SUBMISSION TO SENATE COMMUNITY AFFAIRS COMMITTEE: INQUIRY INTO SUICIDE IN AUSTRALIA

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INTRODUCTION

This documentation is submitted by a group of researchers with expertise in a range of disciplines including epidemiology, public health, psychiatry, psychology, and health policy. The authors have a track record of research characterised by a strong emphasis on collaborative and multi-disciplinary understandings of mental disorder, social differentials and their impacts on suicidal behaviour. Their research output includes analytic and evaluative studies, policy development and advocacy, using both population-level and individual (and clinical) level approaches, to further the understanding of suicidal behaviour and its antecedents.

This group also has extensive previous collaborations with Commonwealth and State Departments, including:

- Assistance and advice in the development and implementation of national and state-level suicide prevention strategies (GM, MD, SM) ;

- Representation on the previously established National Suicide Advisory Council (GM, MD)

- Founding members and ongoing representation in the non-government advocacy group Suicide Prevention Australia (GM, MD);

- Expert advice and collaboration on evaluation of suicide prevention strategies, programs, policies and the development of clinical practice guidelines (GM, MD, GC,WH);

- Management and implementation of collaborative research projects funded by Federal and State governments to address risk factors for suicidal behaviour, including epidemiological studies of self-injury, attempted suicide, suicide and drug use (GM, AP, RT, GC, MD,WH, SM).

- Prof. Martin is also the current National Advisor to the Commonwealth on Suicide Prevention.

The authors have published extensively on suicide, both reports and articles in the peer reviewed scientific literature, including studies of:

- Trends in suicide in Australia over the last century and more recently;

- Socio-economic, geographic and migrant risk factors related to mental disorders, suicide and attempts;

- Psychological and psychiatric predictors of suicide, suicide attempts (especially deliberate self-poisoning), and deliberate self-harm;

- Measurement issues in suicide in Australia;

- The provision of psychiatric interventions and services as they relate to suicidal behaviour

- Suicide in young people

The following documentation provides a summary of **current priorities** and past **research outputs** from this group as they relate to specific Terms of Reference outlined by the Committee.

RESPONSE TO COMMITTEE TERMS OF REFERENCE

"The impact of suicide on the Australian community including high risk groups such as Indigenous youth and rural communities, with particular reference to:"

"the personal, social and financial costs of suicide in Australia;"

Financial costs relating to clinical service

- A substantial component of the financial cost of suicidal behaviour involves the cost for the general hospital treatment of suicide attempts, deliberate self-poisoning and deliberate self harm and the subsequent psychiatric hospitalisation costs for a substantial minority of these persons. Deliberate self poisoning is overwhelmingly the most common type of hospital treated suicidal behaviour followed by "cutting" forms of deliberate self harm.[1]

  We have demonstrated that providing an area-based integrated multidisciplinary service, using a standard model of care, for all deliberate self poisoning patients, substantially reduced hospital costs (as measured by DRGs, bed days or length of stay) compared to national and state comparator hospitals

- We have also shown that a simple postcard intervention delivered over 12 months following hospital-treated deliberate self poisoning halved the subsequent number of events of hospital-treated deliberate self-poisoning, after 12 months and 24 months with a substantial number of bed days saved.[2, 3] We have now followed these persons up for 5 years and shown a saving of over 300 bed days in the general hospital and 2,500 bed days in the psychiatric hospital (manuscript in preparation).

- Important clinical sub-groups of patients have high rates of suicidal behaviour and associated hospital treatment costs e.g. persons with Borderline Personality Disorder. Effective treatments for this clinical group – Dialectical Behaviour Therapy (DBT) and a Day Hospital based mentalization therapy - have been shown to reduce the rates of suicidal behaviours and hospitalisations,[4-7] but these treatment are not widely available in Australia, largely because of the lack of staff training and development of integrated services.

- A recent RCT study of this clinical population in Australia showed an improvement in days out of bed and quality of life for the DBT treated group – a substantial reduction in social costs (Carter et al. ANZJP accepted 2009).

"(b) the accuracy of suicide reporting in Australia, factors that may impede accurate identification and recording of possible suicides, (and the consequences of any under-reporting on understanding risk factors and providing services to those at risk);"

- Numerous previous studies, both in Australia and internationally, have indicated that misclassification of cause of death occurs in the vital registration of suicide, [8-17] and there are numerous underlying reasons for cases of suicide to be misclassified (such religious or cultural reasons). [16,17]

- In Australia, previous studies of the 'undetermined death' category have shown that suicides are likely to be under-enumerated for males by 5-10% (with lower rates of 'undetermined' cases in European migrants),[8] but the use of the undetermined category did not change substantially during the period of the emerging youth suicide 'epidemic'. [9,10]

- More recent investigations focussing on the period (2000-2005) based on a detailed comparison of suicides recorded in the National Coronial System with deaths coded by the Australian Bureau of Statistics (ABS) have found that suicide is under-enumerated by 9%. This period was characterised by misclassifications of likely cases of suicide to unintentional causes of injury, namely accidental hanging and strangulation, unintentional poisoning and unintentional shooting. [18]

- Some reports [11,18,19] have suggested that the marked decline in suicide in young males (aged 20-34 years) after 1997 may be attributable to an increase in 'open-cases' and misallocation of likely cases of suicide by the Australian Bureau of Statistics (ABS) to 'other unintentional' causes of death (such as poisoning, accidental hanging and strangulation, and accidental shooting).

- However, a recent investigation (by members of this group: AP, RT, GM) showed that taking account of this misallocation does not significantly change the decline in suicide rates in young males in the period after 1997 [20] from rates reported previously in the literature.[21] This investigation also shows declines (after 1997) in all-cause mortality, natural causes and non-intentional causes of injury in this age group. This also suggests that declines in suicide in this age group are real.

- An over-emphasis on the role of misclassification in the recent decline in young male suicide may distract us from understanding other more pertinent reasons for a real and significant suicide decline. We specifically need to disentangle the effects of recent prevention activity and other socio-cultural factors on distal, intermediate and proximate factors associated with Australian suicide.

"the appropriate role and effectiveness of agencies, such as police, emergency departments, law enforcement and general health services in assisting people at risk of suicide;"

The role of General Hospitals in treating suicidal behaviour

- We have demonstrated the benefits of offering an integrated multidisciplinary team approach using a standard model of care for hospital-treated deliberate self poisoning patients. This uses a similar operational approach to that of a trauma centre in a general hospital.[22]

- We have also participated in the development of clinical practice guidelines for the treatment of suicidal young people [23] and adults.[24,25]

- The extent to which the guidelines for young people have been followed has been evaluated in Western Australia (Auditor General Western Australia, 2001) but not in other states and territories.

"the role of targeted programs and services that address the particular circumstances of high-risk groups;"

- We have demonstrated the benefits of offering an integrated multidisciplinary team approach using a standard model of care for hospital-treated deliberate self poisoning patients, utilising a similar operational approach to that of a trauma centre.[22]

- We have shown that a simple postcard intervention delivered over 12 months following hospital-treated deliberate self poisoning halved the subsequent number of events of hospital-treated deliberate self-poisoning after 12 months and 24.[2, 3]

- A recent RCT study of women with Borderline Personality Disorder in Australia showed an improvement in days out of bed and quality of life for the DBT treated group (Carter et al. ANZJP accepted 2009).

"(g) the adequacy of the current program of research into suicide and suicide prevention, and the manner in which findings are disseminated to practitioners and incorporated into government policy;"

Current understandings of population trends in suicide

- Despite dramatic declines in Australian young male suicide (20-34 years) since 1997, suicide remains a significant public health problem in terms of potential years of life lost.[21] There has been insufficient research into the reasons for the decline and there is no agreement on the explanations of it. Young adult males aged 20-34 years were the demographic group that experienced an epidemic of

- Numerous studies have identified key antecedents to suicide at individual, interpersonal, and societal levels. A range of population wide prevention and control measures relating to suicide and suicidal behaviour have been developed and implemented both in Australia [28] and internationally.[29] Despite these studies, it remains unclear as to which prevention and control measures are effective in reducing suicidal behaviour and in which populations.[29]

Dissemination and translation into suicide prevention policy and practice

- In the Australian context, and also internationally, there is very little research which **formally integrates and synthesises** aetiological approaches to understanding individual and contextual determinants of suicidal behaviour in individuals and relates this to government (and non-government) strategies to prevent suicides.

- Previous studies of suicide prevention internationally and in Australia, have primarily evaluated the effects of discrete interventions such as firearm restriction legislation, detoxification of domestic gas, changes in antidepressant and alcohol use, or wider public awareness and health promotion campaigns that have often not been based on an understanding of aetiology and contextual factors. Most of these studies of preventive strategies have been examined in a recent international systematic review, the findings of which are summarised below.[29]

- Prevention strategies shown to reduce means-specific suicide rates include restricting access to firearms via legislation,[30-35] detoxification of domestic gas,[36-42] restricting access to barbiturates [41,43-47] and analgesics,[48] mandatory use of catalytic converters in motor vehicles,[49-51] and the erection of barriers at popular jumping sites.[52] Primary care physician education programs in specific regions of Sweden, Hungary, Japan, and Slovenia have been shown to reduce suicide.[29,53] Increases in antidepressant consumption rates, as a proxy measure for better management of key psychiatric risk factors, have also been found to be associated with decreases in suicide rates in general populations in Sweden,[54] Japan,[55] the United States,[56,57] and in older age-groups in Australia.[58] Individual-level prospective studies of antidepressant use and suicide risk thus far are inconclusive because of the low rates of suicidal behaviour and the fact that few clinical trials have included suicidal behaviour as an outcome measure.[29] Quasi-experimental studies in Japan, restricted to the elderly, in localised geographic areas, showed that depression screening,

- Wider public education and awareness campaigns relating to understanding suicide risk factors and help seeking have largely focussed on depression and have had no discernible effect on suicide rates.[29] Similarly, school and community-based mental health promotion programs generally have not been successful in reducing suicide,[29] although some whole-of-population and community approaches to suicide prevention can demonstrably work.[62,63] Such public awareness and mental health promotion programs often are implemented in the absence of evidence-based suicide prevention, and often lack appropriate outcome evaluation strategies.[29]

Future priorities in suicide research and research translation

- In this context of conflicting evidence internationally, and limited information for Australia, there is a need for a **systematic review** and **integrated analysis of the distribution, determinants and effectiveness of measures to reduce suicide**, attempted suicide and self harm in Australia. A thorough and far-reaching review is also needed of related mental health issues, and particularly mental health service provision, in order to inform health service and other state and/or national strategies to reduce population mortality and morbidity from these causes.

- Such a review and analysis should draw heavily on the wealth of **currently available sources of data** that have not been used to their full potential. These sources include: routinely collected social, economic, health and health service, and mortality data, and also individual analytic studies (such as case-control and cohort studies) of mental health and suicidal behaviour; and government and non-government web-based resources such as social-networking sites and crisis telephone services (e.g. Lifeline). There is an opportunity to develop collaborative partnerships to **combine these multiple sources of data** using **novel data linkage protocols** (both individual record linkage and strata matching) to establish **policy priorities** and **monitor and evaluate** the effects of prevention activities at national, regional, and local levels. This includes past, current and future suicide prevention activity funded by the Commonwealth Department of Health and Aging and State counterparts, partly captured in periodic national stocktakes.

- Specifically there is the need to:

  (1) Delineate appropriate risk and protective factors for suicidal behaviour, specifically key psychiatric, psychological and personality factors, precipitants and circumstances, and contextual socio-economic, geographic, cultural and other predictors of self-harm, attempted suicide and suicide.

  (2) Conduct detailed comparative sub-group and geographic analyses of suicide in relation to suicide prevention projects in relation to changes in social, health service, economic, climactic and other variables. The substantial reduction in young male suicide since 1997, compared to stable suicide rates in other male age groups and in females over the same period, is especially worthy of focused study.

(3) Apply this information to: (i) review previous suicide prevention strategies to inform Australian mental health policy and suicide prevention responses (in both government and non-government sectors); (ii) establish the extent to which policy and prevention activity funded by Federal and State governments accords with empirically developed models of suicidal behaviour; (iii) and to identify areas of deficit where cost-effective strategies to address modifiable risk factors could be developed.

"(h) the effectiveness of the National Suicide Prevention Strategy in achieving its aims and objectives, and any barriers to its progress."

- It is unclear what impact these programs have had on longer-term trends in suicide. Previous evaluations of suicide prevention activity in Australia have been restricted to funded projects and programs, and predominantly have been focussed on process indicators rather than reductions in suicide.[28,64] This is partly due to the short period of funding provided and follow-up period (3-5 years), and partly due to the complexities in assessing changes in suicide without also considering other related community health promotion activity and socio-economic change.[28,65]

- It is plausible that the National Youth Suicide Prevention Strategy (and subsequent National Suicide Prevention Strategy) has had an effect in reducing the suicide rates in young males, given the close temporal association between the decline in young male suicide and the start of the National Youth Suicide Prevention Strategy and subsequent National Youth Suicide Prevention Strategy. [21]

- It is not clear what components of the strategy might have been effective: whether particular prevention activity was associated with declines in suicide in particular demographic groups or social strata [26,27]; whether universal, selective or indicated programs were more or less effective; whether implementation and uptake of programs differed by geographic area; and whether levels of funding were commensurate with effects on suicide rates. And if these differences are evident, what were the reasons for them. There is, however, scope to capture publicly available information regarding the original National Youth Suicide Prevention Strategy and subsequent national prevention strategies to examine type of program, area of implementation and intensity (in terms of numbers of programs and level of funding) and relate it to corresponding area-based rates of suicide to establish the extent that prevention and control activity has reduced suicide rates in the Australian population.

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Papers

Postcards from the EDge project: randomised controlled trial of an intervention using postcards to reduce repetition of hospital treated deliberate self poisoning

Gregory L Carter, Kerrie Clover, Ian M Whyte, Andrew H Dawson, Catherine D'Este

Abstract

Objective To determine whether an intervention using postcards (postcards from the EDge project) reduces repetitions of hospital treated deliberate self poisoning.
Design Randomised controlled trial.
Setting Regional referral service for general hospital treated deliberate self poisoning in Newcastle, Australia.
Participants 772 patients aged over 16 years with deliberate self poisoning.
Intervention Non-obligatory intervention using eight postcards over 12 months along with standard treatment compared with standard treatment alone.
Main outcome measures Proportion of patients with one or more repeat episodes of deliberate self poisoning and the number of repeat episodes for deliberate self poisoning per person in 12 months.
Results The proportion of repeaters with deliberate self poisoning in the intervention group did not differ significantly from that in the control group (57/378, 15.1%, 95% confidence interval 11.5% to 18.7% *v* 68/394, 17.3%, 13.5% to 21.0%: difference between groups −2%, −7% to 3%). In unadjusted analysis the number of repetitions were significantly reduced (incidence risk ratio 0.55, 0.35 to 0.87).
Conclusion A postcard intervention reduced repetitions of deliberate self poisoning, although it did not significantly reduce the proportion of individual repeaters.

Introduction

Deliberate self poisoning is common, accounting for 5% of admissions to general hospitals in Australia.[1] In the United Kingdom, deliberate self harm is one of the top five reasons for acute medical admissions.[2] Most patients with deliberate self harm have initial contact with hospital through the emergency department. Repetition of deliberate self harm is also common, ranging from 6% to 30% in 12 months.[2] Repetition is strongly associated with subsequent suicide and has important implications for healthcare resources. Three non-pharmacological interventions were effective in reducing repetition in selected subsets of populations with deliberate self harm,[3–5] but interventions are needed that could be economically delivered to the entire population of patients who deliberately self harm.

We tested the efficacy of a postcard intervention (postcards from the EDge project) over 12 months on repetition of hospital treated deliberate self poisoning.

Methods

The Hunter Area Toxicology Service is a regional toxicology unit at the Newcastle Mater Hospital, New South Wales, Australia, serving a primary referral population of 385 000 adults and a tertiary referral population of a further 170 000. All patients presenting with poisoning to emergency departments in the greater Newcastle region are admitted to the service or notified to the service and entered prospectively into a clinical database.[6] The psychiatry department of the Newcastle Mater Hospital sees all patients with deliberate self poisoning for assessment and diagnosis and to determine discharge destination and follow-up. Details of the model of service for these patients have been described.[7]

Potentially eligible participants were those aged over 16 years who presented to the toxicology service with deliberate self poisoning during April 1998 to December 2001. We excluded patients incapable of informed consent, those of no fixed address, those with insufficient English to complete a structured interview, and those who posed a potential threat to an interviewer.

Variables

Our two dependent variables were the proportion of patients with at least one repeat episode of deliberate self poisoning in 12 months and the number of repeat episodes of deliberate self poisoning per individual over 12 months.

We extracted the descriptive variables of the sample from the toxicology service's database, which were derived from the standardised clinical assessment of patients with deliberate self poisoning.[7 8] The categorical variables were sex, marital status (married or de facto married versus never married, separated, divorced, or widowed), employment (full time or part time versus unemployed, pensioner, student, or other), admission to an intensive care unit, time of admission (9 am to 5 pm weekdays versus out of hours), and discharge destination (psychiatric hospital versus all others). The continuous variables were age, length of stay in hours, median number of previous admissions to the toxicology service for deliberate self poisoning, and number of psychiatric diagnoses from clinical assessment.

Design and randomisation

We used a randomised consent design, using the single consent version (Zelen design).[9 10] This design is a variation on the standard randomised controlled experimental design, where partici-

The postcard is on bmj.com

pants are randomised to control or intervention before consent is sought. In the single consent version, written informed consent to receive the intervention (eight non-obligatory postcards) was sought from participants randomised to the intervention. We assessed the outcomes by an intention to treat analysis on the basis of allocation.

Randomisation was by database (HanDBase version 2.0; DDH Software, FL, USA) on a personal digital assistant (Palm III; Palm, CA, USA) that was populated with a pregenerated randomisation schedule (in blocks of 10) and carried by the duty toxicologist. To avoid recruiting patients more than once, the duty toxicologist sought information on identification in this database and entered only new patients. To maintain blinding to allocated group during recruitment, randomisation was not revealed until after all information was entered and eligibility had been determined. The allocation group was then revealed to obtain patient consent. To monitor any potential alterations (interference), we kept a duplicate record in a hidden field of the database and a copy was held on a separate computer for later verification of correct allocation. All other clinical and research staff remained blinded to allocation.

Intervention

Our intervention was based on a previous study, which showed significantly reduced death by suicide in a population of psychiatric inpatients who received long term contact by letter after hospital discharge.[11 12] Our intervention comprised a postcard sent to participants in a sealed envelope at 1, 2, 3, 4, 6, 8, 10, and 12 months after discharge (see postcard on bmj.com).

Sample sizes

We calculated several sample sizes for different estimates of possible effects.[13] We determined that to detect a difference in proportions (P = 0.05, 80% power) of 15% to 10% required 1364 participants, a difference of 20% to 10% required 392, and a difference of 30% to 20% required 293.

On the basis of clinical experience and previous research we anticipated that between 15% and 30% of participants in the control group would repeat deliberate self poisoning within 12 months, with an average of two episodes, giving overall rates for deliberate self poisoning of 0.30 to 0.60. A sample of 400 participants in each group would allow detection of absolute differences between groups of 0.10 to 0.15 (P = 0.05, 80% power) and 0.12 to 0.17 (P = 0.05, 90% power) yielding relative risks of 0.67 to 0.75 and 0.60 to 0.72 for 80% and 90% power, respectively. This sample size would be adequate to detect differences in the proportion of participants with any deliberate self poisoning of 7-9% (80% power) and 8-10% (90% power and 5% significance level), which we considered would represent a clinically significant reduction.

Statistical analyses

We analysed data using SPSS version 10.0 and Intercooled Stata 7. We used the χ^2 test to determine the difference in proportions of participants with any repetition of deliberate self poisoning. We initially considered a Poisson model for the number of repeat episodes of deliberate self poisoning per individual; however, exploratory analysis indicated that the variance of the number of deliberate self poisonings was much greater than the mean. We therefore used the negative binomial model. We compared the risk of deliberate self poisoning events per individual in the intervention group with that in the control group using negative binomial regression, reported as the incidence risk ratio with 95% confidence intervals. As we found a difference between the sexes, we undertook subgroups analyses of treatment effect for men and women, using negative binomial models.

