising that these non-natural deaths occur earlier than the more common natural causes of death. For the whole cohort of mentally ill individuals, those dying from non-natural causes lost, on average, almost 32 years of life, reinforcing the continuing need for national suicide prevention strategies.

A stable 'mortality gap'?

In addition, contrary to results elsewhere[8,14], we did not find any evidence that the difference in risk of death between the general population and the mentally disordered was worsening over time. In fact, we observed that this 'mortality gap' was stable over 25 years for all the common mental disorders, which offers some reassurance to claims that the mentally disordered have not benefited from improvements in public health[9]. Nevertheless, our data indicates that there continues to be a need for monitoring the physical health of those with mental disorder, and in particular screening for cardiovascular disease.

Strengths and limitations of the study

Strengths of this study include the whole population coverage and the long time series, along with the demonstrable high quality and completeness[23] of the diagnostic coding and cause of death coding. The reliability of a given diagnosis does not necessarily imply that it is valid, however, in a specialty that lacks objective diagnostic tests. We have also taken care with main psychiatric diagnosis assignation, using a pragmatic hierarchical approach to account for the diagnostic shift and co-morbidities that are commonly seen in day-to-day clinical psychiatric practice. Definitive diagnosis is not always easy initially in mental health, and over such a long study period there

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may be shift in diagnostic trends. Main psychiatric diagnosis has therefore been assigned using a hierarchical approach and taking into account all diagnoses recorded on an individual's psychiatric discharge records over the period of study rather than simply diagnosis at first admission. This approach considerably increases the number of people in the higher categories (eg psychoses). For example, of 17,031 individuals who were first admitted with depression, 71% were assigned to depression, 17% subsequently had schizophrenia recorded on a discharge record and so were assigned to "complicated schizophrenia", and 11% were assigned to "complicated bipolar". For some groups the hierarchy is less intuitive, for example, of the 325 individuals who were first admitted with eating disorders but subsequently had other mental ill health problems, 69% moved out of the eating disorder group into another group higher up the hierarchy (data not shown). This will lead to a conservative SMR for some complicated cases due to time at risk for conditions lower down the hierarchy being assigned to a condition higher up the hierarchy in the person-year analysis. Another consideration to bear in mind is that the threshold for admission to a psychiatric hospital will likely have changed over time, particularly as community based alternatives became available. This unquantifiable threshold shift could complicate the interpretation of the time trend data in Table 6.

Comorbidity and early death

Furthermore, we have documented that diagnostic 'complexity' (indicated by further recording of other mental disorders in addition to the main psychiatric diagnosis, substance misuse, or physical health problems), tends to increase the risk of premature death and the average years of lost life in those previously hospitalised due to mental illness. This adverse effect of complexity has not reported before to our knowledge, and emphasises that comorbidity exacerbates prognosis, although an alternate explanation is that increased 'complexity' is in effect a proxy for lesser diagnostic rigour and care, which may in turn affect mortality. Similarly, an increased 'complexity' in a case may be a marker of increased severity of illness, which may in turn be related to early death. Also, our use of the SMR and the 'years of lost life' techniques allows quantification of both the relative and the absolute burden of excess death in this population. However, as this is a secondary care cohort, it will only capture those most severely affected by mental disorder, and hence does not allow comment on, for example, those with depression managed solely in the community. Equally, those hospitalised due to eating disorder are often physically unwell, so it is perhaps no surprise that this diagnostic group had worrying relative and absolute mortality results in this study. Not all comorbidity (or 'complexity') will have been captured here, due to the exclusion of physical ill health discharge records and

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probable under-recording of secondary psychiatric diagnostic codes. Lastly, we designed a 'wash in' period of 5 years (1981-1986) in order to capture only first admissions, but it is likely that some patients with psychiatric admissions prior to 1981 were included. The apparently old age at 'diagnosis'/first admission may suggest that these are in fact not all first admissions ie the relatively short wash in period has allowed us to include patients readmitted after more than 5 years as 'first admissions'.

A systematic review by Saha et al[14] found a SMR of 2.5 for risk of death in schizophrenia, which is greater than our figures of 1.8 (uncomplicated) and 2.0 (complicated), but the more recent study by Hoang and colleagues from England[8] found similar SMRs for both schizophrenia and bipolar disorder to our own results, albeit with a shorter follow up. Large long term follow up mortality studies comparing common mental disorders have not been reported elsewhere, to our knowledge, and our data provide context for the literature on early death in specific disorders such as schizophrenia and bipolar disorder[8], and depression and anxiety[24]. More detailed analysis of the time trends for individual causes of death in specific diagnostic groups would be valuable in the future.

Implications

In previous studies of all-cause mortality in those with mental illness in Scotland, behavioural risk factors such as heavy smoking and a sedentary lifestyle have been linked to early death, along with social isolation and deprivation[25]. Policy makers in the UK have also highlighted the physical health needs and premature mortality of those with mental health problems which echo the worrying disparities in lifespan we have identified for all the common mental disorders compared to the general population. In particular, we have found that the highest risk of early death is associated with young age at first admission; eating disorders; personality disorders; and in those with multiple diagnoses. A national approach across primary and secondary care tackling the complex mix of factors contributing to early death in the mentally disordered is required, addressing intrinsic disease related factors as well as lifestyle issues; lack of help seeking; and even stigma within the healthcare professions[21, 22, 25]. The inequity in life expectancy in the mentally disordered documented here poses a considerable challenge to our healthcare system.

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Table 1: Main psychiatric diagnosis categories of interest (and diagnostic hierarchy)

Main psychiatric diagnosis category	Definition	Hierarchy
Schizophrenia	Schizophrenia and other psychotic disorders including acute psychosis, persistent delusional disorders, schizotypal and schizoaffective disorder, and drug or alcohol induced psychotic disorder	1
Bipolar disorder	Manic episodes and bipolar disorder	2
Depression	Depressive episodes and recurrent depressive disorder (excluding persistent mood disorders such as cyclothymia)	3
Neurosis	Anxiety disorders and obsessive compulsive disorder	4
Eating disorder	Anorexia and bulimia nervosa	5
Personality disorder	All types of personality disorder	6

Note: ICD9 and ICD10 codes available on request.

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Table 2a: Characteristics of the cohort included in the analysis (Males)

	N	%	Median age at first admission (interquartile range)	% in most deprived quintile[1]	Median number of admissions (interquartile range)	Median total length (days) on admission (interquartile range)
Uncomplicated diagnosis group:						
Schizophrenia	8,966	35	33.7 (24.6 -50.2)	29	1.0 (1.0 -2.0)	48.0 (16.0 -161.0)
Bipolar disorder	1,680	7	41.0 (28.4 -56.2)	17	1.0 (1.0 -2.0)	36.0 (17.0 -72.0)
Depression	12,778	49	47.5 (34.2 -66.0)	23	1.0 (1.0 -1.0)	22.0 (7.0 -53.0)
Neurosis	1,129	4	40.7 (29.8 -58.5)	26	1.0 (1.0 -1.0)	14.0 (5.0 -35.0)
Eating disorder	49	<1	22.1 (19.0 -28.8)	33	1.0 (1.0 -1.0)	48.0 (12.0 -89.0)
Personality disorder	1,221	5	30.9 (23.8 -41.7)	30	1.0 (1.0 -1.0)	8.0 (3.0 -24.0)
Total uncomplicated	25,823	100	40.9 (28.4 -59.6)	25	1.0 (1.0 -2.0)	28.0 (9.0 -74.0)
Complicated (hierarchical) diagnosis group:						
Schizophrenia	10,697	43	31.0 (23.3 -44.0)	33	4.0 (2.0 -6.0)	145.0 (52.0 -429.0)
Bipolar disorder	2,159	9	42.4 (30.5 -56.6)	21	3.0 (2.0 -5.0)	115.0 (51.0 -257.0)
Depression	9,421	38	40.1 (30.0 -54.9)	26	2.0 (1.0 -4.0)	44.0 (18.0 -105.0)
Neurosis	915	4	37.0 (27.4 -48.1)	24	2.0 (1.0 -3.0)	32.0 (14.0 -71.0)
Eating disorder	17	<1	31.3 (23.5 -48.5)	29	3.0 (2.0 -4.0)	45.0 (21.0 -148.0)
Personality disorder	1,580	6	31.3 (23.8 -41.6)	31	2.0 (1.0 -3.0)	21.0 (8.0 -49.0)
Total complicated	24,789	100	35.5 (26.0-49.9)	28	3.0(2.0-5.0)	73.0(26.0 -214.0)

Table 2b: Characteristics of the cohort included in the analysis (Females)

	N	%	Median age at first admission (interquartile range)	% in most deprived quintile[1]	Median number of admissions (interquartile range)	Median total length (days) on admission (interquartile range)
Uncomplicated diagnosis group:						
Schizophrenia	6,999	21	53.9 (34.5 -76.0)	25	1.0 (1.0 -2.0)	47.0 (19.0 -122.0)
Bipolar disorder	2,196	7	43.4 (30.5 -61.0)	18	1.0 (1.0 -2.0)	35.0 (17.0 -74.0)
Depression	20,383	61	48.5 (33.8 -69.1)	23	1.0 (1.0 -1.0)	28.0 (10.0 -65.0)
Neurosis	1,946	6	48.5 (33.7 -68.7)	26	1.0 (1.0 -1.0)	18.0 (7.0 -39.0)
Eating disorder	586	2	20.7 (17.5 -26.5)	16	1.0 (1.0 -1.0)	49.0 (13.0 -126.0)
Personality disorder	1,095	3	31.1 (23.0 -43.5)	27	1.0 (1.0 -1.0)	9.0 (3.0 -25.0)
Total uncomplicated	33,205	100	47.6 (32.5-69.5)	23	1.0 (1.0 -1.0)	30.0 (11.0 -73.0)
Complicated (hierarchical) diagnosis group[2]:						
Schizophrenia	8,230	30	40.6 (27.7 -66.0)	29	3.0 (2.0 -6.0)	162.0 (68.0 -410.0)
Bipolar disorder	3,619	13	43.0 (31.2 -59.8)	22	3.0 (2.0 -5.0)	136.0 (60.0 -313.0)
Depression	13,390	48	41.1 (29.8 -61.8)	25	2.0 (2.0 -4.0)	64.0 (25.0 -163.0)
Neurosis	1,136	4	42.9 (31.2 -63.6)	21	2.0 (1.0 -3.0)	38.0 (17.0 -91.5)
Eating disorder	199	1	26.2 (20.7 -34.3)	18	2.0 (1.0 -3.0)	35.0 (10.0 -103.0)
Personality disorder	1,113	4	29.5 (22.5 -40.3)	28	2.0 (1.0 -3.0)	27.0 (10.0 -60.0)
Total complicated	27,687	100	40.6 (28.8 -61.9)	26	3.0 (2.0 -5.0)	89.0 (33.0 -237.0)

1 if there had been no deprivation gradient then around 20% of cases would be in the most deprived quintile

2 . For individuals with a complicated mental health diagnosis (hierarchical) , the age at first admission refers to the first 'ever' admission event.

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Table 3: SMRs and years of life lost for all-cause mortality by diagnosis group (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Observed deaths	Expected deaths	SMR[1] 95% CI	Total YLL	Average YLL
Uncomplicated diagnosis group:					
Schizophrenia	5,060	2,746	1.84 (1.79 - 1.89)	78,027	15.2
Bi-polar	883	525.6	1.68 (1.57 - 1.79)	14,369	16.1
Depression	11,036	6,831.2	1.62 (1.59 - 1.65)	155,582	14.1
Neurotic disorders	838	524.7	1.60 (1.49 - 1.71)	12,373	14.9
Eating disorders	51	11.6	4.39 (3.27 - 5.77)	2,182	39.0
Personality disorders	449	234.9	1.91 (1.74 - 2.10)	10,583	22.8
Complicated (hierarchical) diagnosis group:					
Schizophrenia	5,635	2,876.9	1.96 (1.91 - 2.01)	116,775	19.6
Bi-polar	1,706	1,129.5	1.51 (1.44 - 1.58)	29,351	16.7
Depression	7,282	3,628.8	2.01 (1.96 - 2.05)	146,736	19.0
Neurotic disorders	579	272.8	2.12 (1.95 - 2.30)	12,194	19.9
Eating disorders	38	8.7	4.39 (3.10 - 6.03)	1,317	31.4
Personality disorders	686	221.9	3.09 (2.86 - 3.33)	20,894	27.5
Total	**34,243**	**19,012.4**	**1.80 (1.78 - 1.82)**	600,383	**17.0**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 4: SMRs and years of life lost by diagnosis group and cause of death grouping (natural death, non-natural death, or "other" deaths) (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Natural deaths			Non-natural deaths			Other deaths		
	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL
Uncomplicated diagnosis group:									
Schizophrenia	3,580	1.78 (1.72 - 1.84)	11.8	504	4.40 (4.02 - 4.80)	32.2	976	1.58 (1.48 - 1.68)	16.3
Bi-polar	624	1.69 (1.56 - 1.83)	13.0	97	4.74 (3.84 - 5.78)	32.0	162	1.18 (1.01 - 1.38)	16.4
Depression	7,839	1.60 (1.56 - 1.63)	12.0	1,055	4.93 (4.64 - 5.24)	27.2	2,142	1.25 (1.20 - 1.30)	13.8
Neurotic disorders	622	1.71 (1.58 - 1.85)	13.2	63	3.35 (2.57 - 4.29)	29.4	153	1.07 (0.91 - 1.26)	15.1
Eating disorders	15	2.57 (1.44 - 4.26)	23.8	12	7.21 (3.71 - 12.63)	49.5	24	5.81 (3.72 - 8.66)	39.3
Personality disorders	265	1.67 (1.48 - 1.88)	15.0	96	6.21 (5.03 - 7.58)	37.6	88	1.45 (1.16 - 1.79)	25.6
Complicated (hierarchical) diagnosis group:									
Schizophrenia	3,500	1.71 (1.65 - 1.77)	14.3	767	5.17 (4.81 - 5.55)	35.1	1,368	2.02 (1.91 - 2.13)	20.0
Bi-polar	1,139	1.43 (1.34 - 1.51)	13.7	197	5.06 (4.38 - 5.82)	30.8	370	1.27 (1.14 - 1.41)	15.7
Depression	4,525	1.78 (1.72 - 1.83)	14.8	931	6.54 (6.12 - 6.97)	32.3	1,826	1.94 (1.86 - 2.04)	18.6
Neurotic disorders	379	2.04 (1.84 - 2.25)	16.4	53	4.28 (3.20 - 5.60)	33.6	147	1.98 (1.67 - 2.33)	20.0
Eating disorders	17	3.00 (1.74 - 4.82)	24.4	5	8.99 (2.84 - 21.14)	43.1	16	6.56 (3.74 - 10.68)	32.9
Personality disorders	360	2.46 (2.21 - 2.73)	19.9	129	7.47 (6.24 - 8.88)	39.0	197	3.37 (2.92 - 3.88)	28.8
Total	**22,865**	**1.69 (1.67 - 1.71)**	**13.3**	**3,909**	**5.25 (5.08 - 5.41)**	**31.80**	**7,469**	1.58 (1.55 - 1.62)	**17.4**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 5. SMRs for cardiovascular disease; cancer; and suicide.