Twenty participants in the control group received the intervention due to clerical errors but were included in the control group for the intention to treat analyses.

Results

We excluded 150 of 922 patients (16%) assessed for eligibility to our study, leaving 772 participants—394 in the control group and 378 in the intervention group (fig 1). Among the intervention group, 76 refused the intervention, one missed the intervention, and 32 did not receive the full intervention, usually because the participants were reported as unknown at the address on the postcards. Table 1 shows the characteristics of the participants at baseline. Overall, 129 of 772 (17%) participants had a previous episode of hospital treated deliberate self poisoning: 66 of 394 (17%) in the control group and 63 of 378 (17%) in the intervention group. Poisonings were classified as pharmaceuticals only (473, 61%), pharmaceuticals plus alcohol (217, 28%), opioid or amphetamine (20, 3%), carbon monoxide (17, 2%), herbicide or rodenticide (11, 1%), insulin (7, 1%), any deliberate self harm with deliberate self poisoning (23, 3%), and unknown (4, 1%).

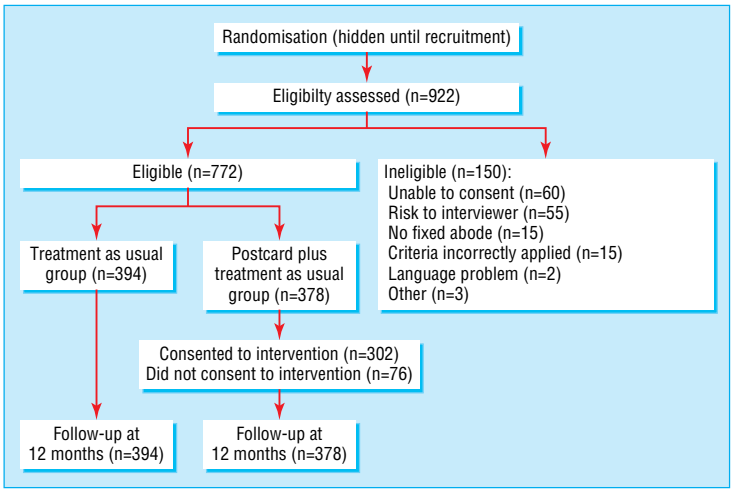

Fig 1 Flow of participants through trial

Table 1 Characteristics of groups receiving a postcard intervention or standard care for hospital treated deliberate self poisoning. Values are numbers (percentages) unless stated otherwise

Characteristic	Missing data	Total (n=772)	Control group (n=394)	Postcard group (n=378)
Women	1	524 (68)	291 (74)	233 (62)
Married or de facto married	31	256 (35)	118 (31)	138 (38)
Employed	153	162 (26)	88 (27)	74 (26)
Admitted to intensive care	0	113 (15)	60 (15)	53 (14)
Admitted outside office hours	0	581 (75)	296 (75)	285 (75)
Discharged to psychiatric hospital	2	208 (27)	106 (27)	102 (27)
Previous admission for deliberate self poisoning	0	129 (17)	66 (17)	63 (17)
Median (interquartile range) age (years)	0	33 (24-44)	34 (23-45)	33 (24-42)
Median (interquartile range) length of stay (hours)	0	18 (12-30)	18 (13-31)	17 (12-29)
Median No of previous admissions for deliberate self poisoning (interquartile range)	0	0 (0-0)	0 (0-0)	0 (0-0)
Median No of psychiatric diagnoses (interquartile range)	0	2 (1-2)	2 (1-3)	2 (1-3)

Proportion of participants repeating deliberate self poisoning

Fifty seven of the participants in the intervention group (15.1%, 95% confidence interval 11.5% to 18.7%) had one or more repeat episodes of deliberate self poisoning compared with 68 (17.3%, 13.5% to 21%) in the control group (difference between groups −2%, −7% to 3%), with no significant difference ($\chi^2 = 0.675$, df = 1, P = 0.41).

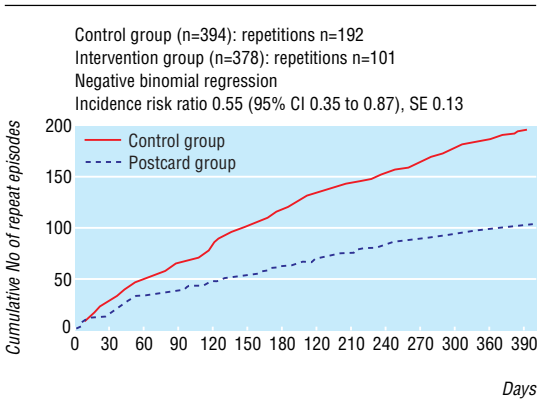

Fig 2 Cumulative number of repeat episodes of hospital treated deliberate self poisoning

Number of repeat episodes

The cumulative number of repeat episodes of deliberate self poisoning was 192 in the control group and 101 in the intervention group (fig 2).

The risk of repetition was statistically significantly lower in the intervention group than in the control group (incidence risk ratio 0.55, 95% confidence interval 0.35 to 0.87; table 2). Although we found no significant interaction between treatment and sex, subgroup analyses by sex showed that the treatment was effective for women (0.54, 0.30 to 0.96) but not for men (0.97, 0.48 to 2.0). Table 3 shows the number of repeat episodes by allocated group and sex.

Discussion

A simple intervention comprising a postcard sent to patients at intervals after discharge for an episode of deliberate self poison-

Table 2 Negative binomial models for intervention effect on repetitions of deliberate self poisoning and for subgroup analyses by sex

	Incidence risk ratio	SE (95% CI)	Z value*	P value*
Group (unadjusted)				
Control	1.00			
Postcards	0.55	0.13 (0.35 to 0.87)	−2.56	0.010
Subgroup analyses				
Men (n=247):				
Control	1.00			
Postcards	0.97	0.35 (0.48 to 1.98)	−0.08	0.937
Women (n=524):				
Control	1.00			
Postcards	0.54	0.16 (0.30 to 0.96)	−2.09	0.037

*Wald test.

Table 3 Number of repeat episodes of deliberate self poisoning by sex and by intervention group. Values are numbers (percentages)

	Control group (n=394)				Postcard group (n=378)			
No of repetitions	Men (n=102)	Total repetitions	Women (n=291)	Total repetitions	Men (n=145)	Total repetitions	Women (n=233)	Total repetitions
0	86 (84)	0	240 (83)	0	125 (86)	0	196 (84)	0
1	13 (13)	13	25 (9)	25	13 (9)	13	21 (9)	21
2	2 (2)	4	8 (3)	16	5 (3)	10	10 (4)	20
≥3	1 (1)	4	18 (6)	125	2 (1)	6	6 (3)	31

One control participant with missing data for sex had five readmissions.

ing nearly halved the number of repeat episodes in 12 months. Although the intervention did not reduce the proportion of individual repeaters, it did reduce the number of events per patient.

Strengths and weaknesses of the study

Our study had several strengths. We used a randomised consent design, which was suited to this study and clinical population. The characteristics of the patients at baseline and principal outcomes were tracked by a database, allowing for complete follow-up. This method has not been used previously in testing interventions for suicidal behaviours. The statistical, ethical, and practical issues concerning the use of a randomised consent design have been extensively reviewed[14 15] and, despite some of the difficulties, this design has been used in recently published studies.[16 17]

The quality of the randomisation was good. Randomisation was undertaken using a handheld personal computer in combination with another computer that would detect any errors of allocation status and interference with randomisation.

All participants and clinical and research staff were blind to outcome, with data extraction done five months after completion of the study period. Only the recruiting toxicologists and secretary responsible for managing the mailing database and postcards were not blind to the allocation status.

Our study had some limitations and caution is needed when interpreting the results. Fewer than 20% of the participants had any repeat episodes of deliberate self poisoning, and a subgroup of repeaters had a highly skewed pattern of more than one repeat episode. It is not known to what extent our population and model of clinical service[7] would be generalisable to other settings. As we studied patients with deliberate self poisoning, the results cannot be generalised to patients with other forms of deliberate self harm.

Replications of this study and additional effectiveness trials would be necessary before considering widespread implementation. Our decision to include a subgroup analysis on the basis of sex was a retrospective one based on the findings from the primary outcomes. Caution is needed in interpreting such subgroup analyses because of (unplanned) reduced sample sizes, and judgment needs to be exercised regarding the biological plausibility of such analyses.

The estimate of efficacy of treatment effect may have been conservative for three reasons: 20 control participants were inadvertently exposed to the intervention, 76 intervention participants did not consent to receive the intervention, and 32 intervention participants were not exposed to the intervention.

Implications of the study

A simple postcard intervention nearly halved the number of repeat episodes for deliberate self poisoning within 12 months. The control group occupied hospital beds for 239 days (192 repetitions) compared with 129 days (101 repetitions) in the intervention group, a total of 110 bed days saved. This represented a considerable saving in opportunity costs, availability of hospital beds, and decrease in workload for the emergency department. The costs of stationery, post, maintenance of a mailing database, and staff time were estimated to be less than $A15 (£6.25; $11.52; €9.19) per participant. This low cost intervention seems to have substantial cost effectiveness. The simplicity of the intervention means that it could be delivered from hospitals that do not have extensive resources for patients with deliberate self poisoning.

The difference in total repetitions for deliberate self poisoning came from one main source; women with three or more repeat episodes (table 3), which accounted for a difference of 94 repeat episodes (125 by control participants and 31 by intervention participants). This was a surprising result as we expected that women multiple repeaters would be relatively unresponsive to such a simple intervention. Our low cost intervention can be applied to almost all adult patients with hospital treated deliberate self poisoning and can be used without identifying patients at high risk of repetition.

The mechanism of action for the postcard intervention is unknown and was not evaluated in this study. Nevertheless, the authors of a study using a letter based intervention[12] speculated about increased social connectedness, a concrete expression that someone still cares about the patient. A similar interpretation would be reasonable for our study. Patients requiring hospital treatment for deliberate self poisoning may believe that their situation is hopeless, that no one cares about them, or that they are viewed as incompetent and undeserving of care. We do not know if the patients in this study experienced any degree of impaired social connectedness but they may well have done so. It may be that, when combined with the postcard intervention, a service model that emphasises respect for the patient, high quality medical and psychiatric management, and follow-up arrangements on discharge is able to reduce the feelings of lack of social connectedness. If so, then simply implementing a postcard intervention without the clinical model of care may not be as effective. The previous letter intervention[12] was, however, effective, even for patients who eschewed all ongoing contact with treatment services, so this type of intervention may have independent effects on repetition of suicidal behaviour.

Conclusion

Previous studies of intervention to reduce repetition of deliberate self harm in unselected patient groups have been unsuccessful in reducing the proportion of repeaters. Even using a meta-analytic approach has shown no benefit from antidepressants, problem solving, intensive care with outreach, an emergency card,[18] a psychosocial crisis intervention, or guaranteed in-patient shelter in cases of emergency.[19]

Although we found no significant difference in the proportion of individual patients who repeated we did find that a low cost postcard intervention was effective in reducing the number of events per individual. The magnitude of the reduction, nearly 50%, was clinically and statistically significant.

A small proportion of the deliberate self poisoning population accounts for substantial numbers of repetitions and treatment costs. This intervention produced considerable savings in opportunity costs for the hospital service in which it was tested. That the effect of reduction in repetitions was seen in only women suggests that future studies need to be adequately powered to test treatment effect by sex.

We thank Jerome Motto for his encouragement to use and modify the original intervention for this project; Trish McGettigan, Patrick Oakley, Nav Gupta, and Geoff Isbister for patient recruitment; Stuart Allen for data management support; Bob Goldney and Natalia Carter for alerting us to the Motto study; Julia Lowe and Dianne O'Connell for schooling us in Zelen designs; and Helen Rowsell, the departmental secretary, who managed the mailing database and mailing lists so diligently.

Contributors: GLC had the original idea for the study and did the original drafting of the manuscript. He is guarantor. GLC, IMW, and AHD planned the study. KC was responsible for managing the data sets and carrying out most of the analyses. CD'E undertook the negative binomial and other regression analyses and gave statistical advice on other issues. All authors reviewed the manuscript and replied to reviewers.

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Competing interests: None declared.

What is already known on this topic

Deliberate self harm is common and costly, with repetition rates of 6-30%

Deliberate self poisoning is the commonest form of deliberate self harm

Few interventions effectively reduce repetitions of deliberate self harm

What this study adds

A simple, inexpensive, postcard intervention for patients with deliberate self poisoning reduced the number of events per individual, but did not reduce the proportion of individual repeaters

Ethical approval: This research project was approved by the Hunter Area Health Services research ethics committee (No 9710153.15).

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Postcards from the EDge: 24-month outcomes of a randomised controlled trial for hospital-treated self-poisoning

GREGORY L. CARTER, KERRIE CLOVER, IAN M. WHYTE, ANDREW H. DAWSON and CATHERINE D'ESTE

Background Repetition of self-poisoning is common.

Aims To report the 24-month outcomes of a non-obligatory postcard intervention (plus treatment as usual) compared with treatment as usual.

Method In a randomised-controlled trial (Zelen design) conducted in Newcastle, Australia, eight postcards were sent to participants over a 12-month period. The principal outcomes were the proportion of participants with one or more repeat episodes of self-poisoning and the number of repeat episodes per person.

Results No significant reduction was observed in the proportion of people repeating self-poisoning in the intervention group (21.2%, 95% CI 17.0–25.3) compared with the control group (22.8%, 95% CI 18.7–27.0; χ^2=0.32, d.f.=1, P= 0.57); the difference between groups was −1.7% (95% CI −7.5 to 4.2). There was a significant reduction in the rate of repetition, with an incidence risk ratio of 0.49 (95% CI 0.33–0.73).

Conclusions A postcard intervention maintained the halving of the rate of repetition of hospital-treated self-poisoning events over a 2-year period, although it did not significantly reduce the proportion of individuals who repeated self-poisoning.

Declaration of interest None.

Hospital-treated self-poisoning is common in Australia (McGrath, 1989). Self-harm is common in the UK (House *et al*, 1998), with self-poisoning being the most common form and with most patients making their initial contact with hospital through the emergency department (Gunnell *et al*, 2005). Repetition of self-harm within 12 months of an index episode is common, with a median rate of 16% (interquartile range 12–25%), has a strong association with subsequent suicide and has significant resource implications for the health system (Owens *et al*, 2002). Five non-pharmacological interventions have been shown to be effective in reducing repetition of self-harm: one after 6 months' follow-up (Guthrie *et al*, 2001), three at the completion of the intervention duration of 12 months (Linehan *et al*, 1991; Brown *et al*, 2005; Carter *et al*, 2005); and one at treatment completion after 18 months (Bateman & Fonagy, 1999). Only three studies have reported sustained, beneficial repetition outcomes beyond the intervention duration: one reported outcomes after 6 months (Guthrie *et al*, 2001), one after 36 months (18 months' follow-up; Bateman & Fonagy, 2001) and one after 24 months (12 months' follow-up; Linehan *et al*, 2006). We have previously shown that a postcard intervention reduced the rate of repetition of hospital-treated self-poisoning events over the 12-month period of the intervention (Carter *et al*, 2005). In this paper we report on the 24-month outcomes. There were two primary outcomes: the proportion of patients with at least one further episode; and the number of further admissions for self-poisoning per individual.

METHOD

The study methods have been previously reported in detail (Carter *et al*, 2005).

Setting

The Hunter Area Toxicology Service (HATS) is a regional toxicology unit at the Newcastle Mater Misericordiae Hospital, New South Wales, Australia, serving a primary referral population of 385 000 adults and a tertiary referral population of a further 170 000. All poisoning presentations to emergency departments in the greater Newcastle region are either admitted to HATS or notified to HATS and entered prospectively into a clinical database (Whyte *et al*, 1997, 2002). The HATS model of service delivery means that in (virtually) all cases of self-poisoning in the catchment area the person is brought to the Newcastle Mater Hospital for treatment and in all cases the person is formally admitted under the care of HATS. The psychiatry department sees all such patients for assessment and diagnosis, and to determine discharge destination and follow-up. Details of the model of service for these patients have been described by Whyte *et al* (1997).

Study population

Patients aged 16 years or over who presented to HATS during the recruitment period (April 1998 to December 2001) were potentially eligible. Inclusion criteria were that the patient must be capable of informed consent, not considered to pose a threat to an interviewer, not of 'no fixed address' and with sufficient English to complete a structured interview.

Variables

The two dependent variables were the proportion of individuals who had one or more readmissions for self-poisoning and the number of readmissions for self-poisoning per individual, over 24 months. Descriptive variables were obtained from the standardised clinical assessment of the patients (Buckley *et al*, 1999) and extracted from the HATS database. The categorical variables were gender, marital status (married, including *de facto* relationships, *v.* never married, separated, divorced or widowed), employment (full-time or part-time *v.* unemployed, pensioner, student or other), intensive care unit admission, time of admission (09.00–17.00 weekdays *v.* out of hours) and discharge destination (psychiatric hospital *v.* all others). The continuous variables were age, length of stay in hours, median number of previous admissions to HATS for self-poisoning and number of psychiatric diagnoses from clinical assessment.

Study design

A randomised consent (Zelen: single consent version) design was used (Zelen,

1979, 1990). This design is a variation on the standard randomised controlled experimental design, in which participants were randomised to control or intervention before consent was sought. In the single consent version, written informed consent to receive the intervention (eight non-obligatory postcards) was sought only from participants randomised to the intervention. The outcomes were assessed by an intention-to-treat analysis based on randomisation status.

The Hunter Area Health Research Ethics Committee approved this study, including the randomised consent design.

Randomisation

Randomisation was by database (HanDBase version 2.0; DDH Software, Wellington, Florida, USA) on a personal digital assistant (Palm III; Palm, Inc., Sunnyvale, California, USA) which was populated with a pre-generated randomisation schedule (in blocks of ten) and carried by the duty toxicologist. To avoid recruiting patients more than once, identification information was searched in this database before enrolment. To maintain masking to allocation status during recruitment, randomisation was not revealed until after all information was entered and eligibility determined. Randomisation status was then revealed in order to obtain patient consent. To monitor any potential alterations (interference) a duplicate record was kept in a hidden field of the database and a copy held on a separate computer for later verification of correct randomisation status.

All other clinical and research staff were unaware of allocation.

Intervention

A new intervention was developed based on the study by Jerome Motto, which demonstrated reduced death by suicide in a psychiatric hospital in-patient population (Motto, 1976; Motto & Bostrom, 2001). The new intervention was a series of eight 'postcards' sent in a sealed envelope in months 1, 2, 3, 4, 6, 8, 10 and 12 after discharge (the postcard is shown in the online supplement to this paper). All participants received treatment as usual.

Sample size

During study planning several sample sizes were calculated based on different estimates of possible effects for the 12-month outcomes (Carter *et al*, 1999). A difference in proportions (5% significance level, 80% power) of 15% to 10% required 1364 participants, 20% to 10% required 392 participants and 30% to 20% required 293 participants. On the basis of clinical experience and previous research it was anticipated that 15–30% of the control group would self-poison again within 12 months, with an average of two episodes, meaning overall self-poisoning rates of 30–60%. A sample of 400 per group would allow detection of absolute differences between groups of 10–15% (5% significance level, 80% power) and 12–17% (5% significance level, 90% power), yielding relative risks of 0.67–0.75 and 0.60–0.72 (80% and 90% power respectively). This sample size would be adequate to detect differences in the proportion of participants who had any episode of self-poisoning of 7–9% (80% power) and 8–10% (90% power and 5% significance level), which we considered would represent a clinically significant reduction.

Statistical analyses

Data were analysed using the computerised statistical packages SPSS version 10.0 and Intercooled Stata versions 7 and 8. The difference in proportions of participants with any readmission for self-poisoning was tested with χ^2 analyses. For the number of readmissions per individual, a negative binomial regression was undertaken to compare the risk of self-poisoning events per individual in the postcard group relative to the control group and is reported as incidence risk ratio (IRR) with 95% confidence intervals. Two subgroup analyses, using negative binomial models, were undertaken for the treatment effect for male and female groups, since a *post hoc* analysis of 12-month outcomes suggested a gender effect (Carter *et al*, 2005).