	Cardiovascular deaths[1]		Cancer deaths[2]		Suicide deaths3	
Uncomplicated diagnosis group						
	% of natural deaths	**SMR (95% CI)**	**% of natural deaths**	**SMR (95% CI)**	**% of unnatural deaths**	**SMR (95% CI)**
Schizophrenia	53%	1.72 (1.65 - 1.80)	12%	1.30 (1.18 - 1.43)	63%	8.05 (7.19 - 8.98)
Bi-polar	54%	1.69 (1.51 - 1.88)	15%	1.39 (1.12 - 1.69)	74%	9.70 (7.59 - 12.22)
Depression	55%	1.59 (1.54 - 1.64)	15%	1.35 (1.28 - 1.43)	75%	13.28 (12.37 - 14.24)
Neurotic disorders	50%	1.60 (1.43 - 1.79)	14%	1.37 (1.10 - 1.69)	65%	6.44 (4.62 - 8.75)
Eating disorders	40%	2.30 (0.83 - 5.04)	20%	2.92 (0.55 - 8.65)	92%	12.22 (6.07 - 21.94)
Personality disorders	51%	1.62 (1.36 - 1.91)	12%	1.17 (0.80 - 1.66)	65%	8.58 (6.57 - 11.00)
Complicated diagnosis group						
Schizophrenia	50%	1.57 (1.50 - 1.65)	9%	0.86 (0.77 - 0.96)	72%	9.05 (8.31 - 9.83)
Bi-polar	52%	1.40 (1.29 - 1.52)	12%	0.88 (0.74 - 1.05)	77%	11.57 (9.80 - 13.57)
Depression	49%	1.62 (1.56 - 1.69)	10%	1.01 (0.93 - 1.11)	74%	13.25 (12.28 - 14.27)
Neurotic disorders	44%	1.65 (1.41 - 1.92)	12%	1.34 (0.98 - 1.81)	70%	7.52 (5.29 - 10.37)
Eating disorders	29%	1.68 (0.53 - 3.95)	12%	2.06 (0.19 - 7.56)	100%	19.49 (6.15 - 45.85)
Personality disorders	43%	2.08 (1.76 - 2.43)	10%	1.32 (0.92 - 1.82)	71%	10.55 (8.49 - 12.95)

All cardiovascular deaths. [1] All cancer, including lung cancer, deaths[2]. All deaths coded as suicides[3]. Cardiovascular and cancer deaths are shown as a proportion of observed natural deaths within each category and suicide is shown as a proportion of observed unnatural deaths within each category.

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Table 6: SMRs by time period of first admission (1986-2000) and followed up for 10 years from first admission (all diagnosis groups combined)

	Period of first admission	Observed deaths	Expected deaths	SMR[1] (95% CI)
Males	1986-90	3185	1514	2.10 (2.03 - 2.18)
	1991-95	2878	1328	2.17 (2.09 - 2.25)
	1996-00	2327	1076	2.16 (2.08 - 2.25)
Females	1986-90	4808	2669	1.80 (1.75 - 1.85)
	1991-95	3882	2112	1.84 (1.78 - 1.90)
	1996-00	2740	1413	1.94 (1.87 - 2.01)

[1] adjusted for age and deprivation category (Carstairs 1991 decile) at first diagnosis

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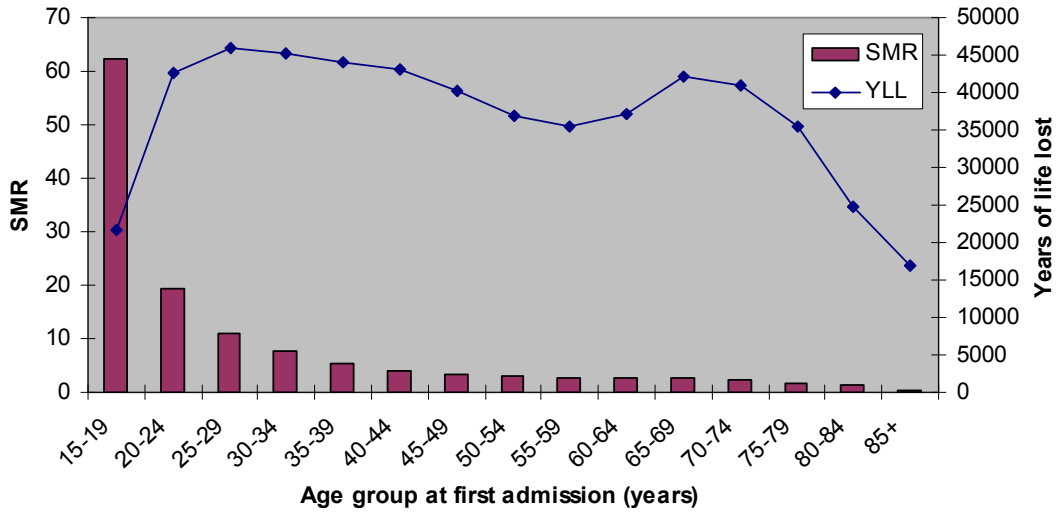
Figure 1: All-cause SMRs and overall YLL for patients diagnosed 1986-2009 and followed up until 31 December 2010 by age group at first admission



* The SMR for the above chart was produced from the table in Appendix A (below)

Appendix A: All cause SMRs for patients admitted to mental health speciality 1986 – 2009 followed up to 31st December 2010, by age group at first admission

Age	Observed	Expected	SMR (95% CI)
15-19	427	6.9	62.18 (56.42 - 68.37)
20-24	918	47.3	19.39 (18.16 - 20.69)
25-29	1112	101.0	11.01 (10.37 - 11.68)
30-34	1232	157.7	7.81 (7.38 - 8.26)
35-39	1357	251.4	5.40 (5.11 - 5.69)
40-44	1529	379.2	4.03 (3.83 - 4.24)
45-49	1690	515.3	3.28 (3.13 - 3.44)
50-54	1849	594.6	3.11 (2.97 - 3.25)
55-59	2162	822.4	2.63 (2.52 - 2.74)
60-64	2718	1055.7	2.57 (2.48 - 2.67)
65-69	3670	1340.3	2.74 (2.65 - 2.83)
70-74	4243	1882.2	2.25 (2.19 - 2.32)
75-79	4487	2509.9	1.79 (1.74 - 1.84)
80-84	3836	3182.7	1.21 (1.17 - 1.24)
85+	3013	6165.9	0.49 (0.47 - 0.51)

APPENDIX B: Main psychiatric diagnoses of interest (ICD 9/10 codes)

Diagnostic Description	ICD 9 Codes	ICD 10 codes
Bipolar disorder	2960,2962, 2963,2966, 2964, 2965	F30, F31
Schizophrenia	2950, 2951, 2952, 2954, 2955,2953,2956,2958,2959 2970, 2971, 2972, 2973, 2978, 2979, 2999 2988,2989, 2981	F20, F22, F28, F29, F24X
Schizoaffective	2957	F25
Depression	311, 2966, 2961, 2980,3004, 3001	F32, F33 F38 F39
Neurotic Disorder	3000, 3002, 3003, 2968, 2969	F40, F41, F42,
Personality Disorder	3010, 3012, 3013,3014, 3015, 3016,3017, 3018,3019, 3011	F60, F61, F62
Eating disorders	3071, 3075	F50

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Early death in those previously hospitalized for mental health care in Scotland – a nationwide follow up study, 1986 - 2010.

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Contributors OA and MT conceived the study. OA and DS ascertained the data. All authors analysed the data and drafted the manuscript. RW is the study guarantor.

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Neither NHS ethical approval nor Privacy Advisory Committee approval was required for this study as no patient identifiable data were released outwith NHS National Services Scotland and no new data linkages were undertaken.