Intent to treat

We assessed 922 patients for eligibility, of whom 150 (16%) were ineligible (Fig. 1), leaving 772 potential participants (control

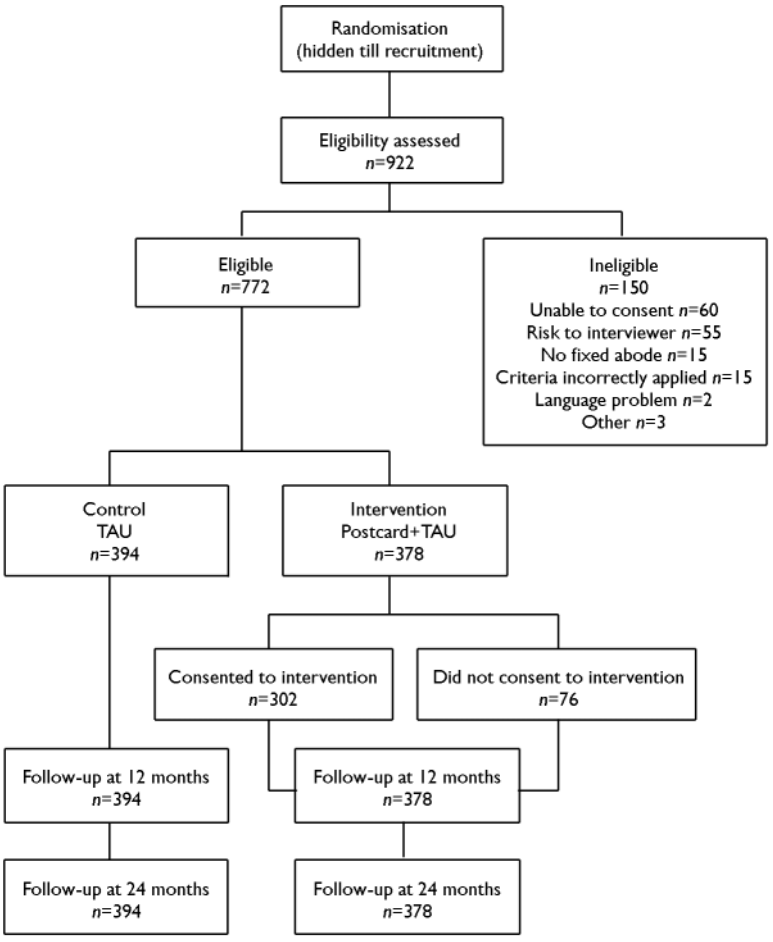

Fig. 1 Study profile (TAU, treatment as usual).

group n=394 intervention group n=378). Among the intervention group, 76 refused the intervention, 1 missed the intervention as planned and 32 did not receive the full intervention (this was due to these people being unavailable, their postcards being returned 'not known at this address – return to sender'). Twenty people in the control group received the intervention owing to clerical errors, but were retained in the control group as data were analysed as intention to treat, based on randomisation.

RESULTS

The characteristics of the sample at baseline are summarised in Table 1. Previous episodes of hospital-treated self-poisoning were recorded for 17% of the total sample, (129/772), 17% of the control group (66/394) and 17% of the intervention group (63/378). The frequency of the poisoning subtypes were: pharmaceuticals only, 473 (61%); pharmaceuticals plus alcohol, 217 (28%); opioid or amphetamine, 20 (3%); carbon monoxide, 17 (2%); herbicide or rodenticide, 11 (1%); insulin, 7 (1%); self-poisoning with additional self-harm 23 (3%); and unknown poison, 4 (1%).

Proportion of sample repeating self-poisoning

In the intervention group 21.2% (80/378; 95% CI 17.0–25.3) had one or more re-admissions for self-poisoning compared with 22.8% (90/394; 95% CI 18.7–27.0) in the control group 24 months after baseline, a non-significant difference (χ^2=0.317, d.f.=1, P=0.57), the difference between groups being −1.7% (95% CI −7.5 to 4.2).

Number of repeat admissions

There were 310 cumulative readmissions in the control group and 145 in the intervention group (Fig. 2). Table 2 shows the relative risks for the intervention group compared with the control group from the negative binomial regressions. The risk of repetition was statistically significantly lower in the intervention group (IRR=0.49, 0.49, 95% CI 0.33–0.73). Separate subgroup analyses by gender showed the treatment was effective for women (IRR=0.49, 95% CI 0.30–0.80) but not for men (IRR=0.97, 95% CI 0.50–1.88. Readmissions by intervention group and gender are shown in Table 3.

Table 1 Characteristics of the study sample

	Missing data *n*	Total sample (*n*=772)	Control group (*n*=394)	Intervention group (*n*=378)
Categorical variables, *n* (%)				
Female	1	524 (68)	291 (74)	233 (62)
Married[1]	31	256 (35)	118 (31)	138 (38)
Employed	153	162 (26)	88 (27)	74 (26)
Admitted to intensive care	0	113 (15)	60 (15)	53 (14)
Admitted outside office hours	0	581 (75)	296 (75)	285 (75)
Discharged to psychiatric hospital	2	208 (27)	106 (27)	102 (27)
Previous admission for self-poisoning	0	129 (17)	66 (17)	63 (17)
Continuous variables, median (Q1–Q3)[2]				
Age, years	0	33 (24–44)	34 (23–45)	33 (24–42)
Length of stay, h	0	18 (12–30)	18 (13–31)	17 (12–29)
Number of prior self-poisoning admissions	0	0	0	0
Number of psychiatric diagnoses	0	2 (1–2)	2 (1–3)	2 (1–3)

1. Includes *de facto* relationships.
2. First quartile–third quartile.

DISCUSSION

Strengths and weaknesses of the study

This study had several strengths. First, a randomised consent design was used, which was suited to this study and this clinical population. In this study the baseline characteristics and principal outcomes were tracked by the HATS database, allowing for complete follow-up. Second, the quality of the randomisation was strong, with randomisation undertaken using a handheld personal computer device in combination with another computer which could detect any errors of allocation status and interference with the randomisation. Third, all participants, clinicians and research staff were masked to the primary outcome measurement; only the recruiting toxicologists and the secretary responsible for managing the mailing database and postcards were aware of allocation status. Owing to the randomised design, the quality of masking to allocation and to outcome, and the service model of HATS in which all cases of self-poisoning are admitted to hospital, we believe that there are few threats to internal validity in this study.

There were some limitations to consider for this study and caution needs to be used when interpreting the results. Less than a quarter of the participants self-poisoned a second time, and a subgroup showed a highly skewed pattern of more than one repeat episode. It is not known to what extent the HATS referral population and model of clinical service (Whyte *et al*, 1997) would be generalisable to other settings. This study investigated patients who self-poisoned and the results cannot necessarily be generalised to patients with other forms of self-harm. We do not currently have data available on mortality and suicide outcomes for the study participants. A previous longitudinal study in our centre found a 1% suicide rate after 24 months and nearly 2% suicide rate after 5 years, which would translate to 8 suicide deaths and 16 suicide deaths respectively (Reith *et al*, 2004). These suicide rates are lower than the 12-month 1.8% rate reported in a recent meta-analysis of psychosocial interventions after self-harm (Crawford *et al*, 2007). We intend to be able to report the mortality and suicide outcomes for the 5-year follow-up of the Postcards from the EDge project in the future.

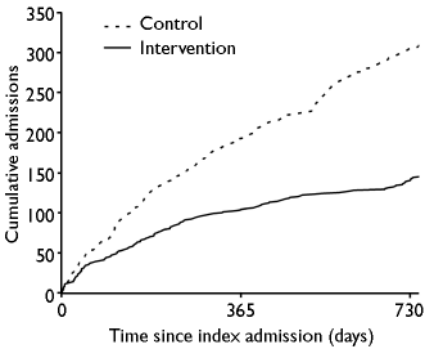

Fig. 2 Cumulative readmissions to hospital for treatment of self-poisoning (24 months; unadjusted for multiple admissions).

Table 2 Negative binomial models for 24-month outcomes for intervention effect on number of readmissions for self-poisoning and for subgroup analyses by gender

	Incidence risk ratio			Wald test	
	IRR	s.e.	95% CI	*Z*	*P*
Whole sample, unadjusted (*n*=772)					
Control	1.00				
Intervention	0.49	0.10	0.33–0.73	−3.51	0.010
Men (*n*=247)					
Control[1]	1.00				
Intervention	0.97	0.33	0.50–1.88	−0.09	0.929
Women (*n*=524)					
Control[1]	1.00				
Intervention	0.49	0.12	0.30–0.80	−2.87	0.004

1. One control group participant with missing data for gender (13 readmissions) is not included in either gender subgroup analysis.

Replications of this study and additional effectiveness trials would be necessary before widespread implementation could be considered. The decision to include a subgroup analysis based on gender was a *post hoc* one based on the findings from the primary outcomes at 12 months. Caution should always be used in interpreting such subgroup analyses because of (unplanned) reduced sample sizes, and judgement needs to be exercised regarding the biological plausibility of such analyses. There may also have been a conservative estimate of treatment effect because 20 persons in the control group were inadvertently exposed to the intervention, whereas 76 persons in the treatment group did not consent to receive the intervention and a further 32 persons were not exposed to the intervention.

Implications of the study

The simple postcard intervention used in this study was previously shown to have nearly halved the number of readmissions for self-poisoning within 12 months: IRR=0.55, 95% CI (0.35-0.87) (Carter *et al*, 2005). This study of 24-month outcomes showed that this benefit was maintained for a further 12 months after the final contact by postcard: IRR=0.49, 95% CI 0.33–0.73. There were 422 bed-days used by the control group and 183 bed-days used by the postcard group, a total of 239 bed-days saved. This represented a considerable ongoing saving in opportunity costs, availability of hospital beds and decrease in emergency department workload. This low-cost intervention seems to have substantial cost-effectiveness. The simplicity of the intervention means that it could be delivered from hospitals that do not have extensive resources. The difference in total readmissions for self-poisoning came from one main source – women with three or more repeat admissions (see Table 3) – which accounted for a difference of 165 repeat admissions (210 in the control group and 45 in the intervention group).

Benefit of treatment beyond the treatment phase

One other study (*n*=101) has shown a significant reduction in self-harm over a 24-month period (12 months after treatment cessation): 23% *v.* 46% (Linehan *et al*, 2006). That study used dialectical behaviour therapy to treat women with recent self-harming behaviour who met criteria for borderline personality disorder. This therapy is an important form of treatment for a subset of patients who self-harm, although it is not applicable universally to the hospital-treated population. One further study (*n*=44) has shown a sustained reduction in self-mutilation (23% *v.* 68%) and suicide gesture (18% *v.* 63%) over 36 months, 18 months after treatment cessation (Bateman & Fonagy, 2001). That study used a psychoanalytically informed day hospital programme in patients with borderline personality disorder. Both of these studies suggested that longer-term alternative behaviours to self-harm were learned, such as improvement in coping strategies, emotion regulation, impulse control, self-understanding or relationship quality, which resulted in the maintenance of the beneficial effects (Bateman & Fonagy, 2001; Linehan *et al*, 2006). A third study of self-poisoning patients (*n*=119), using a brief, nurse-led psychological intervention in the patient's home, found the intervention group less likely to report repeated attempts to harm themselves at the 6-month follow-up (9% *v.* 28%; Guthrie *et al*, 2001). Beneficial effects on repetition sustained beyond the duration of the intervention might have been mediated by other beneficial effects on suicidal ideation and treatment satisfaction. All three of these studies used highly selected subgroups within the hospital-treated self-harm population, either people

Table 3 Number of repetitions of self-poisoning by gender and experimental group

Number of repetitions	Control group (*n*=394)[1]				Intervention group (*n*=378)			
	Men (*n*=102)		Women (*n*=291)		Men (*n*=145)		Women (*n*=233)	
	n (%)	Total repetitions	*n* (%)	Total repetitions	*n* (%)	Total repetitions	*n* (%)	Total repetitions
None	83 (81)	0	221 (76)	0	119 (82)	0	179 (77)	0
One	14 (14)	14	34 (12)	34	19 (13)	19	32 (14)	32
Two	3 (3)	6	12 (4)	24	4 (3)	8	14 (6)	28
Three or more	2 (2)	9	24 (8)	210	3 (2)	13	8 (3)	45

1. One control group participant with missing data for gender had 13 readmissions.

with borderline personality disorder (Bateman & Fonagy, 2001; Linehan *et al*, 2006) or a group of only 119 participants from an initial sample of 587 patients presenting with self-poisoning (Guthrie *et al*, 2001), which makes comparison with our study more difficult. However, these four studies taken together suggest that if some impact on reduction of repetition of self-harm or self-poisoning behaviour can be made, then perhaps the effects might be sustained over a period beyond that of the intervention.

Although it may also be inferred that some participants in our study learned sustained alternative behaviours to self-poisoning, there was no particular component of the intervention that aimed to induce these specific behavioural changes. The mechanism for the long-term benefits in the Postcards from the EDge study remains speculative. We have planned a qualitative study to explore the question of what mechanisms might have contributed to this. We also do not know whether there was any change in the pattern of psychiatric hospital, psychiatric community service or primary care service use that might have been a mediating factor in the difference in repetition events, but we hope to be able to explore some of these possibilities in the planned 5-year follow-up study.

Comparison with other brief interventions

There are other brief interventions for repetition of hospital-treated self-harm or self-poisoning that can be considered. One of the best-known low-cost interventions for self-harm in the UK was the green card study and the subsequent crisis telephone card study, which showed no difference in the proportion of those repeating self-harm at 6 months (Evans *et al*, 1999) or at 12 months (Morgan *et al*, 1993; Evans *et al*, 2005). The first of these studies (n=212) was underpowered and included only those presenting for the first time with self-harm, who subsequently showed a repeat rate of self-harm of only 8% (Morgan *et al*, 1993). The second variation (n=827) was adequately powered, used a self-harm case register to define repetition, and found no difference in proportions of those repeating self-harm, with a 12-month repetition rate of 20% (Evans *et al*, 2005). In France, a telephone contact intervention delivered either 1 month or 3 months after an episode of self-poisoning showed no difference in the proportion of a combined 'adverse effects' outcome or proportion of self-reported suicide attempt (Vaiva *et al*, 2006). That study (n=605) was adequately powered, used a stratified (based on more than four suicide attempts in 3 years), three-arm design and had a 12-month repeat attempted suicide rate of 17%. A multicentre UK study used a manual-assisted cognitive–behavioural therapy intervention for established cases of repeated self-harm and showed no difference in proportion of those with self-reported repeat parasuicide (Tyrer *et al*, 2003). This study (n=480) was adequately powered (for an expected repetition rate of 45%), used a stratified (based on parasuicide score) design and had a 12-month parasuicide rate of 43%. The comparison condition for these studies was standard treatment or treatment as usual and for the Postcards from the EDge study it was postcards plus treatment as usual *v.* usual treatment alone. Each of these studies showed a similar non-significant reduction in the proportion of those repeating self-harm (patient rate) of 2.2–7.0% (Crawford & Kumar, 2007). However, none of these studies of brief, low-cost interventions analysed the number of episodes of repeated self-harm (event rates) as an outcome, and most used different definitions of the primary outcome and different methods of estimating the rates of that outcome, so comparison with the beneficial finding from the Postcards from the EDge study is difficult despite the similarities of intent underlying the interventions.

Concluding remarks

This study of hospital-treated self-poisoning showed that a low-cost postcard intervention was effective in reducing the number of events per individual by a relative reduction of more than 50%, which was clinically and statistically significant. The postcard intervention continued to be effective in reducing repeat episodes of hospital-treated self-poisoning for 1 year after the intervention ceased.

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The decline in Australian young male suicide

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Abstract

Since the late 1990s there has been a sharp downward trend in Australian young male suicide. It is possible that a major government youth suicide prevention initiative, the National Youth Suicide Prevention Strategy (NYSPS), implemented during 1995–1999 may have influenced the decline. In this article, we examine time trends in age- and means-specific male and female Australian suicide rates in relation to unemployment rates and the NYSPS. Based on Australian suicide data over the period 1966–2003, we assess secular changes in the 20–24 year male suicide to total (crude) male suicide rate ratio in relation to the NYSPS, using interrupted time series analysis (ARIMA), since this was previously found to be significantly associated with the 20–24 year male unemployment to total employment ratio.

Results show that a dramatic reduction in Australian young male (aged 20–34 years) suicide has occurred since 1997–1998, declining from approximately 40 per 100,000 in 1997–1998 to approximately 20 per 100,000 in 2003. Most of the decline is due to a decrease in suicide by hanging and to a lesser extent from motor vehicle carbon monoxide and other gases. Further, the previously established strong secular association (lasting over 3 decades from 1966) between the rate ratio of 20–24 year male suicide to total (crude) male suicide, and the rate ratio of 20–24 year male unemployment to total unemployment, appears to have been disrupted. ARIMA modelling of the suicide ratio against the initiative indicates a highly significant statistical association between the NYSPS and the suicide ratio reduction but not between the NYSPS and the unemployment indicator trend, suggesting a break in the link between young male suicide and unemployment. The recent sudden turnaround in Australian young male suicide trends and its extent appears to preclude explanations centring on slow-moving social indices traditionally associated with suicide, or on possible cohort effects. This sudden decrease has occurred mainly in non-impulsive means, and at the same time has broken a long-standing secular link between 20 and 24-year-male suicide and unemployment, lending plausibility to the case for the NYSPS having had an impact on young male suicide in Australia.

Keywords: Suicide; Unemployment; Youth; Australia; Prevention; Men

Introduction

Suicide rates in younger males through the 1970s and 1980s to the 1990s increased in many Western countries including the UK, New Zealand and Australia (Levi et al., 2003), but in some countries have decreased since the mid-1990s, for example 15–19-year-old male rates in the USA (Bridge,

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Barbe, & Brent, 2005). In 1993, two of the authors (SM, RT) investigated the aggregate relationship between suicide and unemployment in Australia over 1907–1990 and found a strong serial correlation between the rate ratio of 20–24 year male unemployment to total unemployment, and the rate ratio of 20–24 year male suicide to total (age-standardised) male suicide (Morrell, Taylor, Quine, & Kerr, 1993). These ratios originally covered the period 1966–1990—age- and sex-specific unemployment rates were first collected systematically in Australia only in 1966. The amount of variation in the 20–24 male suicide rate ratio explained by the 20–24 male unemployment rate ratio was found to be 80%, equivalent to a Pearson correlation coefficient of ≈ 0.9. At the time we interpreted this finding *post hoc* in Durkheimian terms, suggesting that relative unemployment levels may have more bearing on young male suicide risk than absolute unemployment levels because they are even more marginalised than older unemployed males (Morrell et al., 1993). The relationship may not hold in times when measured unemployment is quite high or quite low (currently). During the Great Depression for example, the relationship between relative unemployment and suicide rates was weaker (Morrell, Page, & Taylor, 2001). Presently under low unemployment conditions there may be fewer unemployed young people who really want to work and feel bad about not working, i.e., different selection effects may occur depending on extant economic conditions.

Subsequently, we updated the young male unemployment/suicide relationship to cover 1966–1996 (Morrell, Taylor, & Kerr, 1998), this time with the 20–24 year male suicide rate expressed as a ratio of the crude male suicide rate. The strong correlation with the unemployment rate ratio remained when updated again to cover 1997 (Morrell et al., 2001). This secular relationship between unemployment and suicide did not hold nearly as strongly for other male age groups and did not exist at all for females (Morrell et al., 1993). However, as the association was found to be strongest in males aged 20–24 years, a significant change or break in this particular correlation is easier to show than breaks or changes to already weak associations found in other sub-groups.

Overwhelmingly, studies of socio-economic status, including employment status, and suicide have been aggregate in nature. A recent systematic literature review of aggregate studies of suicide and socio-economic status noted that despite some heterogeneity in findings, "(1) the strongest association between aggregate suicide rates and the socio-economic level of area of residence occurs at the community or neighbourhood level, where suicide rates increase as socio-economic levels decrease; and (2) that area suicide rates are most strongly associated with the proportion of residents that are living below the poverty level (or similar measures of economic deprivation)"(Rehkopf & Buka, 2006).

Clearly unemployment rates are a valid measure of economic deprivation, which poses the question of attribution in the case of significant disruptions or modifications in already established aggregate temporal associations between unemployment and suicide rates.

In 1995, the Australian Commonwealth Government began to fund several dozen youth suicide prevention initiatives, under the rubric of the National Youth Suicide Prevention Strategy (NYSPS), in which key health and social service providers for young people (especially those interacting with young people aged 15–29 years) were resourced to implement and integrate youth suicide prevention programs into their service profiles. Individual projects varied widely but received funding over the 1997–1999 period based on merit, with post-funding sustainability a key criterion. A summary of these projects can be found in Australian Institute of Family Studies (2000) and a 'stocktake' of most Australian suicide prevention initiatives found in *AusEinet* (2000). Each NYSPS-funded project had an evaluation component, centring mainly on process or impact evaluation, not outcome evaluation. At the time, the knowledge on which youth suicide public health prevention measures actually worked was rather limited (Gunnell & Frankel, 1994) and consequently a variety of approaches were tried. Some projects were national in scope, others local, and some, in limited ways, were shown to work and others not. However, it was also immediately apparent that the overall effects of the interventions could not easily be assessed, if at all, since suicide is such a rare event. Certainly some individual funded projects had sufficient statistical power to detect an effect on intermediary or prognostic indicators of suicidality (for example, repeat attempted suicide rates or emergency room readmission rates), but the main aim of suicide reduction in young people was viewed to be beyond evaluation, at least in the short and medium terms.

One approach to this question would be to examine if the prevention measures overall may have had some impact on aggregate national secular trends in suicide in the targeted group, especially if there exists an indicator which is sensitive to change. One such indicator is the secular correlation between the 20 and 24-year-male suicide rate ratio and the 20 and 24-year-male unemployment rate ratio. If a sharp decline in young male suicide occurred but its strong correlation with unemployment remained (movements in unemployment rates can also be sudden), then this would be evidence for the intervention *not* being associated with the downturn; the suicide decline would be more a reflection of improved employment prospects for this group and not the intervention. Of course this approach cannot 'prove' causation, but it can at least be used to rule in or out the possibility that the suicide prevention initiative did have some aggregate association with suicide in young people. Conversely, if any changes in suicide rates have also been accompanied by changes to the particular socio-economic relation found already in 20–24 year male suicide rates, then this would indicate fulfilment of a necessary but not sufficient condition for the success of the initiative. Accordingly, we examined trends in 15–34 year suicide for Australia overall by sex and by method of suicide, and extend to 2003 an examination of the strong secular association found previously between 20 and 24-year-male suicide and unemployment to see if this particular socio-economic link with suicide has remained.

Methods

Suicide data were obtained from the Australian Bureau of Statistics (ABS) for 1976–2003 and from Commonwealth Year books for 1966–1975. Age-specific suicide rates for males and females aged 15–34 years by 5-year age-group were calculated for each year 1966–2003, along with total male suicide rates (crude) to calculate the 20–24 year to total male suicide rate ratio.

The 20–24-year male suicide ratio was calculated for each year of 1966–2003 as the 20–24 year male suicide rate divided by the total (crude) male suicide rate. The 20–24 year male suicide rate per 100,000 males, and rate ratios of 20–24 year male unemployment and suicide were plotted separately for 1966–2003. Unemployment rates by sex and age group were obtained from the electronic time series collection, *AusStats* (Australian Bureau of Statistics, 2005). The unemployment rate for each year, by convention taken as that occurring in August, was obtained for males aged 20–24 years and for all persons. A ratio of the male 20–24 year unemployment rate to the total all-persons unemployment rate was calculated for each year 1966–2003.

Method-specific suicide rates were also examined, based on ICD-9 (for 1979–1998) and ICD-10 (for 1999–2003) cause-of-death classification systems (World Health Organisation, 1976, 2006) to determine if the prevention initiative was associated with changes in rates of suicide by particular means. Means examined were hanging and motor vehicle exhaust and other gases. Following the implementation in 1999 of ICD-10 cause-of-death coding in Australian mortality data, it was not possible to calculate separate rates of suicide by motor vehicle exhaust gas since ICD-10 classifies suicide by motor-vehicle exhaust gas under Code X67, "Intentional self-poisoning by and exposure to other gases and vapours" (World Health Organisation, 2006). Accordingly, suicide trends in this broader category were examined for the whole period 1979–2003.

Statistical assessment of the association between the NYSPS and changes in suicide was by interrupted time series analysis of (i) the young male suicide rate ratio against the prevention initiative (as a step function: $=0$ for 1966–1996, $=1$ for 1997–2003); and (ii) the young male unemployment rate ratio against the prevention initiative. The purpose of this was to test for a possible change in the relationship between the suicide and unemployment rate ratios. In other words, if there is a significant association between the prevention initiative and the suicide rate ratio, but not with the unemployment rate ratio, then this would indicate a breaking of the 30-year secular correlation between the unemployment and suicide rate ratios in 20–24-year Australian males. Otherwise, the link remains and the NYSPS can with high probability be ruled out as being associated with suicide reductions in young people. Proc ARIMA (AutoRegressive Integrated Moving Average) in SAS v 8.2 was used for the time series modelling, to account for secular trends and underlying autoregressive and moving average processes in time series (SAS Institute, 1999). An autoregressive process is where a value at one point in time is correlated with value(s) for previous time point(s). A moving average process is when the value at a given time point is correlated with random error(s) or shocks, technically known

as 'white noise error terms', from previous time point(s).

Results

Suicide rates in 20–24 year old males increased from around 15 per 100,000 in the mid-to-late 1960s ($n \approx 60$–70 annually) and exceeded 40 per 100,000 ($n = 284$) by 1997 (Fig. 1). A steep decline followed, to about 21 per 100,000 in 2003 ($n = 152$). The trend in 25–29 year old males was similar, especially from the mid-1970s, while the trend in 30–34 year old males was also similar, but with somewhat attenuated fluctuations, with the recent suicide decline occurring post 1998. In contrast, suicide rates in 15–19 year old males declined from a peak in 1988 of 21 per 100,000 ($n = 155$) to 12 per 100,000 in 2003 ($n = 81$). The steep suicide declines in the 20–34 year age groups commenced 1–2 years after the suicide prevention initiative was inaugurated in 1995, and contrast with only a moderate decline in the $\geqslant 35$ year old remainder. Female suicide among 15–34 year old age groups showed no discernible trends, especially from the mid-1970s (Fig. 2), with the wide stochastic variation reflecting small suicide event numbers in females (≈ 140–190 suicides annually in females aged 15–34 years). In particular, there appears to have been no significant change in 15–34 year old female suicide rates since the suicide prevention initiative of 1995–1999.

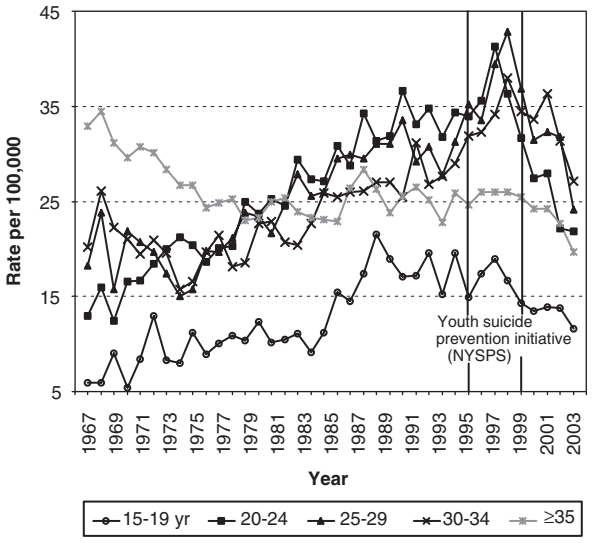

Fig. 1. Suicide in 15–19, 20–24, 25–29, 30–34 and $\geqslant 35$ year old males, Australia 1966–2003.

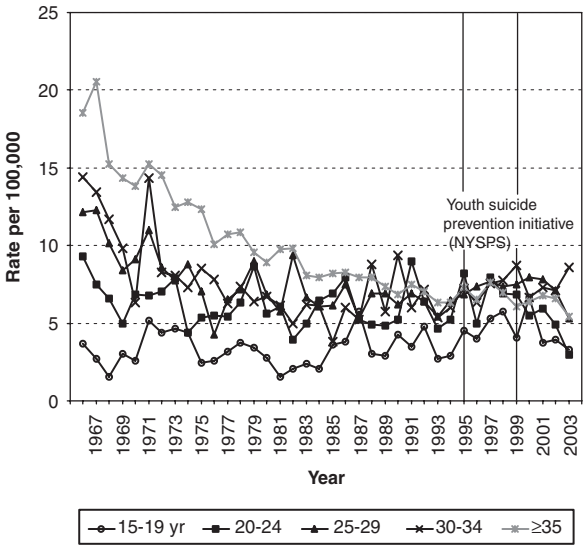

Fig. 2. Suicide rates in 15–19, 20–24, 25–29, 30–34 and $\geqslant 35$ year old females, Australia 1966–2003.

Reduced suicide in 20–34-year old males is largely from a decline in suicide by hanging (decreasing from approximately 21 per 100,000 in 1998 to 14 per 100,000 in 2003) and, to a lesser extent, from motor vehicle exhaust and other gases (Fig. 3). Suicide by firearms (not shown) continued to decline over this period (to reach approximately <2 per 100,000 for the 20–34 age group), but showed no similar sharp decrease to hanging, gas or overall for the post-1997 period. There was a similar peak in female hanging suicide as in males after 1998 (3–5 per 100,000), with a subsequent decline from 2000 onwards (not shown).

The strong secular association between the rate ratio of male 20–24 year old suicide to total (crude) male suicide, and the rate ratio of male 20–24 year old unemployment to total unemployment, appears to have been broken by 1998 (Fig. 4). The 20–24 year old-to-total male suicide rate ratio declined from over 1.8 in 1997 to under 1.4 in 2003, while at the same time the 20–24 year old male-to-total employment rate ratio remained at around 1.8.

The extent of the aggregate associations between the suicide prevention initiative and the 20–24 year old male suicide and unemployment rate ratios are shown in the regression model output (Table 1). After differencing by one lag to eliminate secular trend, both time series were best characterised as order 1 moving average (MA(1)) processes, meaning for both the suicide and unemployment rate ratios that any given year in each series was most strongly

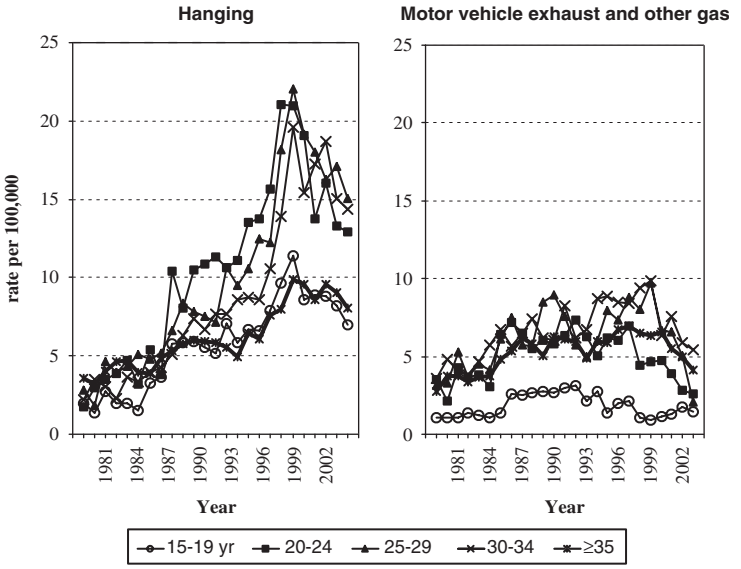

Fig. 3. Suicide rates by hanging and by other gases and vapours including motor vehicle exhaust gas, males aged 15–19, 20–24, 25–29, 30–34 and $\geqslant$35 year old males, Australia 1979–2003.

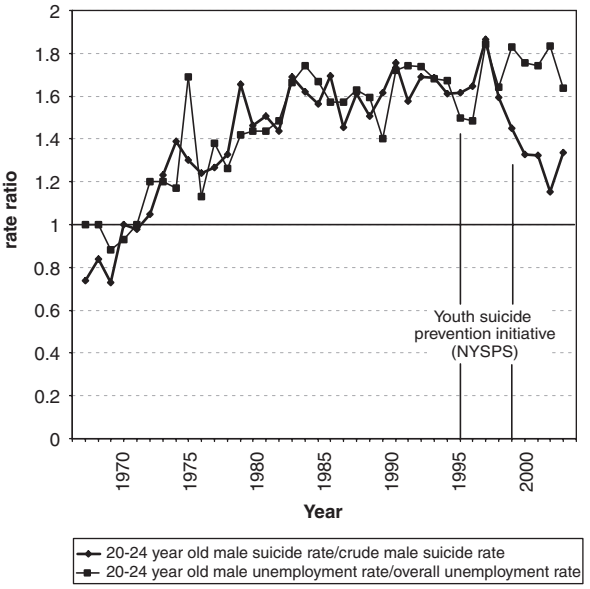

Fig. 4. Ratios of 20–24 year old male suicide rate to total crude male suicide rate and of 20–24 year old male unemployment rate to total unemployment rate, 1966–2003, Australia.

correlated to random shocks to the previous year's suicide rate than to the previous year's suicide rate itself. After accounting for trend and these moving average effects, the intervention initiative was highly statistically significantly associated with the 20–24 year male suicide rate ratio ($p = 0.001$), but not with the unemployment rate ratio ($p = 0.55$), reflecting the evident graphical departure of the suicide rate and unemployment rate ratios, especially after 1998 (Fig. 4).

Discussion and implications

In normal circumstances the marked decline in 20–24 year old male suicide rates would not easily be associated with youth suicide prevention initiatives. After all, suicide rates concern rare events that can vary greatly from year to year, and assessing the NYSPS initiative against these alone would not necessarily indicate its success or otherwise. Certainly there appears to be a temporal statistical association between the NYSPS and the decline in suicide rates that was dominated by the hanging suicide reduction in younger males aged 20–34 years. The suicide decline in the narrower 20–24-year-old male age range might simply have been a continuation of a link with unemployment that was previously shown to exist since the mid-to-late 1960s (Morrell et al., 1993, 1998, 2001). However, this association also now appears to be broken and the break occurred around the same time as the commencement of the 20–24 year old male suicide rate decline. In other words, something has halted, and to some extent reversed, the rising secular trend in 20–24 year old male suicide rates, and something has also broken the decades-long link between these and the 20–24 year old male unemployment rate.

Table 1
Results of interrupted time series analysis for possible effects of youth suicide prevention initiative on (i) ratios of 20–24 year old male suicide rate to total (crude) male suicide rate, 1966–2003; and (ii) ratios of 20–24 year old male unemployment rate to total unemployment rate, 1966–2003

Variable	Parameter estimate	Standard error	t-value, p[a]
(i) *20–24 year old male suicide rate ratio*[b]			
Suicide rate ratio Mu	0.0319	0.0106	3.01, .0049
Suicide rate ratio MA1,1	0.5690	0.1454	3.91, .0004
Prevention initiative (= 0/1 < / ⩾ 1997)	−0.1036	0.0288	−3.59, .0010
(ii) 20–24 year old male unemployment rate ratio[c]			
Unemployment rate ratio Mu	0.0235	0.0075	3.14, .0034
Unemployment rate ratio MA1,1	0.7525	0.1170	6.43, <.0001
Prevention initiative (= 0/1 < / ⩾ 1997)	−0.0149	0.0247	−0.60, .5519

[a]Approximate p-value.
[b]Ratio of 20–24 year old male suicide rate to total (crude) male suicide rate.
[c]Ratio of 20–24 year old male unemployment rate to total (persons) employment rate.

The decline in 25–34 year male suicide rates was similar but less so in males aged 15–19 and ⩾35 years. Accordingly, three rather important necessary (but not sufficient) conditions have been fulfilled to suggest the plausibility of youth suicide prevention measures having had some effect on young male suicide.

Implemented over 1995–1999, the NYSPS allocated AUS$31 million to promote a public health approach to reducing suicide and attempted suicide in young people (Australian Institute of Family Studies, 1999, 2000). In particular, the strategy was directed at youth-specific health and social service providers to establish or augment their suicide prevention activities, system-level policies and capacity building. Primary prevention programs included measures to enhance capacity for early intervention and crisis intervention, and secondary and tertiary prevention initiatives including treatment, support and postvention. System-level initiatives centred on policy and planning, research and evaluation, development and dissemination of good practise guidelines, education and training, intersectoral collaboration, restricting access to means, and community development. About 70 such projects were funded by the NYSPS, and a key criterion for funding was sustainability so that measures undertaken would continue after the initial funding had expired. Most funded projects commenced in 1997 or after, and some key funding recipients included *Lifeline*, *Here for Life Suicide Prevention Program*, and *Cellblock Youth Health Service*.

A summative evaluation of the strategy acknowledged that the funding had most likely improved the capacity of services to implement primary prevention and early intervention programs in the community and health sectors, but concluded that there was no evidence that the strategy had led to, or was associated, with reductions in suicidal behaviour or suicide in young people (Australian Institute of Family Studies, 2000). It should be borne in mind that this evaluation report appeared in 2000, somewhat early for an examination of secular trends in youth suicide before and after the NYSPS, especially as death data in Australia do not become available for research purposes for at least 18 months following official vital registration. However, with the added benefit of a few more years of hindsight it is clear that the NYSPS was not associated with any changes in female suicide (see Fig. 2). This is partly due to the infrequency of female suicide in Australia compared to males (about one-fifth as frequent) and partly due to the fact that funding would have been directed more toward higher priority areas including young marginalised or Indigenous males.

Whether further aggregate evidence may be found that the suicide prevention measures have actually caused, or were 'responsible' for a reversal in the increasing secular trend in young male suicide is another question. For instance, a number of studies have correlated antidepressant use with suicide (Isacsson, 2000; Olfson, Shaffer, Marcus, & Greenberg, 2003) including a recent Australian cross-sectional study of age-specific antidepressant use and suicide (Hall et al., 2003). However, the beneficial effect of antidepressants in the Australian study mainly was confined to older age groups (Hall et al., 2003). Also, the increasing secular trend in

antidepressant use in Australia has been gradual over the 1990s, and does not correlate strongly with the sharp turnaround in young male suicide in 1997.

Another often mooted possibility is recent gun control legislation, implemented in 1996 shortly following the Port Arthur tragedy in which 35 tourists were murdered in a shooting spree by a lone gunman (Dudley, Cantor, & de Moore, 1996). However, firearm suicide rates had been declining steadily for most of the 1980s and 1990s prior to this legislation, with hanging as a main substitute, and no substantial further firearm suicide decrease followed the implementation of the 1996 gun control legislation which, moreover, outlawed semi-automatic weapons (when a single shot generally suffices for suicide). Furthermore, the large decrease in Australian young male suicide mainly has come from hanging suicide, a less impulsive method not amenable to legislative measures that overwhelmingly aim to restrict access to means. It could be argued at an individual level that suicide prevention measures such as cognitive behavioural therapy would be less effective against impulsive means like firearms, jumping or single motor vehicle fatality, especially when fuelled by alcohol, and more effective against means which require more planning, pre-meditation and thought, such as suicide by hanging or from motor vehicle exhaust or other gases. As Fig. 3 shows, the decline in suicide by motor vehicle exhaust and other gases, while not as dramatic in absolute terms as hanging, has nevertheless also shown a similarly large proportional decline in young males since 1997–1998.

Further possible reasons for the dramatic reduction in young male suicide rates are less easy to pinpoint. For instance, cohort effects would not be associated with such a dramatic short-term change post 1997, since cohort effects act more gradually. In any case, a recent analysis covering the 19th and 20th century found little evidence of cohort effects in NSW suicide (Morrell, Page, & Taylor, 2002). Similar arguments apply to other slow-moving social indicators known to be associated with suicide, including marriage/divorce rates, fertility rates, drug and alcohol consumption rates, levels of religiosity and so on.