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Article Focus

- Examines whether those previously hospitalised for mental disorder die earlier than people with no overt serious mental disorder.
- Do individuals with 'complicated' diagnoses (ie additional mental or physical ill health diagnoses in conjunction with their main psychiatric diagnosis) have higher excess mortality than those with 'uncomplicated' diagnoses?
- Is the apparent inequality in mortality rates between those with serious mental disorder and the general population worsening over time?

Key messages

- The average reduction in lifespan in those previously hospitalised for mental disorder compared to the general population is 17 years. People with eating disorders and personality disorder died earliest of all.
- In general, patients with 'complicated' diagnoses experience higher excess mortality than those without.
- Cardiovascular and respiratory diseases were the most common causes of death and accounted for a high proportion of the total burden of years of life lost, but suicides led to more years of lost life at the individual level due to predominantly affecting younger adults. No worsening of the 'mortality gap' over three decades was observed.

Strengths and limitations

- A large representative population studied over a long time period, which is important when examining causes of death.
- Innovative use of a diagnostic hierarchy to determine individuals' main psychiatric diagnosis.
- People with mental disorder who never required in-patient hospital care could not be included in this study.

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Objectives:

To compare the mortality in those previously hospitalised for mental disorder in Scotland to that experienced by the general population.

Design:

Population based historical cohort study using routinely available psychiatric hospital discharge and death records.

Setting & participants:

Individuals with a first hospital admission for mental disorder in Scotland, 1986-2009.

Outcomes:

The main outcome measure was death from any cause, 1986-2010. Excess mortality in individuals with previous psychiatric admission was presented as standardised mortality ratios (SMR) and years of life lost (YLL). Excess mortality was assessed overall and by age, sex, main psychiatric diagnosis, whether the psychiatric diagnosis was 'complicated' (ie additional mental or physical ill health diagnoses present), cause of death, and time period of first admission.

Results

111504 people were included in the study, and 34243 had died by 31/12/2010. The average reduction in life expectancy for the whole cohort was 17 years, with eating disorders (39 year reduction) and 'complicated' personality disorders (27.5 year reduction) being worst affected. 'Natural' causes of death such as cardiovascular disease showed modestly elevated relative risk (SMR1.7) but accounted for a high proportion of all deaths (67%) and of the total burden of years of life lost (54%). Non-natural deaths such as suicide showed higher relative risk (SMR5.2) and tended to occur at a younger age but were less common overall (11% of all deaths and 22% of all YLL). Having a 'complicated' diagnosis tended to elevate the risk of early death. No worsening of the overall excess mortality experienced by individuals with previous psychiatric admission over time was observed.

Conclusions

Early death for those hospitalised with mental disorder is common, and represents a significant inequality even in well developed healthcare systems. Prevention of suicide and cardiovascular disease deserve particular attention in the mentally disordered.

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Declaration of interest

All authors are employed by NHS Scotland. MT has received fees and / or hospitality from the manufacturers of various antipsychotic medications. TA, DS, and RW have no other conflicts to declare.

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Many of the most disabling medical conditions worldwide are mental illnesses, according to the WHO[1]. As well as adversely affecting day to day function, it has been known for many years that people with mental illness are at increased risk of premature death[2-5] with schizophrenia and bipolar disorder in particular being associated with an early death[6-8]. These inequalities in life expectancy have recently[9] been declared a "scandal", as even the Scandinavian countries[5], Scotland[10] and England[8,11] , despite relatively high quality and equitably distributed healthcare, have not been able to demonstrate any improvement in this premature mortality for the mentally ill over many years.

Non-natural deaths[12] including suicide and accidents, account for a disproportionate amount of this premature mortality in the mentally ill, particularly affecting young adults. High rates of cardiovascular disease, respiratory disease and other so-called natural causes also contribute[5,13,14] to the elevated relative risk of early death in the mentally ill. Precise estimates of the varying causal contributions to premature mortality in the mentally disordered have been limited by the lack of large representative populations being followed up over a lengthy period, and related studies have usually focussed on schizophrenia and bipolar disorder[8,15] rather than all major mental disorders. Additionally, the effects of comorbidity or multiple diagnoses on this premature mortality have also not been quantified. Concern has also been expressed that those with mental illness have not benefitted from improvements in public health over the last few decades[9,14] and that this mortality gap between the general population and the mentally ill is widening in recent years.

Using routinely collected national data, available from 1981, we set out to examine the ages and causes of death in those previously hospitalised with mental disorder in Scotland, and quantify any excess mortality. We also aimed to explore the relative contribution of different causes of death and trends over time.

Methods

Whenever a patient is discharged from a mental ill health hospital/specialty in Scotland, a Scottish Morbidity Record for Mental ill health (SMR04) is returned to the NHS National Services Scotland Information Services Division (ISD). SMR04 records contain information on patient demographics such as personal identifiers, age, and sex; the diagnosis that necessitated the admission; and aspects of the care given such as the psychiatric subspecialty admitted to. One primary diagnosis and up to five

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further secondary diagnoses can be recorded. Diagnoses are coded according to the International Classification of Diseases (ICD) (version 9 to 1997 and version 10 from 1997 to present). Statutory death records (containing demographic and ICD coded cause of death information) are returned to the National Records of Scotland (NRS) with copies passed to ISD for analytical purposes.

For this study, SMR04 records for adults discharged from mental ill health hospitals/specialities in Scotland between 1981 and 2009 were obtained. Patients aged less than 15 years at the date of first admission and those admitted to the learning disabilities subspecialty were excluded from the sample, in accordance with the aim of studying the ages and causes of death in adults with mental illness and personality disorder. Death records for the period 1986-2010 were also obtained. We created a single patient record for each individual by linking all their hospital discharge records and their death record (if died) using a range of patient identifiers and previously developed probabilistic matching algorithms. These methods have been described previously[16, 17]. All patients who had had an admission to a mental ill health specialty between 1981 and 1985 were excluded to give a cohort of patients with (as close as possible to) a first inpatient admission between 1986 and 2009 in order to clarify the issue of diagnostic shift or comorbidity.

All patient level data used in this study were held and analysed within ISD. Only aggregate results, from which individual patients could not be identified, were shared with members of the study team not based within ISD (MT). ISD operates strict procedures to maintain patient privacy and confidentiality and no specific additional permissions were required for this study. In particular, permission for linkage of previously unlinked health datasets held by ISD is required from the Privacy Advisory Committee. PAC approval was not required for this study however as SMR04 and death records have been routinely linked within ISD for decades for purposes such as monitoring patient outcomes.

Diagnostic assignation

We then assigned each individual to a main psychiatric diagnosis category (see table 1) and excluded individuals who did not have any admissions relating to a diagnostic group of interest. The diagnostic groups of interest included were schizophrenia, bipolar disorder, depression, neurosis, eating disorder, and personality disorder.

Table 1 here

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Patients with a single primary psychiatric diagnosis of interest recorded on all their psychiatric discharge records over the period of study, and no other or additional diagnoses at any admission, were described as 'uncomplicated'. For example, an individual with five hospital admissions which were all coded solely to depression would be described as 'uncomplicated depression'.

In contrast, patients with more than one diagnosis recorded were described as 'complicated'. For patients with more than one diagnosis from the diagnostic groups of interest, a hierarchical approach was used to determine the main diagnosis and hence assign a patient to one group (see table 1) with schizophrenia being assigned the highest rank. For example, a patient diagnosed as having bipolar disorder at their first hospital admission and then admitted for neurosis at a later date would be assigned to the 'complicated bipolar' group. Conversely, someone who had three hospital admissions for neurosis and then one for neurosis with depression recorded as an additional secondary diagnosis would be described as 'complicated depression' and their time at risk in the cohort would be taken from their first neurosis admission.

Patients may also have had other/additional diagnoses not within the diagnostic groups of interest. These included other psychiatric problems (mainly dementia, stress reactions and adjustment disorders); alcohol or drug misuse; or (rarely) physical health problems such as pneumonia. Someone with an admission for personality disorder with drug misuse recorded as an additional secondary diagnosis would therefore be described as 'complicated personality disorder'.