While there have been recent reductions in overall unemployment rates in Australia, to levels not seen since at least the early 1980s, the rate ratio of 20–24 year male to overall unemployment has remained high ($\approx$1.8), but the corresponding male suicide rate ratio has departed from its close secular association with unemployment for the first time since the mid-1960s. It might be argued that the government's imposition of a 'work-for-the-dole' scheme on the unemployed has produced the desired Durkheimian effect of increased levels of 'inclusion' and 'regulation', especially in the lives of younger unemployed people. 'Work for the dole' was instituted ostensibly to tackle the deleterious effects on the 'work ethic' of the long-term unemployed in particular. While this explanation has superficial appeal, given that specific job-search interventions have also been shown to reduce psychological morbidity in the unemployed (Price, Van Ryn, & Vinokur, 1992), such schemes generally have been shown to be of limited efficacy in reducing the characteristically high levels of psychological morbidity associated with being unemployed, especially when the activity involves temporary job placements (Branthwaite & Garcia, 1985). In Australia 'work-for-the-dole' initially targeted 18–24 year old unemployed people (in 1998) with temporary work, usually 6-month placements in community and in private employment settings, as well as other 'voluntary' activities which was extended to older unemployed people (aged 25–39 years) only in 2000, (http://www.aph.gov.au/library/intguide/sp/dole.htm) after the turnaround in male suicide rates in these older age groups. Also, after 1999 the NYSPS became the National Suicide Prevention Strategy (NSPS) with a brief to prevent suicide in a broader age range, but using the same overall strategy as the NYSPS. While the NSPS might be expected to have had a somewhat more diluted effect on young male suicide rates, the delayed reduction in suicide rates in the targeted older (25–34 years) male age groups, occurring post 1998, is consistent with the prevention strategy affecting suicide rates, since the NSPS was implemented later than the NYSPS and the reduction in suicide in the older male age groups also occurred later.

To conclude: if the fall in young male suicide rates since 1997 had occurred without a corresponding break in the long-term secular association with youth unemployment, then one would be forced to conclude that the NYSPS was not associated with the youth suicide rate reduction, since the latter would be expected to continue to vary with youth unemployment. However, the evidence is more consistent statistically and circumstantially in favour of the NYSPS plausibly being associated with

the post-1997 fall in young male suicide rates. Still, it is also clear that these findings require more research to better explain the changes in young male suicide that have recently occurred in Australia.

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ORIGINAL PAPER

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Divergent trends in suicide by socio-economic status in Australia

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Abstract *Objectives* This study investigated secular trends in socio-economic status (SES) differentials in Australian suicide (1979–2003), which includes overall declines in male suicide from 1998. *Method* Suicide rates were stratified by approximate equal-population quintiles of area-based SES for the period 1979–2003 and examined across five quinquennia, centred on each Australian Census from 1981 to 2001, to determine if (1) SES differentials in suicide have persisted over time, and (2) if SES differentials have widened or narrowed. Suicide rates (per 100,000) were adjusted for confounding by sex, age, country-of-birth, and urban–rural residence using Poisson regression models, and secular changes in SES differentials were assessed using trend tests on suicide rate ratios (low to high SES quintiles). *Results* Socio-economic status (SES) differentials persisted across the study period for both males and females after adjusting for the effects of age, migrant status, and urban–rural residence, with the largest differences between low and high SES groups evident in males, and especially young males (20–34 years). For males, suicide rates increased significantly in all SES groups until 1998, before diverging significantly in the most recent 5-year period, particularly in younger males ($P < 0.0001$). In young males, suicide rates in the most recent period increased in the low SES group from 44.8 in 1994–1998 to 48.6 in 1999–2003 (an 8% increase). In contrast, suicide rates in the middle SES group decreased from a peak of 37.3 to 33.5 (a 10% decrease), and in the high SES group from a peak of 33.0 to 27.9 (a 15% decrease). A similar statistically significant divergence of a lesser magnitude was also evident in all age males and younger females (20–34 years). *Conclusion* This study shows that SES differentials in suicide persisted in Australia for most of the period 1979–2004. The decline in suicide in young males in the most recent quinquennium was limited to middle and high SES groups, while the low SES group displayed a continued increase. The continued increase in suicide in low SES males has implications for social and economic intervention and suicide control programs.

Key words suicide – socio-economic status – secular trends – Australia

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Introduction

Secular trends in socio-economic differentials of all-cause and cause-specific mortality have been demonstrated previously, using both individual and aggregate measures of socio-economic status (SES) [1]. Persistent socio-economic inequalities in mortality have been found in the United Kingdom [11, 14, 24, 25, 30, 39], in the United States [26, 33], and in Scandinavia [17, 28]. Furthermore, these studies show that social inequalities have widened over recent decades in all cause mortality [26] and for specific causes of mortality, such as cardio-vascular disease [17, 24, 28], cancer survival [14], and accidents and external causes [24]. Significant cross-national differences in mortality have also been known for some time, with populations from higher income and more economically developed countries having longer life expectancies than in developing countries [23].

Numerous cross-sectional studies have also noted increasing suicide gradients from high to low SES [2, 10, 13, 29, 34]. Fewer have investigated secular changes in such socio-economic suicide differentials [18, 25, 38]. Of the latter, Turrell and Mathers [38] found low-to-high area-based SES suicide rate differentials to increase in Australian young males (aged

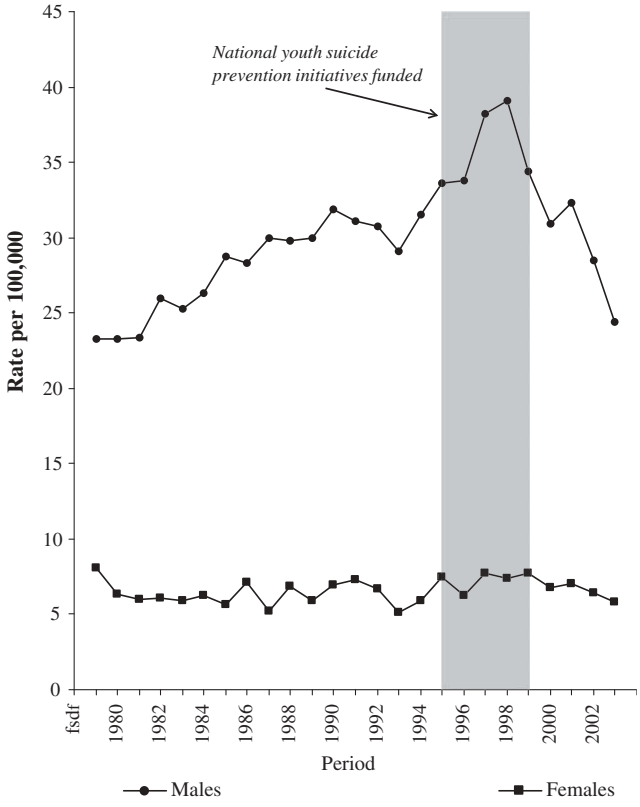

Fig. 1 Australian suicide rates in young adults (20–34 years)*. *National youth suicide prevention strategy was funded from 1995–1999

15–24 years) when comparing the two periods 1985–1987 and 1995–1997, but a decrease in SES differentials in older age groups (25–64 years) for both sexes.

The present study examines SES trends in Australian suicide over a longer period (1979–2003) to determine how socio-economic status differentials in suicide have changed during a period that has covered a (male) "youth suicide epidemic" from the 1970s into the 1990s, and a decline in suicide in the late 1990s into the 21st century (Fig. 1).

Methods

Data

Unit record suicide data were obtained from the Australian Bureau of Statistics (ABS) for the period 1979–2003. Corresponding population data for each Local Government Area were also obtained from the 1981, 1986, 1991, 1996, and 2001 Australian censuses. Key demographic factors previously shown to potentially confound the association between SES and suicide were also included in analyses. These included sex, age, country-of-birth, and urban–rural residence [36, 37].

Age was classified into 10-year groups: 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, and ≥75 years. Analyses also focussed on a younger age group (20–34 years), as it was expected that different socio-economic patterns might be evident. Many studies have investigated younger age groups, sometimes including adolescents (e.g., 15–24 years), however recent Australian suicide data have shown the highest rates occurring in young adult age groups (25–34 years) [7].

Country-of-birth groups were defined as: Australia, New Zealand, United Kingdom and Eire, Southern Europe, Western Europe, Eastern Europe and the former USSR, Other Europe, Middle East, and Asia. All remaining countries were grouped into an "Other" category. These groupings reflect the Australian immigration pattern during the study period.

Urban–rural residence was defined using the Rural, Remote, and Metropolitan Area (RRMA) classification system, which for Australian small-area data is a combination of the population density (defined as "personal distance" and calculated as an index of remoteness) and population size [16]. Similar age-adjusted suicide rates in particular RRMA categories enabled aggregation into three regions for this study: Metropolitan (capital city and other metropolitan areas); regional centres (comprising small and large rural centres), and other rural areas (combining the remaining rural classifications). Aggregation into these broad groups also minimised the effects of small-area boundary changes to rural and remote areas in more recent periods [9].

Socio-economic status was based on the economic resource index of the Socio-economic Indexes for Areas (SEIFA) developed by the ABS [5]. SEIFA indices from the 1986, 1991, 1996, and 2001 censuses are based on population characteristics of a given area in terms of income level, educational attainment, occupational status, unemployment rates, home ownership rates, dwelling size, among others [5]. The economic resource index measures the economic resources within areas (such as income and expenditure, home ownership rates, dwelling size and vehicle ownership) without reference to measures of education or occupational status.

The economic resource index was selected as the main SES study factor as it has previously been shown to demonstrate the greatest magnitude in suicide differentials (compared to the educational and occupational measure), especially for males [29]. It is also perhaps a more internally consistent proxy measure of wealth than alternative SEIFA indices that combine education and occupation factors, which can be construed as different, though related, SES constructs [19]. Migrant status and urban–rural residence are not incorporated into the economic resources index, but are included in the present study explicitly as confounders.

As SEIFA indices are not available for the 1981 census, corresponding to the earliest 5-year period in the study (1979–1983), the indices from the 1986 census were used for the earlier period. Changes to SEIFA scores over time have resulted in some areas being categorised into a different quintile, but these areas were relatively small in number (approximately 5%). For each period except 1979–1983, each area was assigned to an SES category based on information from the census for the middle year of each period, and it is unlikely that socio-economic characteristics of areas would change quickly enough over a five-year period to substantially impact upon suicide data.

The economic resource index was stratified into approximate equal-population quintiles. Preliminary analyses of SES quintiles showed similarity in suicide rates and trends between the three middle SES groups (quintiles 2, 3, and 4) and these accordingly were aggregated into a broad "Middle" SES group, with the lowest quintile remaining "Low" and the highest quintile "High."

Data were stratified into each combination of, sex, age group, country-of-birth group, regional classification, and SES quintile, with corresponding counts of suicide and population. Major changes to ABS geographic coding systems, along with significant aggregations and dis-aggregations of small-area classifications (Statistical Local Areas and Local Government Areas), have occurred over the study period. Moreover, different area coding systems between mortality and population data were used until the mid-1980s, and the same code was sometimes used for different areas when the coding systems were changed. Incomplete documentation of changes to geographic coding systems, particularly in earlier years, also occurred. To circumvent these problems, all small-area codes were resolved to their corresponding population LGA code at the closest census. Five cross-sections were produced for the periods 1979–1983, 1984–1988, 1989–1993, 1994–1998, and 1999–2003. There were 79 small-areas in the mortality data without coding documentation (representing 3% of all small-areas in Aus-

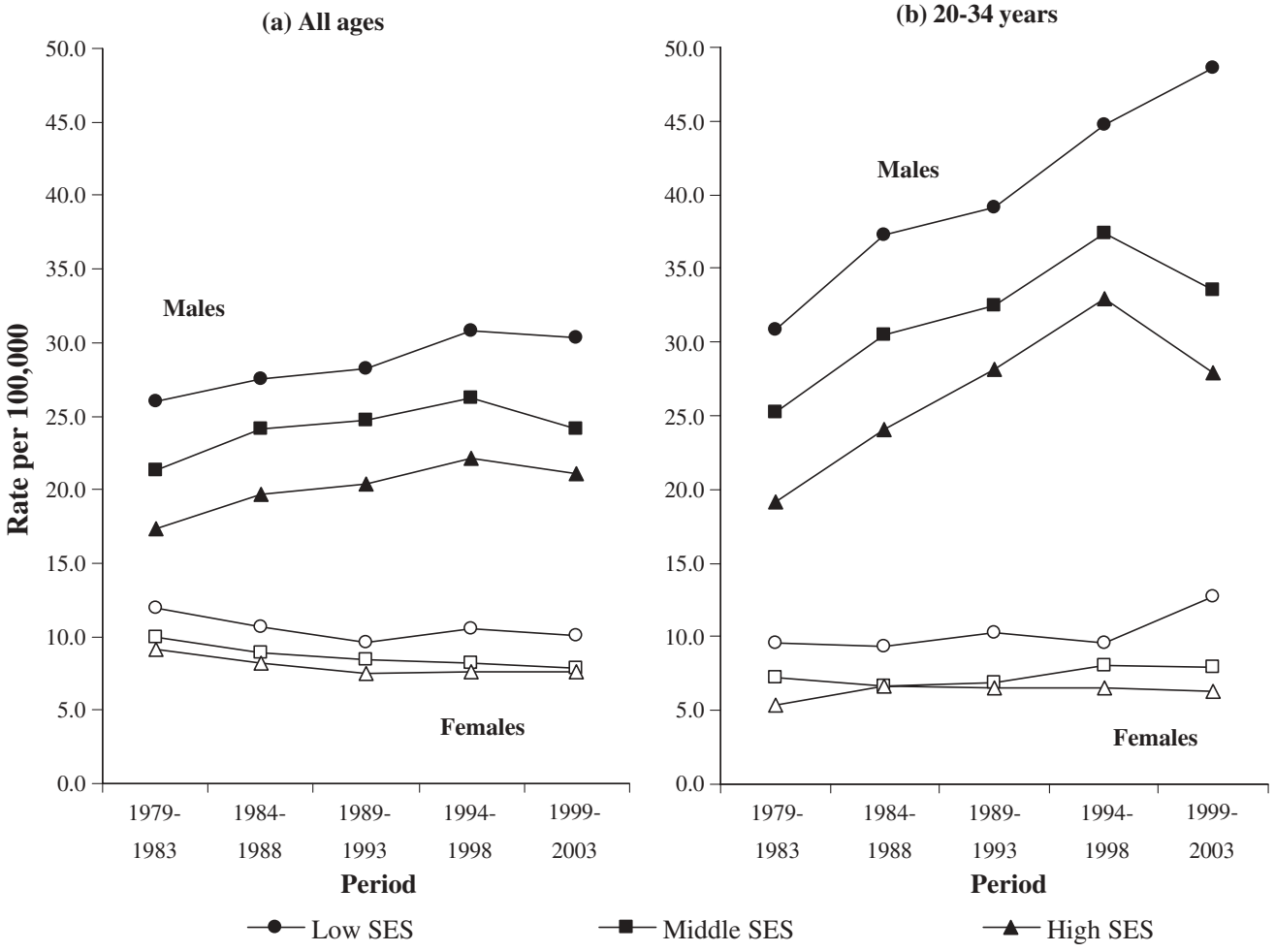

Fig. 2 Australian suicide rates by low, middle, and high SES† groups, 1979–2003 (rate per 100,000). †SES defined using the Index of Economic Resources [5]. SES groups were grouped using population quintiles: High SES (20%), Middle SES (60%), Low SES (20%). Suicide rates are adjusted for age, country-of-birth, and urban–rural residence

tralia for the period, and less than 0.5% of all suicides), which were excluded from the analysis. While the SES of a minority of areas changed over the study period, this did not affect analyses, as SES in each period was defined in quintiles of population—the lowest population quintile always comprised those areas with the lowest SES scores; the highest population quintile always comprised those areas with the highest SES scores.

Analysis

A series of Poisson regression models using a logarithmic link function were used to investigate associations between SES and suicide risk over time. Adjusted suicide rates (per 100,000) were calculated from these models using the intercept and beta estimates (of the main effects of SES, period, and the interaction between SES and period). The following general model, stratified by sex, was specified:

$$\ln(d/p) = \beta_1\text{age} + \beta_2\text{cob} + \beta_3\text{urbrur} + \beta_4\text{ses} + \beta_5\text{period} + \beta_6\text{ses*period} + k \quad (1)$$

where d refers to the number of suicides, p refers to the corresponding denominator population, $\beta_1 \ldots \beta_6$ to the relevant regression coefficients (specified categorically), with k as the constant. "Age" refers to 10-year age group, "cob" refers to country-of-birth group, "urbrur" refers to urban–rural residence, and "ses" refers to socio-economic status group. The "ses*period" term refers to the interaction between period and SES, and the statistical significance of the corresponding regression term (β_6) is a test of the divergence or convergence in suicide rates by SES. The baseline referent group was the 45–54 year age group, Australian country-of-birth, urban residence, and the highest SES quintile. Chi-square tests for trend (where df = 1) in each SES group and in low-to-high SES rate ratios over the period were calculated from the β-estimates for period specified ordinally in the Poisson regression models.

Rate ratios of suicide of the lowest to highest SES groups for each period were derived for each sex and age group from adjusted suicide rates in low and high SES groups using composite beta estimates by adding main effects and interaction effects. Standard errors (and thus 95% confidence intervals) for these composite beta estimates were derived from the variance calculated as suggested by Armitage et al. [4] using the following formula:

$$\text{var}(y) = \text{var}(x_i) + \text{var}(x_{ij}) + 2\text{cov}(x_i,x_j)$$

where y represents the derived estimate, x_i the main effect of the SES group i, and x_{ij} the interaction effect between SES group i and period j. Variance and covariance estimates were derived from each model's variance–covariance matrix. A series of age- and sex-specific models with both SES and period specified as ordinal variables were used to determine whether suicide rates in the high and low SES groups converged or diverged over time, using the P value of the period*SES interaction term for statistical significance. Analyses were carried out in SAS using PROC GENMOD.

Table 1 SES[d] differentials in Australian suicide, 1979–2003[a]

	Rate per 100,000 *(Number of suicides in brackets)*							
	All ages				20–34 years			
	High SES[b]	Middle SES	Low SES	Rate ratio, low/high (95% CI)	High SES[b]	Middle SES	Low SES	Rate ratio, low/high (95% CI)
Males								
1979–1983	17.3 *(851)*	21.4*** *(3,388)*	26.0*** *(1,436)*	1.50 (1.43–1.57)***	19.1 *(314)*	25.3*** *(1,314)*	30.9*** *(551)*	1.62 (1.50–1.75)***
1984–1988	19.6 *(1,093)*	24.1*** *(4,349)*	27.5*** *(1,751)*	1.40 (1.34–1.46)***	24.0 *(412)*	30.5*** *(1,719)*	37.3*** *(727)*	1.55 (1.45–1.66)***
1989–1993	20.3 *(1,247)*	24.7*** *(4,845)*	28.2*** *(1,890)*	1.38 (1.33–1.44)***	28.1 *(506)*	32.5*** *(1,999)*	39.1*** *(723)*	1.39 (1.30–1.49)***
1994–1998	22.2 *(1,439)*	26.3*** *(5,466)*	30.7*** *(2,323)*	1.39 (1.34–1.44)***	33.0 *(594)*	37.3*** *(2,244)*	44.8*** *(880)*	1.36 (1.28–1.44)***
1999–2003	21.1 *(1,498)*	24.2*** *(5,044)*	30.3*** *(2,112)*	1.44 (1.38–1.49)***	27.9 *(568)*	33.5*** *(1,831)*	48.6*** *(721)*	1.74 (1.64–1.86)***
P for trend[c]:								
1979–2003	<0.001	<0.001	<0.001	0.802	<0.001	<0.001	<0.001	0.092
1979–1998				0.060				<0.001
1994–2003				0.016				<0.001
Females								
1979–1983	9.1 *(375)*	9.9*** *(1,169)*	11.9*** *(451)*	1.31 (1.24–1.37)***	5.3 *(92)*	7.2*** *(333)*	9.5*** *(140)*	1.78 (1.62–1.96)***
1984–1988	8.2 *(386)*	8.9** *(1,204)*	10.7*** *(471)*	1.31 (1.24–1.37)***	6.6 *(117)*	6.7 *(340)*	9.3*** *(153)*	1.41 (1.29–1.54)***
1989–1993	7.5 *(408)*	8.4*** *(1,286)*	9.6*** *(388)*	1.28 (1.22–1.35)***	6.5 *(123)*	6.9 *(403)*	10.2*** *(138)*	1.57 (1.43–1.71)***
1994–1998	7.7 *(450)*	8.2** *(1,337)*	10.5*** *(513)*	1.37 (1.30–1.44)***	6.5 *(122)*	8.0 *(457)*	9.5** *(147)*	1.47 (1.34–1.60)***
1999–2003	7.6 *(471)*	7.9 *(1,335)*	10.1*** *(475)*	1.33 (1.27–1.40)***	6.3 *(134)*	7.9*** *(415)*	12.7*** *(150)*	2.01 (1.85–2.19)***
P for trend[c]:								
1979–2003	<0.001	<0.001	<0.001	0.347	0.952	0.899	0.303	0.306
1979–1998				0.063				0.031
1994–2003				0.870				<0.001

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

[a] Suicide rates adjusted for age, country-of-birth, and urban–rural residence

[b] High SES is the referent group for comparisons within cross-sections

[c] Represents linear increase across the study period for each SES group. *P* value for Rate Ratio indicates divergence from parallel SES differences between High and Low SES (see Fig. 2) and is derived from the period*SES interaction term

[d] SES defined using the Index of Economic Resources [5]. SES groups were grouped using population quintiles: High SES (20%), Middle SES (60%), Low SES (20%)

Results

Significant socio-economic status (SES) differentials persisted across the study period for both males and females after adjusting for the effects of age, migrant status, and urban–rural residence, with the largest differences between low and high SES areas evident in males, and especially young males (20–34 years) (Table 1, Fig. 2). Suicide rate ratios of low to high SES areas were of a similar magnitude by sex, ranging from 1.36 to 1.74 in males and 1.28 to 2.01 in females, but suicide rates (per 100,000) were approximately 3–4 times higher in males than females. The rate ratio for young males (RR = 1.74, 95% CI: 1.64–1.86) and for young females (RR = 2.01, 95% CI: 1.85–2.19) in the most recent period were the greatest differentials found for the study period, and occurred in the context of increasing suicide rates in the low SES group and decreasing suicide rates in the middle and high SES groups.

For males, suicide rates increased significantly in low, middle, and high SES areas until 1998, before diverging significantly in the most recent period, particularly in young males (*p* for period*SES interaction <0.0001) (Table 1, Fig. 2). Suicide rates in the most recent period increased in the low SES group from 48.8 per 100,000 in 1994–1998 to 48.6 per 100,000 in 1999–2003 (an 8% increase). In contrast, suicide rates in the middle SES group decreased from a peak of 37.3 per 100,000 to 33.5 per 100,000 (a 10% decrease), and in the high SES group from a peak of 33.0 per 100,000 to 27.9 per 100,000 (a 15% decrease). The 1994–1998 period covered the peak in the "youth suicide epidemic" in Australia, and also coincided with the implementation of the national youth suicide prevention strategy (Fig. 1). A similar divergence, of lesser magnitude, was also evident in all-age male suicide and in younger females (20–34 years) (Table 1, Fig. 2).

Discussion

This study investigated secular trends in sex- and age-specific Australian suicide rates for the period 1979–2003 by area socio-economic status (SES) groups to determine if SES differentials in suicide changed over time. Analyses by sex adjusted for effects of age, migrant status, and urban–rural residence using Poisson regression.

Significantly higher rates in lower (compared to higher) SES areas persisted over time for both males and females with the greatest SES differentials evident in males, especially young males aged 20–34 years. Male suicide rates increased significantly over time in

all SES groups, but suicide rates diverged in the latter part of the study period with decreases evident in high and middle SES groups accompanying further increases in the low SES group.

There are a number of methodological considerations in interpreting the results of the present study. Firstly, this study used small-area mortality and population data in defining area-based strata for analysis, and there may be misclassification bias due to changes in local government area (LGA) boundaries over the relatively long study period. However, an examination of LGA changes in the broad SES categories showed little variation in LGAs by SES group from the 1986 census to the 2001 census (approximately 5% of LGAs changed SES categories).

Also, analyses were based on approximate equal-population quintiles of SES, irrespective of how the SES score of an area had changed from one census to the next, and consequently the most disadvantaged quintile always represented the lowest 20% of the population in terms of SES, and the least disadvantaged quintile always represented the highest 20%. Broad categories of area-based strata (SES and urban–rural residence) were also defined, which would minimise the effect of misclassification due to boundary changes.

Cross-level bias (or the "ecological fallacy") [31], where observed group-level differences in the outcome are correlated with aggregate individual data but not attributable to individual characteristics, also needs consideration. The group-level associations of the present study may imply that individuals of low SES have higher rates of suicide. The present ecological association between SES and suicide is consistent with individual level studies of SES and suicide, where higher suicide risk is associated with lower (compared to higher) income level, occupational status, and education level [3, 15, 22].

The increasing social gradients in suicide from high to low SES found in previous aggregate cross-sectional Australian studies [13, 29, 34, 36] were also evident in earlier periods in analyses of all-age suicide. Previous longitudinal studies of suicide in the United Kingdom [18] and Australia [38] have found aggregate and individual socio-economic differentials in suicide to persist over-time, and a divergence between high and low SES in youth (15–24 years) suicide rates was found in the individual-level UK study over a similar period (1970–1993) [18]. The present study found similar results to those of Turrell and Mathers [38] in their study of cause-specific mortality using area-based SES, although the age groups and time periods are not directly comparable. Turrell and Mathers [38] found socio-economic differentials in age-adjusted suicide rates in young males (15–24 years) to increase across the two cross-sections (1985–1987 and 1995–1997), and a decrease in differentials in young females.

The most interesting result of this study, not demonstrated previously, is the divergence in young male suicide rates (and to a lesser extent young females) in the lowest SES stratum in the period after 1998. The youth suicide epidemic peaked in 1997 and 1998, covered by the 1994–1998 quinquennium, after which time male youth suicide rates declined substantially. The decrease in male suicide rates in the late 1990s also coincided with the implementation of a well-funded national youth suicide prevention strategy over the period 1995–1999 [8]. The national strategy implemented primary prevention strategies that focussed on early intervention and cultural change in addressing antecedent phenomena; secondary prevention strategies that included treatment, support and post-vention of at risk groups; and system level strategies that centred on policy and planning, the development of practice guidelines, education and training, and research and evaluation. Early evaluations of program activity, however, suggested negligible effects on suicide reduction [8]. This evaluation was conducted in the immediate period after the strategy was funded, when sufficient data would not have been accumulated to detect any significant secular trend.

The decreases in suicide coinciding with suicide prevention activity, and the divergence in suicide rates by SES groups in this period are worth consideration. There are perhaps four (not mutually exclusive) explanations for this divergence in young adult suicide by SES areas. Firstly, gains in overall economic prosperity over the study period [6] may not have been distributed across all strata of society. For example, distal antecedent factors to suicide where improvements have been evident, such as reported reductions in unemployment, wage gains, and improved access to education and training [6], have been differentially distributed to those in higher SES groups, and those in low SES groups have not experienced any improvement in economic conditions. The differential distribution of gains in economic prosperity across social strata is evident in the widening of income inequality in Australia in the period after 1994 [32], which also occurred contemporaneously with the divergence in suicide between high and low SES areas shown in the present study. Income in the highest earning quintile of the population increased 9-fold during this period compared to the lowest earning quintile (AUS $111 per week increase compared to a AUS $13 per week increase) [32]. Such distal socio-economic antecedents conceivably act upon more proximate intermediary factors associated with suicide, like life-prospects, mental disorder, and psychological and familial stress [37].

A second explanation may be that the suicide prevention strategy was successful in reducing suicide in middle and higher SES areas, but had no effect in low SES areas. Suicide prevention activity may have been more intensive and better funded in higher SES areas, and people in higher SES areas more receptive to preventive messages and interventions because of their

education, social position and connections, and financial resources. Also, primary, secondary, and tertiary prevention initiatives may have been implemented differentially by area, and have been dependent on local area policies, resources, and commitment.

A third explanation (related to the second) may be that reduced exposure to proximate psychiatric and psychological risk factors reduced suicide rates in middle and higher SES areas, but not in low SES areas. For example, mental disorder, particularly depression, is a well-known risk factor for suicide, and recent studies have suggested that increased antidepressant consumption in the Australian population is associated with decreases in suicide rates [20], although studies from the United Kingdom suggest that increases in anti-depressant consumption had little effect on prevalence of mental disorder [12, 27]. Higher levels of economic resources in middle and high SES areas (relative to low SES areas) affords more flexibility in accessing a wider array of health services and treatment options usually associated with such proximate antecedents to suicide—the benefits of which are differentially distributed by SES. Changes in mental health literacy [21] may also be differentially distributed by population groups according to available economic resources. There may also be differential availability or use of services, or of health professional practice styles, based on urban or rural residence and other cultural factors. To some extent these factors were adjusted for in the present analysis (urban–rural residence and migrant status).

A fourth explanation, though less likely, may relate to the standard pattern and progression of an "epidemic." The decrease in male youth suicide after 1998 in middle and high SES areas may reflect an exhaustion of those individuals susceptible to commit suicide in the population, just as the incidence of an infectious disease declines once those susceptible either die or recover. In the low SES group this point may not have yet been reached, and suicide rates have continued to increase. Certainly antecedents that increase susceptibility to suicide, such as mental disorder and previous suicide attempts are more prevalent in lower SES groups in Australia [35]. In contrast, the observed decreases in Australian youth suicide in higher SES groups may reflect an adaptation to social and cultural changes resulting from the extended period of economic growth with corresponding reduction in unemployment rates over the 1990s.

The persistent SES suicide differentials over time, and divergence between higher and lower SES groups in the most recent period, suggest that circumstances associated with social disadvantage such as low income level, poor education, and lack of employment opportunities may cause or serve to promote suicidal behaviour (so called social-causation). Alternatively, psychological distress or mental illness may lead to poor social functioning and a slide down the social scale (social-selection). Individual-level cross-sectional studies of mental disorders in Australia, from mental health population survey data collected in the late 1990s, have shown consistent socio-economic gradients in 12-month prevalence of affective, substance use, and anxiety disorders, based on *previously* established and relatively static socio-economic status, as measured by educational achievement, which implies social-causation [35]. Moreover, adjusting for such disorders did not substantially reduce the higher prevalence of suicidal behaviour in lower SES groups [35].

Conclusion

The present study has shown persistent socio-economic status differentials in suicide over time for both males and females, especially young males. Most striking was the divergence in young male suicide rates between low SES groups (which continued to rise) and middle and high SES groups (which peaked and then decreased) during a period when suicide rates decreased overall, and a national suicide prevention strategy was implemented. These are the largest SES differentials in suicide observed over the last 25 years. While suicide prevention activity and overall economic gains during the 1990s may have assisted in reducing suicide rates in some sections of society, it is clear that beneficial effects have not been shared equally.

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Further increases in rural suicide in young Australian adults: Secular trends, 1979–2003

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Abstract

This study investigates changes in Australian urban–rural suicide differentials over time in the context of overall declines in (male) suicide in the late 1990s, and determines the extent to which differences in socio-economic status (SES) account for observed urban–rural trends. Suicide data were stratified for the period 1979–2003 by metropolitan, rural and remote areas and examined across five quinquennia, centred on each Australian census from 1981 to 2001. Suicide rates (per 100,000) were adjusted for confounding by sex, age, country-of-birth and the mediating effects of area SES, using Poisson regression models. Male suicide rates in metropolitan, rural and remote areas diverged significantly over time, especially in young males (15–24 years). Young male suicide rates increased significantly in metropolitan, rural and remote areas over 1979–1998, and in the most recent period (1999–2003) increased further in remote areas from 38.8 (per 100,000) to 47.9 (23% increase). In contrast suicide rates in rural areas decreased from a peak of 27.5 to 19.8 (28% decrease), and in metropolitan areas from a peak of 22.1 to 16.8 (24% decrease). Similar divergence in the 1999–2003 quinquennium, though of a lesser magnitude, was also evident for males aged 25–34 years. Female suicide rates in the earlier part of the period were significantly lower in rural and remote areas than in metropolitan areas, particularly for those aged 25–34 years, then increased in rural and remote areas to converge with female suicide rates in metropolitan areas. Adjusting for SES in addition to age and country-of-birth reduced urban–rural suicide differentials in both males and females, consistent with SES being an intermediary between rural residence and suicide. Nevertheless, urban–rural differences remained statistically significant. These results show that the largest urban–rural male suicide differentials for the 25-year study period occurred in the most recent period (1999–2003), in the context of decreasing male suicide rates overall.

Keywords: Suicide; Rural residence; Secular trends; Australia; Socio-economic status; Young adults

Introduction

Differences in suicide rates in urban and rural areas have previously been investigated both in Australia (Burnley, 1995; Cantor & Slater, 1997; Dudley et al., 1997; Dudley, Kelk, Florio, Howard, & Waters, 1998; Dudley, Waters, Kelk, & Howard,

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1992; Morrell, Taylor, Slaytor, & Ford, 1999; Wilkinson & Gunnell, 2000) and internationally (Connolly & Cullen, 1996; Kondrichin & Lester, 1998; Levin & Leyland, 2005; Middleton, Gunnell, Frankel, Whitley, & Dorling, 2003; Saunderson, Haynes, & Langford, 1998; Schorr, Crabtree, Wagner, & Wetterau, 1989; Singh & Siahpush, 2002), with (predominantly) rural male suicide rates higher compared to urban, or national, suicide rates. Significant differences between urban and rural areas in age-adjusted suicide rates have been found in Australia (Burnley, 1995; Cantor & Slater, 1997; Dudley et al., 1992, 1997, 1998; Morrell et al., 1999; Wilkinson & Gunnell, 2000), particularly in young males where suicide rates have increased substantially relative to young males in metropolitan areas (Dudley et al., 1997, 1998). Explanations for these differences have been largely speculative, and have included urban–rural differences in employment opportunities, access to means, and mental health service provision (Baume & Clinton, 1997; Dudley et al., 1997). Cross-sectional studies of urban–rural differences in Australian suicide have found that socio-economic factors, such as area-based economic, educational and occupational resources, and migrant composition, account for a greater proportion of the urban–rural suicide differential than psychiatric factors or health service access (Taylor, Morrell, Slaytor, & Ford, 1998; Taylor, Page, Morrell, Harrison, & Carter, 2005).

Few secular studies of Australian urban–rural suicide differences have explicitly considered confounders other than age, and analyses of observed divergence in suicide in rural and remote areas (relative to urban areas) have remained largely descriptive. Previous cross-sectional studies of suicide have shown that migrant status and socio-economic status (SES) are associated with suicide (Cantor & Slater, 1997; Morrell et al., 1999), and there are significant differences in patterns of suicide between urban and rural areas associated with these variables (Cantor & Slater, 1997; Morrell et al., 1999; Taylor et al., 1998, 2005). Socio-economic factors can be considered as intermediary variables between environmental factors (such as rural residence) and more proximate risk factors for suicide (Taylor et al., 2005), but no previous Australian studies have examined how trends in urban–rural suicide differentials have changed over time in conjunction with socio-economic factors.

There has been a general national decline in male youth suicide in the late 1990s (Fig. 1) in Australia, which followed the peak of the 'youth suicide epidemic' in 1997–1998. This also coincided with a national suicide prevention initiative (Fig. 1), and suicide declines that were more apparent in higher than lower, SES areas (Page, Morrell, Taylor, Carter, & Dudley, 2006). The impact of the decline in male youth suicide, and the differential effect by SES, on rural suicide trends is not clear.

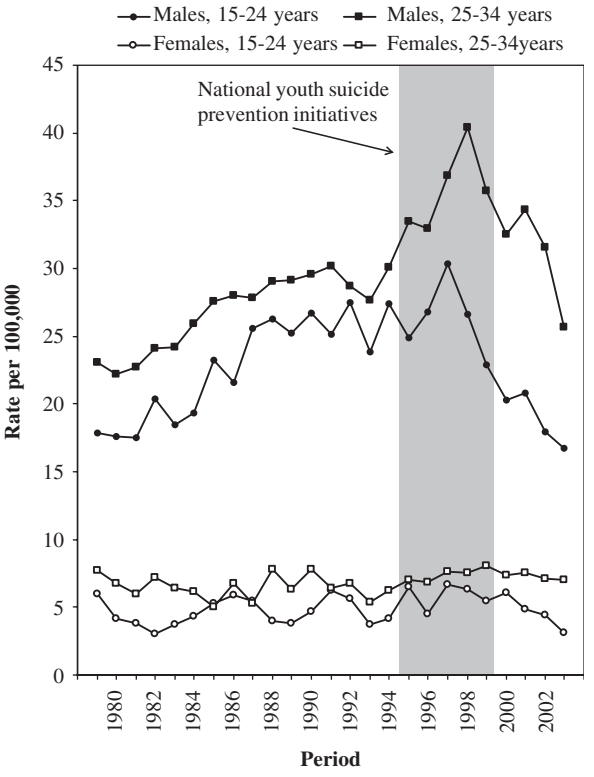

Fig. 1. Australian suicide rates in young adults (15–34 years). *Note*: National youth suicide prevention strategy was funded from 1995 to 1999.

Accordingly, the present study examines urban and rural suicide differences for the period 1979–2003 to quantify (a) urban–rural suicide differentials over time in the context of the overall decline in the late 1990s and (b) the extent to which SES accounts for observed trends in urban–rural differences in suicide.

Methods

Data

Unit record suicide data were obtained from the Australian Bureau of Statistics (ABS) for the period 1979–2003. Corresponding population data for each

Local Government Area (LGA) were also obtained for the 1981, 1986, 1991, 1996 and 2001 censuses. Demographic variables included usual area of residence, sex, age, country-of-birth, urban–rural residence and SES. Age groups were defined in 10-year groups: 15–24, 25–34, 35–44, 45–54, 55–64, 65–74 and $\geqslant$75 years. Six country-of-birth groups were also defined: Australia, New Zealand, United Kingdom and Eire, Europe, Asia and all other.

Analyses are focussed on younger age groups, both in terms of a 'youth' group (15–24 years) and a young adult group (25–34 years), given that the highest suicide rates have occurred in the more recent periods for young adult age groups (ABS, 2000). It was expected that different patterns by urban–rural residence would be evident for each of these groups. The younger age group (15–24 years) comprises adolescents and students (as well as working young people), whereas the older group (25–34 years) comprises predominantly working age people less dependent on resources other than from their own employment.

Urban–rural residence was defined using the Rural, Remote and Metropolitan Area (RRMA) classification system (DPIE/DHSH, 1994). The RRMA has seven categories (capital city, other metropolitan area, large rural centre, small rural centre, other rural area, remote centre, other remote area), and has been used in previous secular studies of suicide trends (Dudley et al., 1997, 1998; Wilkinson & Gunnell, 2000). Other classifications of small-areas have been developed more recently, each measuring different aspects of remoteness and accessibility, and each with advantages and disadvantages (AIHW, 2004).

The advantage of using the RRMA is that the broad zones (metropolitan, rural and remote) underpinning the finer categories of the classification accurately reflect differences in relation to service and infrastructure, economic base, land use, natural resources and other socio-demographic factors, even though such categories may contain heterogeneous populations, especially in rural areas (AIHW, 2004). The RRMA classification was also developed at approximately the mid-point of the study period (1991). Preliminary analyses showed similar age-adjusted suicide rates for some categories of RRMA. Accordingly, these groups were aggregated into three categories to increase underlying numbers and statistical power: metropolitan areas (comprising capital cities, and other metropolitan areas), rural areas (comprising large and small rural centres, and other rural areas), and remote areas (remote centres, and other remote areas).