Analysis

A final record was then created for each patient within the mental ill health cohort containing hierarchically defined main psychiatric diagnosis, a flag indicating whether the main diagnosis was 'complicated' or not, date of first admission, age at first admission, sex, deprivation category at first admission, date of death and (main) cause of death. Deprivation category was determined using Carstairs 1991 area-based deprivation deciles[18] based on postcode of residence at first admission and corresponding population denominators from the Consistent Areas Through Time (CATTS) classification tables[19] which allows us to create a long time series of deprivation-specific mortality rates.

This linked dataset was used to calculate indirectly standardised mortality ratios (SMRs) for the mental ill health patients using a person-years approach which took

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account of each individual's time at risk (from time of first admission) across different age categories, time periods, sex and deprivation decile since diagnosis. All analyses were carried out using Stata 11.0 (Stata Corp, College Station, Texas) using the stsplit command to split age (in days) across the time periods. Age was defined in days from birth date to diagnosis date, and study exit was defined in days from diagnosis date to end of follow-up interval or death, whichever came first.

Years of Life Lost (YLL) were computed by multiplying the number of deaths in the study cohort (in each period of death, sex, age band at death and deprivation decile) by the corresponding life expectancy at that age. The average YLL (AYLL) was derived by dividing the total YLL by the actual number of deaths within the subgroups of interest. Scottish national mortality rates split by year of death (in time bands), sex, five-year age band and deprivation decile were used as the reference standard for the SMRs. Life tables were compiled based on these national mortality rates following the Chiang[20] methodology for the YLL analyses. To examine possible trends over time in the excess mortality experienced by individuals with previous psychiatric admission, we chose three time period cohorts each with 10 years of follow up for each cohort to capture a wide range of causes of death.

We looked at overall mortality; mortality by specific cause; and mortality split into natural deaths (cardiovascular, cancer, respiratory, digestive, endocrine, nervous system, infectious disease), non-natural deaths (accidental, suicide/undetermined, homicide), and other (all other deaths including those recorded as mental and behavioural).

Results

Over the time period of study (1986-2009) there were 59,028 individuals who had a consistent diagnosis within and between admissions (classified as uncomplicated) and 52,476 individuals who had an unstable diagnosis or additional co-morbidity within and/or between admissions (classified as complicated). Women comprised 55% of the cohort largely due to a higher number of cases of depression in women. Women tended to be older than men at their first included admission, particularly for schizophrenia and neurosis. Complicated diagnoses resulted in higher numbers of hospitalisations and total length of time spent in hospital as would be expected (see Table 2a and 2b).

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Increasing deprivation was linked to mental ill health problems for both men and women, with the exception of bi-polar disorder (no clear trend across deprivation groups for either sex) and eating disorder in females (uncomplicated more common in least deprived group; complicated no clear trend across deprivation groups) (Table 2 and additional analyses available on request).

Overall, 34,243 individuals in the study cohort had died by the 31 December 2010, around 80% more (SMR=1.8) than expected based on the general population (see table 3). The standardised mortality ratios tended to be higher for those with complicated diagnoses, and overall were highest for those with eating disorders (SMR=4.4) and complicated personality disorders (SMR=3.1). Overall life expectancy for the whole cohort of individuals with mental ill health was 17 years less than that for the general population. The largest reduction in life expectancy was seen for individuals with eating disorders (39 years of life lost for those with uncomplicated diagnosis) and personality disorders (27.5 YLL for those with complicated diagnosis) however as most deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

Relative risk of early death

The excess risk of death was extremely high for those in the youngest age group at first included admission, and the excess reduced as age at first admission increased (see figure 1). However, total years of life lost told a slightly different story, with a relatively constant YLL for those diagnosed at ages 20-24 through to 75-79 years, with lower YLL for those aged 15-19, 80-84 and 85+ years. This reflects the fact that the absolute risk of dying generally increases with age. The same age-related pattern is seen for males and females, although the excess risk of death is higher for females compared to males at every age (data not shown).

Figure 1 here

Around two thirds of deaths (22,865 deaths) in the mental ill health cohort were from natural causes, 11% (3,909) from non-natural causes and the remaining 21% (7,469) were from "other" deaths not coded as natural or non-natural including 'mental or behavioural disorder' (36% of "other" causes of death). The excess risk of death was much higher from non-natural causes (SMR=5.2) compared to natural causes (SMR=1.7) and "other" deaths (SMR=1.6). On average, 31.8 years of life were lost due to every non-natural death compared to 13.3 years due to every natural death

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and 17.4 years of life lost for each "other" death, reflecting the fact that non-natural deaths tend to occur at younger ages (see Table 4).

There was a significant excess risk of natural, non-natural and "other" deaths for patients in each diagnosis group (except uncomplicated neurotic disorders resulting in "other" deaths (SMR=1.1, ns). The highest excess risks were seen for eating disorders across death groupings, although the number of deaths in individuals with eating disorders was small (see Table 4). Natural deaths accounted for more years of life lost than non-natural deaths in each diagnostic group. Cardiovascular disease accounted for around half of all years of life lost from natural causes, with digestive disorders, cancer, and respiratory disorders accounting for most of the remainder. Suicide accounted for the majority of years of life lost due to non-natural causes in each diagnostic group (data not shown). Table 5 reveals the proportions of observed ~~and expected~~ deaths for the two main natural causes of death, namely heart disease and cancer, as well as suicide, the main causes of unnatural death.

Tables 2a; 2b; 3; 4; and 5 here

Mortality trends over time

Looking at individuals whose first admissions were in the periods 1986-90, 1991-95 and 1996-2000 and following each individual in these sub-cohorts up for 10 years from their first admission, the all cause standardised mortality ratios showed no evidence of a narrowing of the mortality excess over time (see Table 6).

Table 6 here

Discussion

Main findings

This large national study provides an accurate estimate of the risk of early death experienced by adults previously hospitalised for mental disorder. We showed that overall life expectancy for the whole cohort of individuals previously hospitalised due to mental ill health was 17 years less than that for the general population. The excess risk of early death was greatest for patients first admitted at the youngest age (15-19 years old) but individuals first admitted at older ages experienced greater numbers of early deaths. The largest reduction in life expectancy was seen for individuals with

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eating disorders and personality disorders – namely an alarming 39 years reduction in life expectancy for uncomplicated eating disorders, and 27.5 for those with a complicated personality disorder. However as the greatest number of deaths were seen in individuals with depression and schizophrenia, these conditions accounted for the greatest number of years of life lost.

The majority of deaths in those previously hospitalised for mental disorder are due to 'natural' causes such as cardiovascular and respiratory disorder, which mirrors the results of a similar study from Denmark[7] examining the life expectancy of those with schizophrenia and bipolar disorder. By contrast, although only 11% of deaths in our study population were attributable to 'non-natural' causes such as suicide, accidents, and homicide, we found that these 'non-natural' causes carried a substantially higher comparative excess risk of early death – ranging between 27 years of lost life for depression to a staggering 49.5 years for eating disorders, emphasising that these non-natural deaths occur earlier than the more common natural causes of death. For the whole cohort of mentally ill individuals, those dying from non-natural causes lost, on average, almost 32 years of life, reinforcing the continuing need for national suicide prevention strategies.

A stable 'mortality gap'?

In addition, contrary to results elsewhere[8,14], we did not find any evidence that the difference in risk of death between the general population and the mentally disordered was worsening over time. In fact, we observed that this 'mortality gap' was stable over 25 years for all the common mental disorders, which offers some reassurance to claims that the mentally disordered have not benefited from improvements in public health[9]. Nevertheless, our data indicates that there continues to be a need for monitoring the physical health of those with mental disorder, and in particular screening for cardiovascular disease.

Strengths and limitations of the study

Strengths of this study include the whole population coverage and the long time series, along with the demonstrable high quality and completeness[23] of the diagnostic coding and cause of death coding. The reliability of a given diagnosis does not necessarily imply that it is valid, however, in a specialty that lacks objective diagnostic tests. We have also taken care with main psychiatric diagnosis assignation, using a pragmatic hierarchical approach to account for the diagnostic shift and co-morbidities that are commonly seen in day-to-day clinical psychiatric practice. Definitive diagnosis is not always easy initially in mental health, and over such a long study period there

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may be shift in diagnostic trends. Main psychiatric diagnosis has therefore been assigned using a hierarchical approach and taking into account all diagnoses recorded on an individual's psychiatric discharge records over the period of study rather than simply diagnosis at first admission. This approach considerably increases the number of people in the higher categories (eg psychoses). For example, of 17,031 individuals who were first admitted with depression, 71% were assigned to depression, 17% subsequently had schizophrenia recorded on a discharge record and so were assigned to "complicated schizophrenia", and 11% were assigned to "complicated bipolar". For some groups the hierarchy is less intuitive, for example, of the 325 individuals who were first admitted with eating disorders but subsequently had other mental ill health problems, 69% moved out of the eating disorder group into another group higher up the hierarchy (data not shown). This will lead to a conservative SMR for some complicated cases due to time at risk for conditions lower down the hierarchy being assigned to a condition higher up the hierarchy in the person-year analysis. Another consideration to bear in mind is that the threshold for admission to a psychiatric hospital will likely have changed over time, particularly as community based alternatives became available. This unquantifiable threshold shift could complicate the interpretation of the time trend data in Table 6.

Comorbidity and early death

Furthermore, we have documented that diagnostic 'complexity' (indicated by further recording of other mental disorders in addition to the main psychiatric diagnosis, substance misuse, or physical health problems), tends to increase the risk of premature death and the average years of lost life in those previously hospitalised due to mental illness. This adverse effect of complexity has not reported before to our knowledge, and emphasises that comorbidity exacerbates prognosis, although an alternate explanation is that increased 'complexity' is in effect a proxy for lesser diagnostic rigour and care, which may in turn affect mortality. Similarly, an increased 'complexity' in a case may be a marker of increased severity of illness, which may in turn be related to early death. Also, our use of the SMR and the 'years of lost life' techniques allows quantification of both the relative and the absolute burden of excess death in this population. However, as this is a secondary care cohort, it will only capture those most severely affected by mental disorder, and hence does not allow comment on, for example, those with depression managed solely in the community. Equally, those hospitalised due to eating disorder are often physically unwell, so it is perhaps no surprise that this diagnostic group had worrying relative and absolute mortality results in this study. Not all comorbidity (or 'complexity') will have been captured here, due to the exclusion of physical ill health discharge records and

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probable under-recording of secondary psychiatric diagnostic codes. Lastly, we designed a 'wash in' period of 5 years (1981-1986) in order to capture only first admissions, but it is likely that some patients with psychiatric admissions prior to 1981 were included. The apparently old age at 'diagnosis'/first admission may suggest that these are in fact not all first admissions ie the relatively short wash in period has allowed us to include patients readmitted after more than 5 years as 'first admissions'.

A systematic review by Saha et al[14] found a SMR of 2.5 for risk of death in schizophrenia, which is greater than our figures of 1.8 (uncomplicated) and 2.0 (complicated), but the more recent study by Hoang and colleagues from England[8] found similar SMRs for both schizophrenia and bipolar disorder to our own results, albeit with a shorter follow up. Large long term follow up mortality studies comparing common mental disorders have not been reported elsewhere, to our knowledge, and our data provide context for the literature on early death in specific disorders such as schizophrenia and bipolar disorder[8], and depression and anxiety[24]. More detailed analysis of the time trends for individual causes of death in specific diagnostic groups would be valuable in the future.

Implications

In previous studies of all-cause mortality in those with mental illness in Scotland, behavioural risk factors such as heavy smoking and a sedentary lifestyle have been linked to early death, along with social isolation and deprivation[25]. Policy makers in the UK have also highlighted the physical health needs and premature mortality of those with mental health problems which echo the worrying disparities in lifespan we have identified for all the common mental disorders compared to the general population. In particular, we have found that the highest risk of early death is associated with young age at first admission; eating disorders; personality disorders; and in those with multiple diagnoses. A national approach across primary and secondary care tackling the complex mix of factors contributing to early death in the mentally disordered is required, addressing intrinsic disease related factors as well as lifestyle issues; lack of help seeking; and even stigma within the healthcare professions[21, 22, 25]. The inequity in life expectancy in the mentally disordered documented here poses a considerable challenge to our healthcare system.

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Table 1: Main psychiatric diagnosis categories of interest (and diagnostic hierarchy)

Main psychiatric diagnosis category	Definition	Hierarchy
Schizophrenia	Schizophrenia and other psychotic disorders including acute psychosis, persistent delusional disorders, schizotypal and schizoaffective disorder, and drug or alcohol induced psychotic disorder	1
Bipolar disorder	Manic episodes and bipolar disorder	2
Depression	Depressive episodes and recurrent depressive disorder (excluding persistent mood disorders such as cyclothymia)	3
Neurosis	Anxiety disorders and obsessive compulsive disorder	4
Eating disorder	Anorexia and bulimia nervosa	5
Personality disorder	All types of personality disorder	6

Note: ICD9 and ICD10 codes available on request.

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Table 2a: Characteristics of the cohort included in the analysis (Males)

	N	%	Median age at first admission (interquartile range)	% in most deprived quintile[1]	Median number of admissions (interquartile range)	Median total length (days) on admission (interquartile range)
Uncomplicated diagnosis group:						
Schizophrenia	8,966	35	33.7 (24.6 -50.2)	29	1.0 (1.0 -2.0)	48.0 (16.0 -161.0)
Bipolar disorder	1,680	7	41.0 (28.4 -56.2)	17	1.0 (1.0 -2.0)	36.0 (17.0 -72.0)
Depression	12,778	49	47.5 (34.2 -66.0)	23	1.0 (1.0 -1.0)	22.0 (7.0 -53.0)
Neurosis	1,129	4	40.7 (29.8 -58.5)	26	1.0 (1.0 -1.0)	14.0 (5.0 -35.0)
Eating disorder	49	<1	22.1 (19.0 -28.8)	33	1.0 (1.0 -1.0)	48.0 (12.0 -89.0)
Personality disorder	1,221	5	30.9 (23.8 -41.7)	30	1.0 (1.0 -1.0)	8.0 (3.0 -24.0)
Total uncomplicated	25,823	100	40.9 (28.4 -59.6)	25	1.0 (1.0 -2.0)	28.0 (9.0 -74.0)
Complicated (hierarchical) diagnosis group:						
Schizophrenia	10,697	43	31.0 (23.3 -44.0)	33	4.0 (2.0 -6.0)	145.0 (52.0 -429.0)
Bipolar disorder	2,159	9	42.4 (30.5 -56.6)	21	3.0 (2.0 -5.0)	115.0 (51.0 -257.0)
Depression	9,421	38	40.1 (30.0 -54.9)	26	2.0 (1.0 -4.0)	44.0 (18.0 -105.0)
Neurosis	915	4	37.0 (27.4 -48.1)	24	2.0 (1.0 -3.0)	32.0 (14.0 -71.0)
Eating disorder	17	<1	31.3 (23.5 -48.5)	29	3.0 (2.0 -4.0)	45.0 (21.0 -148.0)
Personality disorder	1,580	6	31.3 (23.8 -41.6)	31	2.0 (1.0 -3.0)	21.0 (8.0 -49.0)
Total complicated	24,789	100	35.5 (26.0-49.9)	28	3.0(2.0-5.0)	73.0(26.0 -214.0)