Socio-economic status was also included in some analyses. Approximate equal population quintiles of SES were created in relation to the index of economic resources, one of the census-derived socio-economic indices developed by the ABS (1998). The economic resources index measures characteristics of an area according to income and expenditure, home ownership rates and dwelling size, among other factors, without reference to education or occupational factors. This index was selected as a previous study of suicide showed the largest socio-economic differentials in suicide for this index (Page, Morrell, & Taylor, 2002). Socio-economic status is an important variable to consider when investigating urban–rural differentials in suicide, as low SES populations are differentially distributed across rural and urban areas. Across this study period (1979–2003), the proportion of the population from the lowest SES quintile in metropolitan areas ranged from 5% to 16%, in rural areas ranged from 29% to 56%, and in remote areas ranged from 44% to 66%. The economic resource index was available for the 1986, 1991, 1996 and 2001 censuses. The economic resource index was not available for the 1981 census, so for the earliest 5-year period in the study (1979–1983) the 1986 indices were used.

Data were stratified for each combination of LGA, sex, age group, country-of-birth group, SES quintile, and area of residence classification, with corresponding counts of suicide and population. Major changes to ABS geographic coding systems have occurred along with significant aggregations and dis-aggregations of small-area classifications and attendant boundary changes over the study period. Moreover, different coding systems between mortality and population data were used until the mid-1980s, and in some cases codes were reused for different areas when the coding systems were changed. Incomplete documentation of changes to geographic systems, particularly in earlier years, also occurred. To circumvent these problems, all small-area codes were resolved to their corresponding population LGA code at the closest census. Five cross-sections were produced for the periods 1979–1983, 1984–1988, 1989–1993 and 1994–1998 and 1999–2003.

Analysis

Suicide rate (per 100,000) trends and differentials were examined over five quinquennia (1979–2003).

Associations between urban–rural residence and suicide risk over time were investigated using a series of Poisson regression models using a logarithmic link function, offset by the log of the population. Adjusted suicide rates (per 100,000) were calculated from these models by taking the anti-log of composite beta estimates derived from model intercepts, main effects terms and interaction terms. Models were adjusted for the confounding effects of age and country-of-birth (stratified by sex). Additional models also adjusted for SES in addition to age and country-of-birth. SES was considered an intermediary variable, and these additional models were used to investigate the extent to which the urban–rural residence effect was mediated by SES. The following general models, stratified by sex, were specified:

$$\ln\left(\frac{d}{p}\right) = \beta_1 \text{age} + \beta_2 \text{cob} + \beta_3 \text{urbrur} + \beta_4 \text{period} + \beta_5 \text{urbrur} \times \text{period} + k, \quad (1)$$

$$\ln\left(\frac{d}{p}\right) = \beta_1 \text{age} + \beta_2 \text{cob} + \beta_3 \text{ses} + \beta_4 \text{urbrur} + \beta_5 \text{period} + \beta_6 \text{urbrur} \times \text{period} + k, \quad (2)$$

where d refers to the number of suicides, p refers to the corresponding denominator population, $\beta_1, \ldots, \beta_6$ to the relevant regression coefficients, with k as the constant. 'Age' refers to 10-year age group, 'cob' refers to country-of-birth group, 'ses' refers to SES quintile and 'urbrur' refers to urban, rural or remote residence. The baseline referent groups were the 45–54 year age group, Australian country-of-birth, urban residence and the highest SES quintile. Chi-square tests for trend (with d.f. = 1) in each urban-rural category over the period were calculated with period specified ordinally.

Rate ratios for each period between remote areas and metropolitan areas, and between rural areas and metropolitan areas were calculated for each sex and age group from composite beta estimates by adding main effects and interaction effects. Standard errors (and 95% confidence intervals) for these composite beta estimates were derived from the variance calculated as suggested by Armitage, Berry, and Matthews (2002) using the following formula:

$$\text{var}(y) = \text{var}(x_i) + \text{var}(x_j) + 2\,\text{cov}(x_i, x_j), \quad (3)$$

where y represents the derived estimate, x_i the main effect for a particular geographic group and x_j the corresponding interaction effect between urban–rural residence and period. Variance and covariance estimates were derived from each model's variance–covariance matrix. A series of age- and sex-specific models with both urban–rural residence and period specified as ordinal variables were used to determine whether suicide rates in regional centres and other rural areas converged or diverged over time, relative to metropolitan areas (using the p-value of the period × urban–rural interaction term for significance). Analyses were carried out in SAS using PROC GENMOD (SAS Institute Inc., 1999).

Results

Males

Male suicide rates were 4–5 times higher than female suicide rates (Tables 1 and 2). Male suicide rates in metropolitan, rural and remote areas diverged significantly over the study period, especially in young males (p for period × urban–rural area interaction <0.0001, Table 1), after adjusting for the effects of age and country-of-birth (Fig. 2), and age, country-of-birth and SES (Fig. 3). The largest differentials over the period were evident in the latter decade of the study period (1994–2003). Adjusting for SES (in addition to age and country-of-birth) reduced urban–rural differentials for males (all ages and youth) by approximately 20–50% in the most recent periods, consistent with a mediating effect of SES on rural and remote suicide, but urban–rural differentials and the divergent trends in males remained statistically significant (Tables 1 and 2).

Suicide rate ratios were highest for males 15–24 years, peaking at RR = 2.85 (95% CI 2.33–3.49) in the most recent period for remote areas relative to metropolitan areas (Table 1, Fig. 3). During 1979–1998 male suicide rates increased significantly in metropolitan, rural and remote areas, while in the most recent period (1999–2003) they continued to increase in remote areas, from 38.8 (per 100,000) to 47.9 (23% increase). In contrast, suicide rates in rural areas decreased from a peak of 27.5 to 19.8 (28% decrease), and in metropolitan areas from a peak of 22.1–16.8 (24% decrease). The 1994–1998 period contained the peak in the youth suicide epidemic in 1997–1998 (Fig. 1).

A similar divergence in the 1999–2003 period, though of a lesser magnitude, was also evident for males aged 25–34 years. Differentials in this age group between metropolitan, rural and remote areas were not significant until the most recent period

Table 1
Australian male suicide rates[a] by urban–rural residence[b]

	Rate per 100,000 (no. of suicides)			Rate ratio	
	Metropolitan areas[c]	Rural areas	Remote areas	Rural:metro (95% CIs)	Remote:metro (95% CIs)
All ages					
1979–1983	(4176) 19.5	(1581) 19.2	(254) 20.2	0.99 (0.93–1.05)	1.04 (0.91–1.18)
1984–1988	(5249) 21.8	(2172) 23.7*	(326) 22.8	1.09 (1.03–1.14)**	1.04 (0.93–1.17)
1989–1993	(5788) 22.9	(2433) 22.9	(362) 23.6	1.00 (0.95–1.05)	1.03 (0.93–1.15)
1994–1998	(6542) 24.2	(2792) 25.4	(454) 27.0	1.05 (1.00–1.10)	1.12 (1.01–1.23)
1999–2003	(5995) 22.4	(2680) 23.8***	(436) 31.3***	1.07 (1.02–1.12)*	1.40 (1.27–1.54)***
p for divergence in trend[d]					
1979–2003				0.1939	0.0001
1979–1998				0.1621	0.2820
1994–2003				0.0170	<0.0001
15–24 years					
1979–1983	(790) 15.4	(305) 15.7	(52) 16.0	1.02 (0.89–1.16)	1.04 (0.78–1.37)
1984–1988	(1053) 19.2	(455) 23.0**	(80) 22.8	1.20 (1.07–1.34)**	1.19 (0.95–1.50)
1989–1993	(1187) 21.6	(508) 24.8	(95) 30.3	1.15 (1.03–1.28)*	1.40 (1.14–1.74)**
1994–1998	(1186) 22.1	(530) 27.5***	(117) 38.8***	1.24 (1.12–1.38)***	1.75 (1.45–2.13)***
1999–2003	(835) 16.8	(371) 19.8***	(109) 47.9***	1.18 (1.04–1.34)*	2.85 (2.33–3.49)***
p for divergence in trend[d]					
1979–2003				0.1263	<0.0001
1979–1998				0.0001	<0.0001
1994–2003				0.3191	<0.0001
25–34 years					
1979–1983	(1003) 20.6	(304) 16.2***	(61) 17.3	0.79 (0.69–0.90)***	0.84 (0.65–1.09)
1984–1988	(1277) 24.1	(485) 23.8	(62) 15.9**	0.99 (0.89–1.10)	0.66 (0.51–0.85)**
1989–1993	(1454) 26.5	(506) 22.2**	(82) 19.6*	0.84 (0.76–0.93)**	0.74 (0.59–0.93)*
1994–1998	(1738) 30.3	(602) 28.8	(115) 27.8	0.95 (0.86–1.05)	0.92 (0.76–1.11)
1999–2003	(1547) 28.8	(569) 29.8**	(146) 46.5***	1.03 (0.94–1.14)	1.61 (1.36–1.91)***
p for divergence in trend[d]					
1979–2003				0.0063	<0.0001
1979–1998				0.0077	0.0792
1994–2003				0.0072	<0.0001

COB, country-of-birth; SES, socio-economic status. $^{*}p<0.05$. $^{**}p<0.01$. $^{***}p<0.001$.

[a]Suicide rates adjusted for age, country-of-birth and socio-economic status.

[b]Rural categories based on the Rural, Regional, Metropolitan Area classification: Metropolitan (capital cities, other metropolitan areas); Rural areas (large and small rural centres, other rural areas); Remote areas (remote centres, other remote areas).

[c]'Metropolitan centres' is the referent group for comparisons within cross-sections.

[d]*p*-value for rate ratio indicates divergence from parallel urban–rural differences between (1) rural areas and metropolitan areas and (2) remote areas and metropolitan areas (see Fig. 2), and is derived from the period × urban–rural interaction term.

(suicide rates in rural and remote areas were lower in the early part of the study period). Male suicide rates in remote areas in the 1999–2003 period increased further and became significantly higher than rates in metropolitan areas (RR = 1.61, 95% CI 1.36–1.91) (Table 1).

Females

Similar to males, adjusting for SES (in addition to age and country-of-birth) reduced urban–rural differentials for females (Figs. 2 and 3), consistent with a mediating effect of SES on rural and remote suicide, but urban–rural differentials and trends remained statistically significant in most cases (Table 2). Female suicide rates were significantly lower in rural and remote areas than in metropolitan areas, particularly for those aged 25–34 years (Table 2). The largest urban–rural differentials were evident in the earlier part of the period (1979–1993), after which female suicide rates increased in remote areas to converge significantly with female suicide

Table 2
Australian female suicide rates[a] by urban–rural residence[b]

	Rate per 100,000 (no. of suicides)			Rate ratio	
	Metropolitan areas[c]	Rural areas	Remote areas	Rural:metro (95% CIs)	Remote:metro (95% CIs)
All ages					
1979–1983	(1674) 8.6	(361) 5.3***	(38) 4.7***	0.62 (0.55–0.69)***	0.55 (0.40–0.76)***
1984–1988	(1658) 7.6	(481) 6.3***	(43) 4.5***	0.83 (0.75–0.92)**	0.60 (0.44–0.81)**
1989–1993	(1673) 7.2	(489) 5.4***	(38) 3.6***	0.75 (0.68–0.83)***	0.50 (0.36–0.68)***
1994–1998	(1808) 7.1	(567) 5.9***	(63) 5.3*	0.83 (0.75–0.92)**	0.75 (0.58–0.96)*
1999–2003	(1749) 6.8	(612) 6.1	(61) 6.0	0.89 (0.81–0.98)*	0.87 (0.67–1.13)
p for divergence in trend[d]					
1979–2003				<0.0001	0.0110
1979–1998				<0.0001	0.0020
1994–2003				<0.0001	0.0044
15–24 years					
1979–1983	(199) 4.1	(44) 2.5**	(9) 3.4	0.61 (0.44–0.84)**	0.83 (0.43–1.63)
1984–1988	(242) 4.6	(71) 3.9	(13) 4.5	0.84 (0.64–1.10)	0.97 (0.55–1.70)
1989–1993	(247) 4.7	(70) 3.6	(9) 3.3	0.77 (0.58–1.01)	0.70 (0.36–1.38)
1994–1998	(265) 5.0	(84) 4.6	(14) 5.4	0.92 (0.72–1.18)	1.07 (0.63–1.85)
1999–2003	(213) 4.4	(81) 4.6	(14) 7.0*	1.04 (0.80–1.36)	1.60 (0.93–2.76)
p for divergence in trend[d]					
1979–2003				0.0161	0.1483
1979–1998				<0.0001	0.3059
1994–2003				0.0199	0.0012
25–34 years					
1979–1983	(316) 6.4	(65) 3.6***	(10) 3.6*	0.57 (0.44–0.75)***	0.57 (0.30–1.06)
1984–1988	(314) 5.8	(83) 4.1**	(8) 2.5*	0.71 (0.56–0.91)*	0.43 (0.21–0.86)*
1989–1993	(349) 6.2	(97) 4.1***	(10) 2.8**	0.67 (0.53–0.84)**	0.45 (0.24–0.84)*
1994–1998	(380) 6.4	(105) 4.9*	(16) 4.5	0.76 (0.61–0.95)*	0.71 (0.43–1.17)
1999–2003	(393) 7.0	(122) 6.1	(17) 6.2	0.88 (0.71–1.08)	0.88 (0.54–1.44)
p for divergence in trend[d]					
1979–2003				0.0120	0.1077
1979–1998				<0.0001	0.0777
1994–2003				0.0048	0.0608

*$p<0.05$. **$p<0.01$. ***$p<0.001$.

[a]Suicide rates adjusted for age, country-of-birth and socio-economic status.

[b]Rural categories based on the Rural, Regional, Metropolitan Area classification: Metropolitan (capital cities, other metropolitan areas); Rural areas (large and small rural centres, other rural areas); Remote areas (remote centres, other remote areas).

[c]'Metropolitan centres' is the referent group for comparisons within cross-sections.

[d]*p*-value for rate ratio indicates divergence from parallel urban–rural differences between (1) rural areas and metropolitan areas and (2) remote areas and metropolitan areas (see Fig. 2), and is derived from the period × urban–rural interaction term.

rates in metropolitan areas (*p* for period-urban–rural area interaction <0.05, for all ages and 25–34 years) (Table 2, Fig. 3).

Discussion

This study investigated secular trends in urban and rural suicide (1979–2003) to (a) determine if differentials had changed over time, and changed in the context of decreases in male suicide in the late 1990s and differential declines in male suicide by area-based SES (Page et al., 2006) and (b) determine the extent to which SES accounted for observed trends in urban–rural differences in suicide. Analyses were stratified by sex and focussed on younger age groups, and adjusted for effects of age, migrant status (country-of-birth) and potential mediating effects of SES using Poisson regression.

Male suicide rates in rural areas (comprising regional centres and other rural areas) and remote areas (comprising remote centres and other remote areas) diverged significantly from suicide rates in

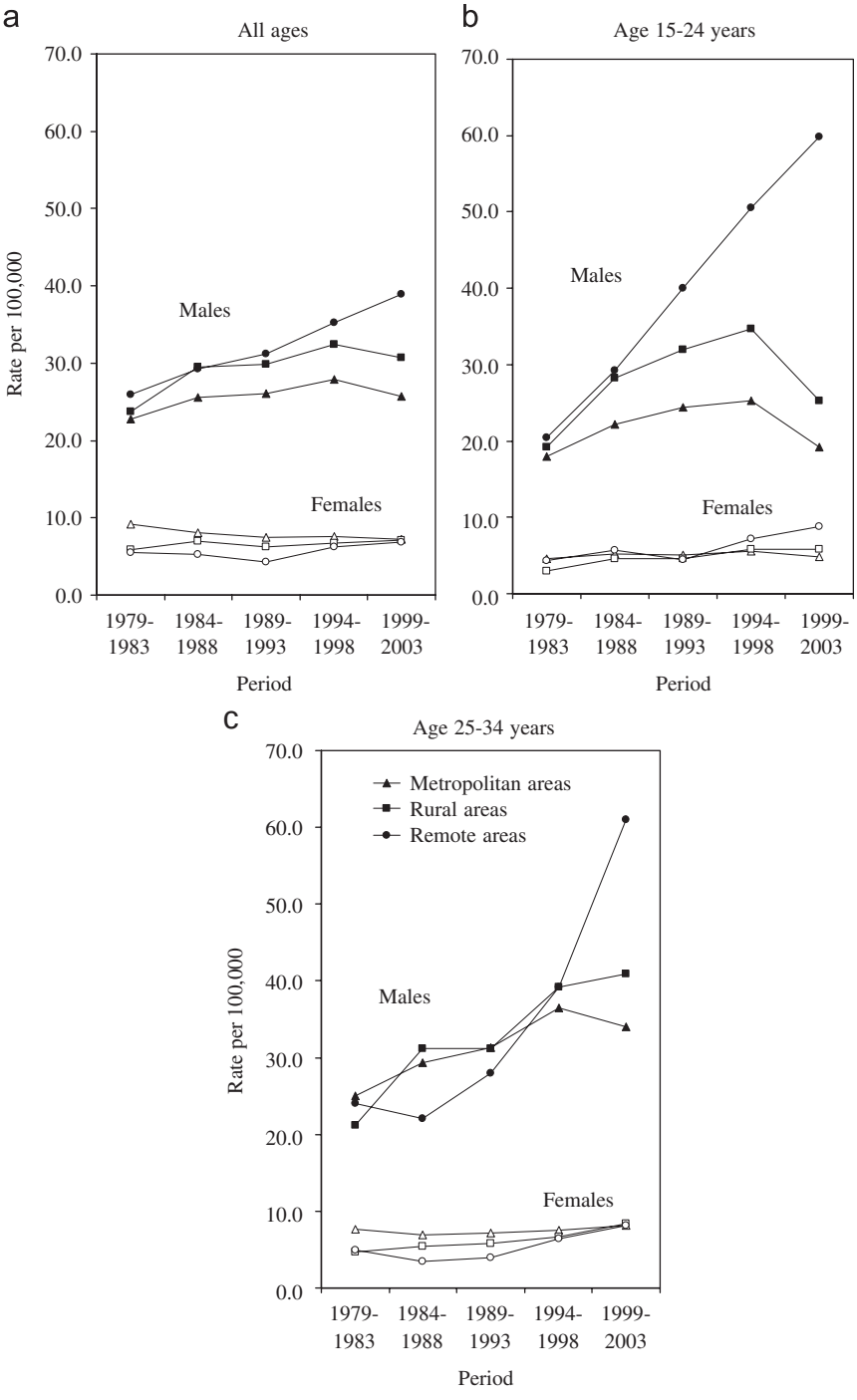

Fig. 2. Australian suicide rates by metropolitan areas, rural areas and remote areas, adjusted for age and country-of-birth 1979–2003. *Note*: Rural categories based on the Rural, Regional, Metropolitan Area classification: Metropolitan (capital cities, other metropolitan areas); Rural areas (large and small rural centres, other rural areas); Remote areas (remote centres, other remote areas).

metropolitan areas over time, especially in young males aged 15–24 years. Male suicide rates increased significantly in all areas over the study period, then diverged markedly in the most recent period (1999–2003) with decreases in suicide in metropolitan and rural areas, but further increases in remote