Table 2b: Characteristics of the cohort included in the analysis (Females)

	N	%	Median age at first admission (interquartile range)	% in most deprived quintile[1]	Median number of admissions (interquartile range)	Median total length (days) on admission (interquartile range)
Uncomplicated diagnosis group:						
Schizophrenia	6,999	21	53.9 (34.5 -76.0)	25	1.0 (1.0 -2.0)	47.0 (19.0 -122.0)
Bipolar disorder	2,196	7	43.4 (30.5 -61.0)	18	1.0 (1.0 -2.0)	35.0 (17.0 -74.0)
Depression	20,383	61	48.5 (33.8 -69.1)	23	1.0 (1.0 -1.0)	28.0 (10.0 -65.0)
Neurosis	1,946	6	48.5 (33.7 -68.7)	26	1.0 (1.0 -1.0)	18.0 (7.0 -39.0)
Eating disorder	586	2	20.7 (17.5 -26.5)	16	1.0 (1.0 -1.0)	49.0 (13.0 -126.0)
Personality disorder	1,095	3	31.1 (23.0 -43.5)	27	1.0 (1.0 -1.0)	9.0 (3.0 -25.0)
Total uncomplicated	33,205	100	47.6 (32.5-69.5)	23	1.0 (1.0 -1.0)	30.0 (11.0 -73.0)
Complicated (hierarchical) diagnosis group[2]:						
Schizophrenia	8,230	30	40.6 (27.7 -66.0)	29	3.0 (2.0 -6.0)	162.0 (68.0 -410.0)
Bipolar disorder	3,619	13	43.0 (31.2 -59.8)	22	3.0 (2.0 -5.0)	136.0 (60.0 -313.0)
Depression	13,390	48	41.1 (29.8 -61.8)	25	2.0 (2.0 -4.0)	64.0 (25.0 -163.0)
Neurosis	1,136	4	42.9 (31.2 -63.6)	21	2.0 (1.0 -3.0)	38.0 (17.0 -91.5)
Eating disorder	199	1	26.2 (20.7 -34.3)	18	2.0 (1.0 -3.0)	35.0 (10.0 -103.0)
Personality disorder	1,113	4	29.5 (22.5 -40.3)	28	2.0 (1.0 -3.0)	27.0 (10.0 -60.0)
Total complicated	27,687	100	40.6 (28.8 -61.9)	26	3.0 (2.0 -5.0)	89.0 (33.0 -237.0)

1 if there had been no deprivation gradient then around 20% of cases would be in the most deprived quintile

2 . For individuals with a complicated mental health diagnosis (hierarchical) , the age at first admission refers to the first 'ever' admission event.

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Table 3: SMRs and years of life lost for all-cause mortality by diagnosis group (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Observed deaths	Expected deaths	SMR[1] 95% CI	Total YLL	Average YLL
Uncomplicated diagnosis group:					
Schizophrenia	5,060	2,746	1.84 (1.79 - 1.89)	78,027	15.2
Bi-polar	883	525.6	1.68 (1.57 - 1.79)	14,369	16.1
Depression	11,036	6,831.2	1.62 (1.59 - 1.65)	155,582	14.1
Neurotic disorders	838	524.7	1.60 (1.49 - 1.71)	12,373	14.9
Eating disorders	51	11.6	4.39 (3.27 - 5.77)	2,182	39.0
Personality disorders	449	234.9	1.91 (1.74 - 2.10)	10,583	22.8
Complicated (hierarchical) diagnosis group:					
Schizophrenia	5,635	2,876.9	1.96 (1.91 - 2.01)	116,775	19.6
Bi-polar	1,706	1,129.5	1.51 (1.44 - 1.58)	29,351	16.7
Depression	7,282	3,628.8	2.01 (1.96 - 2.05)	146,736	19.0
Neurotic disorders	579	272.8	2.12 (1.95 - 2.30)	12,194	19.9
Eating disorders	38	8.7	4.39 (3.10 - 6.03)	1,317	31.4
Personality disorders	686	221.9	3.09 (2.86 - 3.33)	20,894	27.5
Total	**34,243**	**19,012.4**	**1.80 (1.78 - 1.82)**	600,383	**17.0**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 4: SMRs and years of life lost by diagnosis group and cause of death grouping (natural death, non-natural death, or "other" deaths) (all patients diagnosed 1986-2009 and followed up until 31 December 2010)

	Natural deaths			Non-natural deaths			Other deaths		
	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL	N	SMR (95% CI)	AYYL
Uncomplicated diagnosis group:									
Schizophrenia	3,580	1.78 (1.72 - 1.84)	11.8	504	4.40 (4.02 - 4.80)	32.2	976	1.58 (1.48 - 1.68)	16.3
Bi-polar	624	1.69 (1.56 - 1.83)	13.0	97	4.74 (3.84 - 5.78)	32.0	162	1.18 (1.01 - 1.38)	16.4
Depression	7,839	1.60 (1.56 - 1.63)	12.0	1,055	4.93 (4.64 - 5.24)	27.2	2,142	1.25 (1.20 - 1.30)	13.8
Neurotic disorders	622	1.71 (1.58 - 1.85)	13.2	63	3.35 (2.57 - 4.29)	29.4	153	1.07 (0.91 - 1.26)	15.1
Eating disorders	15	2.57 (1.44 - 4.26)	23.8	12	7.21 (3.71 - 12.63)	49.5	24	5.81 (3.72 - 8.66)	39.3
Personality disorders	265	1.67 (1.48 - 1.88)	15.0	96	6.21 (5.03 - 7.58)	37.6	88	1.45 (1.16 - 1.79)	25.6
Complicated (hierarchical) diagnosis group:									
Schizophrenia	3,500	1.71 (1.65 - 1.77)	14.3	767	5.17 (4.81 - 5.55)	35.1	1,368	2.02 (1.91 - 2.13)	20.0
Bi-polar	1,139	1.43 (1.34 - 1.51)	13.7	197	5.06 (4.38 - 5.82)	30.8	370	1.27 (1.14 - 1.41)	15.7
Depression	4,525	1.78 (1.72 - 1.83)	14.8	931	6.54 (6.12 - 6.97)	32.3	1,826	1.94 (1.86 - 2.04)	18.6
Neurotic disorders	379	2.04 (1.84 - 2.25)	16.4	53	4.28 (3.20 - 5.60)	33.6	147	1.98 (1.67 - 2.33)	20.0
Eating disorders	17	3.00 (1.74 - 4.82)	24.4	5	8.99 (2.84 - 21.14)	43.1	16	6.56 (3.74 - 10.68)	32.9
Personality disorders	360	2.46 (2.21 - 2.73)	19.9	129	7.47 (6.24 - 8.88)	39.0	197	3.37 (2.92 - 3.88)	28.8
Total	**22,865**	**1.69 (1.67 - 1.71)**	**13.3**	**3,909**	**5.25 (5.08 - 5.41)**	**31.80**	**7,469**	1.58 (1.55 - 1.62)	**17.4**

[1] adjusted for sex, age, period and deprivation category (Carstairs 1991 decile) at first diagnosis

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Table 5. SMRs for cardiovascular disease; cancer; and suicide.

	Cardiovascular deaths[1]		Cancer deaths[2]		Suicide deaths3	
Uncomplicated diagnosis group						
	% of natural deaths	SMR (95% CI)	% of natural deaths	SMR (95% CI)	% of unnatural deaths	SMR (95% CI)
Schizophrenia	53%	1.72 (1.65 - 1.80)	12%	1.30 (1.18 - 1.43)	63%	8.05 (7.19 - 8.98)
Bi-polar	54%	1.69 (1.51 - 1.88)	15%	1.39 (1.12 - 1.69)	74%	9.70 (7.59 - 12.22)
Depression	55%	1.59 (1.54 - 1.64)	15%	1.35 (1.28 - 1.43)	75%	13.28 (12.37 - 14.24)
Neurotic disorders	50%	1.60 (1.43 - 1.79)	14%	1.37 (1.10 - 1.69)	65%	6.44 (4.62 - 8.75)
Eating disorders	40%	2.30 (0.83 - 5.04)	20%	2.92 (0.55 - 8.65)	92%	12.22 (6.07 - 21.94)
Personality disorders	51%	1.62 (1.36 - 1.91)	12%	1.17 (0.80 - 1.66)	65%	8.58 (6.57 - 11.00)
Complicated diagnosis group						
Schizophrenia	50%	1.57 (1.50 - 1.65)	9%	0.86 (0.77 - 0.96)	72%	9.05 (8.31 - 9.83)
Bi-polar	52%	1.40 (1.29 - 1.52)	12%	0.88 (0.74 - 1.05)	77%	11.57 (9.80 - 13.57)
Depression	49%	1.62 (1.56 - 1.69)	10%	1.01 (0.93 - 1.11)	74%	13.25 (12.28 - 14.27)
Neurotic disorders	44%	1.65 (1.41 - 1.92)	12%	1.34 (0.98 - 1.81)	70%	7.52 (5.29 - 10.37)
Eating disorders	29%	1.68 (0.53 - 3.95)	12%	2.06 (0.19 - 7.56)	100%	19.49 (6.15 - 45.85)
Personality disorders	43%	2.08 (1.76 - 2.43)	10%	1.32 (0.92 - 1.82)	71%	10.55 (8.49 - 12.95)

All cardiovascular deaths. [1] All cancer, including lung cancer, deaths[2]. All deaths coded as suicides[3]. Cardiovascular and cancer deaths are shown as a proportion of observed natural deaths within each category and suicide is shown as a proportion of observed unnatural deaths within each category.

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Table 6: SMRs by time period of first admission (1986-2000) and followed up for 10 years from first admission (all diagnosis groups combined)

	Period of first admission	Observed deaths	Expected deaths	SMR[1] (95% CI)
Males	1986-90	3185	1514	2.10 (2.03 - 2.18)
	1991-95	2878	1328	2.17 (2.09 - 2.25)
	1996-00	2327	1076	2.16 (2.08 - 2.25)
Females	1986-90	4808	2669	1.80 (1.75 - 1.85)
	1991-95	3882	2112	1.84 (1.78 - 1.90)
	1996-00	2740	1413	1.94 (1.87 - 2.01)

[1] adjusted for age and deprivation category (Carstairs 1991 decile) at first diagnosis

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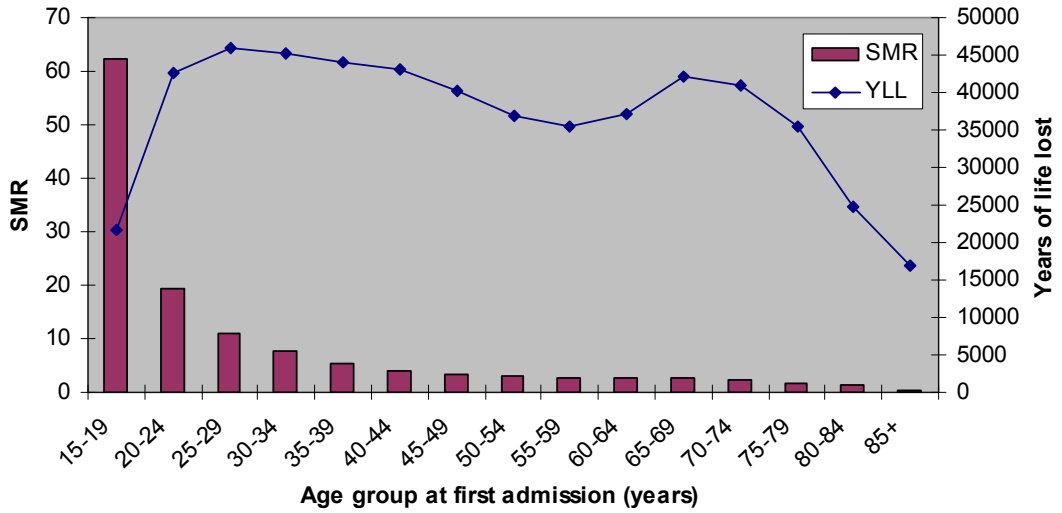
Figure 1: All-cause SMRs and overall YLL for patients diagnosed 1986-2009 and followed up until 31 December 2010 by age group at first admission



* The SMR for the above chart was produced from the table in Appendix A (below)

Appendix A: All cause SMRs for patients admitted to mental health speciality 1986 – 2009 followed up to 31st December 2010, by age group at first admission

Age	Observed	Expected	SMR (95% CI)
15-19	427	6.9	62.18 (56.42 - 68.37)
20-24	918	47.3	19.39 (18.16 - 20.69)
25-29	1112	101.0	11.01 (10.37 - 11.68)
30-34	1232	157.7	7.81 (7.38 - 8.26)
35-39	1357	251.4	5.40 (5.11 - 5.69)
40-44	1529	379.2	4.03 (3.83 - 4.24)
45-49	1690	515.3	3.28 (3.13 - 3.44)
50-54	1849	594.6	3.11 (2.97 - 3.25)
55-59	2162	822.4	2.63 (2.52 - 2.74)
60-64	2718	1055.7	2.57 (2.48 - 2.67)
65-69	3670	1340.3	2.74 (2.65 - 2.83)
70-74	4243	1882.2	2.25 (2.19 - 2.32)
75-79	4487	2509.9	1.79 (1.74 - 1.84)
80-84	3836	3182.7	1.21 (1.17 - 1.24)
85+	3013	6165.9	0.49 (0.47 - 0.51)

APPENDIX B: Main psychiatric diagnoses of interest (ICD 9/10 codes)

Diagnostic Description	ICD 9 Codes	ICD 10 codes
Bipolar disorder	2960,2962, 2963,2966, 2964, 2965	F30, F31
Schizophrenia	2950, 2951, 2952, 2954, 2955,2953,2956,2958,2959 2970, 2971, 2972, 2973, 2978, 2979, 2999 2988,2989, 2981	F20, F22, F28, F29, F24X
Schizoaffective	2957	F25
Depression	311, 2966, 2961, 2980,3004, 3001	F32, F33 F38 F39
Neurotic Disorder	3000, 3002, 3003, 2968, 2969	F40, F41, F42,
Personality Disorder	3010, 3012, 3013,3014, 3015, 3016,3017, 3018,3019, 3011	F60, F61, F62
Eating disorders	3071, 3075	F50

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

Re: **Mental disorder and early death – a nationwide follow up study, 1981 - 2010.**

'Tomi Ajetunmobi[1], Mark Taylor[2], Diane Stockton[1], and Rachael Wood[1].

	Item No	Recommendation
Title and abstract	1 Done, p1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2 Done – p2	Explain the scientific background and rationale for the investigation being reported
Objectives	3 Done – p2	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4 Done	Present key elements of study design early in the paper
Setting	5 Done	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 Done	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7 Done	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8* Done	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 In method & discussion	Describe any efforts to address potential sources of bias
Study size	10 Done	Explain how the study size was arrived at
Quantitative variables	11 Done	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12 Done	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13* Done	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage

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		(c) Consider use of a flow diagram
Descriptive data	14* Done	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	15* Done	Report numbers of outcome events or summary measures
Main results	16 Done where applicable	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 SMRs and YLL	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18 Done	Summarise key results with reference to study objectives
Limitations	19 Done	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 Done	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21 Commented on	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22 Done	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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