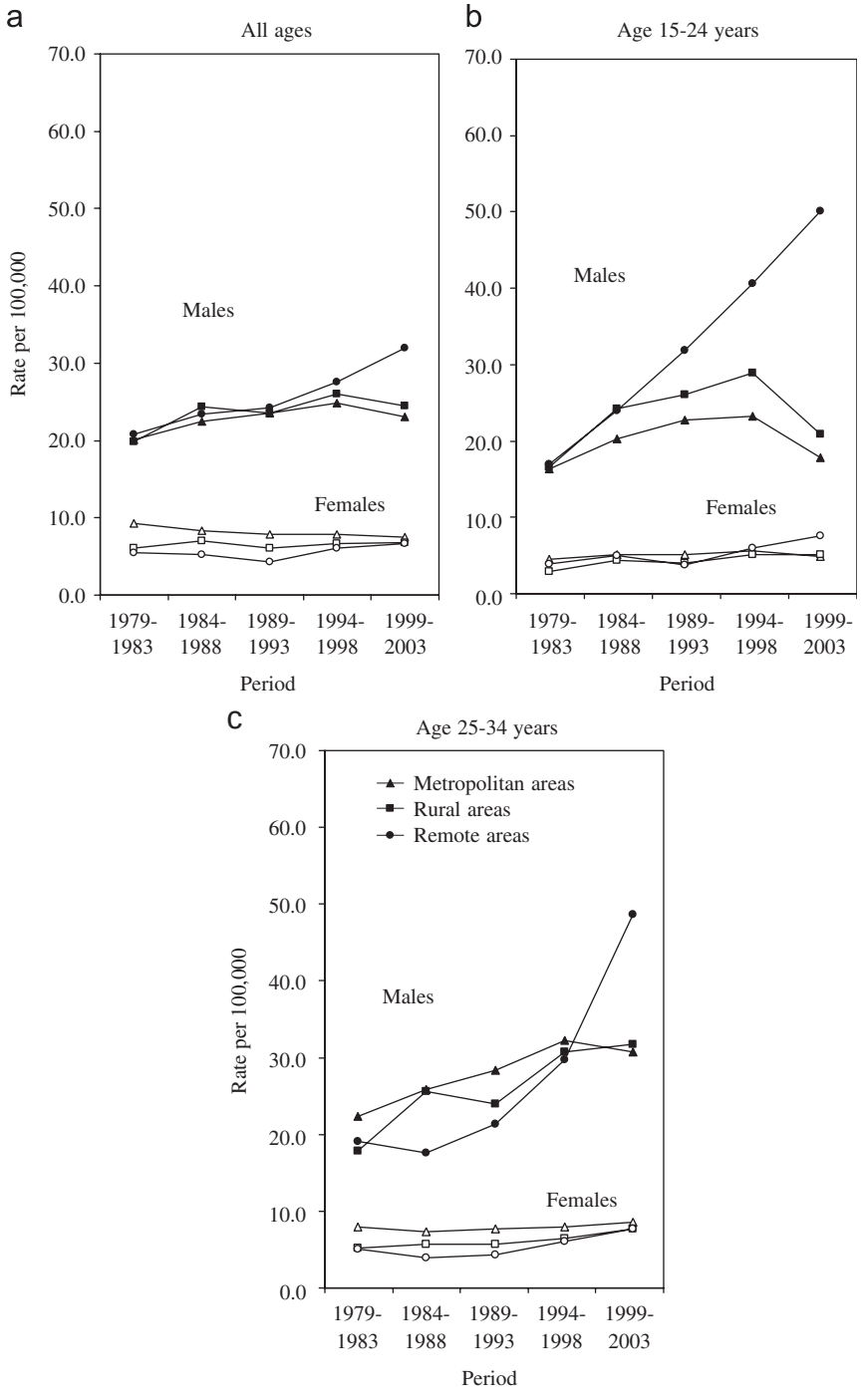

Fig. 3. Australian suicide rates by metropolitan areas, rural areas and remote areas, adjusted for age, country-of-birth and SES 1979–2003. *Note*: Rural categories based on the Rural, Regional, Metropolitan Area classification: Metropolitan (capital cities, other metropolitan areas); Rural areas (large and small rural centres, other rural areas); Remote areas (remote centres, other remote areas).

areas. Suicide rates in females were lower in rural and remote areas, but increased over time and by the latter part of the study period were similar to female suicide rates in metropolitan areas. Adjusting male and female models for SES in addition to age and country-of-birth decreased urban–rural

suicide differentials in both males and females, and is consistent with socio-economic factors partly mediating regional differences in suicide.

There are a number of limitations to this study that need to be considered in interpreting these results. First, misclassification bias may be evident in the outcome variable (suicide) and area-based study factors (urban–rural residence and SES) due to boundary changes to the small-area units of analysis over the relatively long study period. The observed secular trends by geographic categories could be affected by the changing geographic characteristics of LGAs over time (for example 'rural' areas on the outskirts of metropolitan centres becoming 'urban'). It is expected that such misclassification would be minimal as LGAs were grouped into SES quintiles and periods into 5 years, coded to the nearest census year of each quinquennium. The net result in any case would reduce the observed differences in suicide between urban and rural areas (i.e. bias results towards the null).

Also of importance is the definition of 'rurality' used in the present study. Defining a separate 'remote' category showed differences over time that would otherwise have been obscured if more aggregated rural groups were used. Even so, the categories defined for analysis (metropolitan, rural areas, remote areas) aggregated small-areas with differing characteristics and sub-populations. Different rural sub-populations may respond uniquely to particular environmental characteristics and other structural factors associated with rural and remote areas, or have different exposures to antecedent factors associated with suicide. Additionally, the characteristics of urban and rural areas may be subject to the effects of internal migration of (less suicide prone) individuals from rural areas to urban areas, and vice versa. The urban and rural categories used in the present study comprise heterogeneous populations, and suicide rates in particular sub-groups, such as farmers and agricultural labourers (Page & Fragar, 2002), and Indigenous groups (notwithstanding issues of enumeration) (Hunter & Harvey, 2002), may differ within rural areas compared to other sub-groups.

To some extent this heterogeneity was accounted for by adjusting for age and migrant status using individual-level data, and the economic resources of the area. As Indigenous status is unreliably recorded on Australian mortality data in most jurisdictions, it was not possible to examine suicide by Aboriginal or Torres Strait Islander status. However, Indigenous population compositions are highest in the remotest areas of Australia, and it is likely that a substantial proportion of the suicide excess in these areas, and its continued increase compared to decreases in non-remote areas may be of Indigenous origin.

Migrants have different (usually lower) suicide rates than the Australian born (Morrell et al., 1999; Taylor et al., 1998). Migrants are also differentially distributed between urban and rural areas (proportionally less in rural areas), and across SES groups (proportionally less in upper SES groups) (Taylor et al., 2005). Significant SES suicide differentials have also previously been demonstrated in Australian suicide (higher suicide rates in lower SES groups compared to higher SES groups) (Page et al., 2002; Taylor et al., 1998), and SES also differs by urban–rural residence, with proportionally less rural residents in upper SES groups (Taylor et al., 2005). The present study accounted for these socio-demographic factors by adjusting for confounding by age and country-of-birth, and by considering the mediating effect of SES on urban–rural suicide differentials.

Investigating suicide in specific sub-populations in rural areas has inherent difficulties associated with sparse data which can produce substantial stochastic variation in rates over time (due to small underlying numerators and denominators) which can be over-interpreted. To address this, the present study aggregated data over 5-year periods to minimise stochastic effects, and used Poisson regression to model counts of suicide offset by the population (logarithm), a method which considers underlying population size in calculating statistical significance.

This is the first study to demonstrate that urban–rural differentials in suicide have continued to widen in the most recent period (1999–2003) largely due to decreases in large rural and metropolitan areas and further increases in remote areas, and that differentials between metropolitan and remote areas are the largest they have been for the past 25 years. Previous investigations of secular trends in Australian rural suicide have found significant differentials between urban and rural areas in young males (Dudley et al., 1998; Wilkinson & Gunnell, 2000) and found a divergence between metropolitan and rural areas (Dudley et al., 1997). However, these studies examined age-adjusted or age-specific suicide rates, and did not control for confounding by country-of-birth or

consider the mediating effects of SES on urban–rural suicide differentials. Wilkinson and Gunnell (2000) found no divergence in suicide between urban and rural areas in a recent Australian study of age-adjusted suicide rates over a 10-year period (1988–1997), but used a definition of 'metropolitan' (>20,000 people) that would have comprised regional centres (as defined in the present study) as well as metropolitan areas (Wilkinson & Gunnell, 2000).

The present study found the largest differences between metropolitan and rural suicide rates to be in young males aged 15–24 years, after considering the effects of migrant composition and SES, which is also consistent with previous studies that considered age-specific rates only (Dudley et al., 1997., 1998). Findings from the present study, not previously demonstrated, show a diverging trend attributable to a continued increase in suicide in remote areas alongside a decline in suicide in large rural and metropolitan areas. The present study also did not find substantial urban–rural suicide differences in the 25–34 year age group, similar to previous studies (Wilkinson & Gunnell, 2000), until the most recent period (1999–2003) at which time male suicide rates in this age group increased further in remote areas and were significantly greater than rates in the metropolitan areas. This increase in the 25–34 year age group has previously not been shown.

Lower age-adjusted female suicide rates in non-metropolitan areas compared to metropolitan areas have also previously been noted (Wilkinson & Gunnell, 2000), although the significant increase over time in rural female suicide, after accounting for important socio-demographic factors, has not been previously demonstrated in Australia or internationally.

The peak of the youth suicide epidemic in males coincided with the implementation of the national youth suicide prevention strategy. In considering the implications of the present study, one explanation could be that the national strategy reduced suicide successfully in metropolitan and rural areas, but not in remote areas. Suicide prevention programmes and policies may have been more intensive, better resourced, and more relevant to the circumstances of more populated areas of Australia. Populations in metropolitan and rural areas may also have been more receptive to prevention messages. Further increases in suicide have also been found in areas of low SES in the period after the suicide prevention strategy was implemented (Page et al., 2006), areas which comprise both metropolitan and rural areas. The present study adjusted for these effects, and found that the large urban–rural differentials remained.

What may also be important is the significant public awareness of youth suicide as a public health issue, which occurred contemporaneously to the development and implementation of the national strategy. The response of government was largely a response to community awareness, public health advocacy, and research on suicide trends in young males, and it may be that these factors, and other economic and cultural shifts, occurred at the same time as the national strategy, differentially distributed by geographic area. Also, it is important to note in this context that the marked increase over the 1990s and subsequent decline in young male suicide after 1997 is most obvious in Australia. There were declines in young male suicide (15–24 years and 25–44 years) in Ireland and New Zealand after 1997, however, these declines were of a lesser magnitude and followed a different secular pattern from 1980 than young males in Australia (AISRAP, 2003). Other Western countries (e.g. Canada, US, England, Scotland, Northern Ireland) showed no substantial declines in the period after 1997 (AISRAP, 2003).

Gender also has a major effect on suicide risk, with males 4–5 times more likely to die from this cause than females in Australia, and an even greater sex differential exists in rural areas where women have lower rates of suicide compared to females in urban areas. The gender difference of the effect of rurality on suicide in Australia is striking. Higher suicide rates occurring in males residing in non-metropolitan areas (compared to metropolitan areas), especially among youth, have been attributed to ongoing economic change in rural communities and the agricultural industry, and a chronic lack of employment opportunities in rural and remote areas (Baume & Clinton, 1997; Dudley et al., 1997; Page & Fragar, 2002).

As well, perceived life choices in females are different than in males, in terms of family and occupational roles (Morrell et al., 1999). Lower female suicide rates in rural areas have been attributed to a greater variety of social networks available to women (Dudley et al., 1997; Morrell et al., 1999) and the use of less lethal means of suicide (Dudley et al., 1997). The increasing trend in rural male and female suicide, especially in younger

age groups, is perhaps indicative of the effects of structural change and social fragmentation unique to rural communities over the previous three decades, over and above the socio-economic effects previously shown to be associated with suicide (Saunderson et al., 1998; Whitley, Gunnell, Dorling, & Smith, 1999).

Other psychosocial environmental factors include, for some people, the isolation and rigours of rural life, greater access to firearms, and a prevailing rural masculine culture (Baume & Clinton, 1997). Higher levels of stress-related illness and drug abuse in rural areas, compared to urban areas, coupled with poor levels of mental health service provision, have also been suggested as contributing to high rural suicide rates in males (Dudley et al., 1997). However, a recent cross-sectional study of Australian suicide has shown that mental disorder (including drug and alcohol use) and mental health service utilisation are more likely to be intermediary factors, with socio-economic factors accounting for a greater part of the urban–rural suicide rate difference in males (Taylor et al., 2005). This study used a broad urban–rural category and did not consider remoteness separately, as in the present study.

The difference in young male suicide between metropolitan and remote areas is the largest it has been for the previous 25 years. Male young adult suicide continued to increase in remote areas, while in metropolitan and larger rural areas suicide rates declined. Suicide prevention activities may have reduced rates of suicide and ameliorated the effects of some antecedents to suicide, but these benefits appear to have been shared differentially by geography.

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Papers

Association between antidepressant prescribing and suicide in Australia, 1991-2000: trend analysis

Wayne D Hall, Andrea Mant, Philip B Mitchell, Valerie A Rendle, Ian B Hickie, Peter McManus

Abstract

Objective To examine the association between trends in antidepressant prescribing and suicide rates in Australia for 1991-2000.

Design Analysis of databases of suicide and rates of antidepressant prescribing according to age and sex.

Setting Australian Bureau of Statistics data, sales data from the Australian pharmaceutical industry, prescribing data in general practice.

Subjects Men and women aged 15 years and over in 10 year age groups.

Main outcome measures Trends in suicide rates and trends in antidepressant prescribing. Association measured by Spearman's rank correlations.

Results While overall national rates of suicide did not fall significantly, incidence decreased in older men and women and increased in younger adults. In both men ($r_s = -0.91$; $P < 0.01$) and women ($r_s = -0.76$; $P < 0.05$) the higher the exposure to antidepressants the larger the decline in rate of suicide.

Conclusions Changes in suicide rates and exposure to antidepressants in Australia for 1991-2000 are significantly associated. This effect is most apparent in older age groups, in which rates of suicide decreased substantially in association with exposure to antidepressants. The increase in antidepressant prescribing may be a proxy marker for improved overall management of depression. If so, increased prescribing of selective serotonin reuptake inhibitors in general practice may have produced a quantifiable benefit in population mental health.

Introduction

In many developed countries the number of prescriptions for antidepressants increased steeply during the 1990s, after the introduction of selective serotonin reuptake inhibitors (SSRIs).[1–4] In some countries the increased rate of prescribing coincided with fall in the suicide rate.[2–4]

Research has been carried out to test the hypothesis that increased antidepressant prescribing was partially responsible for this decline. In Sweden between 1991 and 1996 antidepressant prescribing increased steeply after the introduction of the SSRIs in 1990, and the rate of suicides was inversely related to rates of antidepressant prescribing in most age and sex groups.[3] In another study in Sweden Carlsten et al examined data for 1977-97 (using official mortality statistics) and data on antidepressant use from surveys of sales to pharmacies.[2] They found that suicide rates declined over the whole study period, but the rate of decline accelerated after the SSRIs were introduced in 1990. In Hungary in 1984-98 antidepressant prescribing rose steeply after the introduction of SSRIs in the early 1990s and rates of suicide declined, despite steep increases in unemployment and per capita alcohol consumption.[4]

Contrary to these positive findings, however, in Italy Barbui et al did not find any association between suicide rates and antidepressant use for 1986-96, during which time SSRIs were introduced.[5]

We examined the association between changes in antidepressant prescribing in Australia for 1991-2000 and changes in rates of suicide. We analysed differences in suicide trends between men and women in different age groups to assess whether age and sex rates in suicide were related to differences between age and sex groups in exposure to antidepressant medication. We also examined any differences between age and sex groups in rates of antidepressant prescribing and whether these were related to trends in suicide rates in these age and sex groups.

Methods

We used a quasi-experimental approach to analyse associations using prospectively collected data sets.[6] We used information on per capita alcohol consumption, unemployment rates, and method of suicide to assess the plausibility of competing explanations of any associations.

Suicide—The Australian Bureau of Statistics provided data on the age and sex in all cases of suicides for each year for 1986-90 and 1996-2000.[7] We calculated annual mortality for men and women in eight age groups (15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, and ≥85 years) using population estimates.

Antidepressant use—We estimated trends in prescribing of antidepressants by combining data on sales with estimates of the proportion of antidepressants that were prescribed to men and women in the eight age groups. Data on total sales of antidepressants were obtained from IMS Health Australia, the leading international provider of data on drug use to the pharmaceutical and healthcare industries. We converted data (retrieved as kilograms of active ingredient)

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to defined daily dose (DDDs). This figure is based on the assumed average daily dose of the drug when it is used by adults for its main indication.[8] The estimated age and sex profile of people prescribed antidepressant drugs was derived from a series of large scale surveys of prescribing by Australian general practitioners, who account for the bulk of such prescribing in Australia.[9–11] Information collected from these surveys was encounter based with randomly sampled general practitioners (in 1990-1, 1995, and 1998-2001) recording prescription practices over a set number of consecutive encounters. The level of antidepressant prescribing in each age and sex group was expressed as the estimated defined daily doses per 1000 population per day (DDD/1000/day).

Statistical analyses—We used Spearman rank correlations (r_s) to assess the associations between trends in rates of suicide and trends in antidepressant prescribing for each sex. The trend in suicide within each age group was measured by the difference between the suicide rates per 100 000 people in two five year periods (1986-90 and 1996-2000). We assessed the trends in antidepressant prescribing by the mean of the DDD/1000/day in each age group across the three large general practice surveys and by the difference between the DDD/1000/day in 1991 and that in 2000. The former was a measure of each group's total exposure to antidepressants; the latter was a measure of the change in rate of antidepressant prescribing for the group over the study period.

Results

Trends in suicide and antidepressant prescribing—The total suicide rate for Australian men and women did not change between 1991 and 2000 because marked decreases in older men and women (table 1) were offset by increases in younger adults, especially younger men.[7] Between 1991 and 1998 the rate fluctuated between a low of 11.8 in 1993 and a high of 14.7 per 100 000 in 1997, when there were 2723 suicides (2146 men and 577 women).[7] Table 2 shows the trends in DDD/1000/day for each age group separately for men and women. Exposure to antidepressants was generally higher for women than men in all age groups and increased markedly for both men and women over the study period, with the largest increases among older adults.

Association between suicide and antidepressant prescribing—Among both men ($r_s = -0.91$; 95% confidence interval -0.57 to -0.98) and women ($r_s = -0.76$; -0.12 to -0.95) the largest declines in suicide occurred in the age groups with the highest exposure to antidepressants across the study period (fig 1). There was also a significant inverse association between change in DDD/1000/day and change in suicide in women ($r_s = -0.74$; -0.07 to -0.95, fig 2). The latter correlation was not significant in men but the confidence interval around it was consistent with a large negative correlation ($r_s = -0.62$; 0.36 to -0.80; fig 2).

Discussion

We found a steep increase in antidepressant prescribing in Australia from 1991 to 2000, which, unlike in earlier studies, was not accompanied by a decline in overall rates of suicide because there was a large increase in suicide in young people over the same period.[7] There was, however, a strong association between the groups with high exposure to antidepressants and the groups in which the rate of suicide fell. The groups with the highest antidepressant exposure showed the largest declines in suicide.

Making causal inferences from ecological data

Because we have studied ecological rather than individual level data, correlations between overall trends in suicide rate and antidepressant prescribing do not necessarily mean that antidepressant prescribing has reduced rates of suicide in depressed patients. Ecological data can support causal inferences if they

Table 1 Rates of suicide (per 100 000 people) in Australia by sex and age, 1986-2000

	Men			Women		
Age (years)	1986-90	1991-5	1996-2000	1986-90	1991-5	1996-2000
15-24	24.83	26.05	24.81	4.75	5.35	5.74
25-34	28.90	30.32	35.73	6.69	6.60	7.52
35-44	25.04	26.17	30.49	7.01	7.10	8.34
45-54	24.09	24.77	23.78	8.31	7.17	6.94
55-64	25.13	22.75	20.68	8.07	7.04	6.00
65-74	27.32	23.24	21.91	8.36	5.95	5.78
75-84	36.53	30.37	28.68	8.13	7.63	5.74
≥85	44.02	40.49	37.45	6.90	5.53	4.09

Table 2 Estimated use of antidepressants (defined daily dose/1000 people/day) by sex and age

	Men			Women		
Age (years)	1990-91	1995	1998-2001	1990-1	1995	1998-2001
15-24	1.2	2.7	14.3	3.2	7.9	30.7
25-34	3.5	11.8	26.4	10.4	22.2	58.0
35-44	7.6	15.8	36.4	14.6	29.5	73.1
45-54	10.9	20.0	43.0	24.2	47.2	86.7
55-64	14.5	23.6	44.8	32.9	50.9	87.8
65-74	24.1	29.6	47.5	40.0	60.5	103.6
75-84	29.6	38.2	61.3	45.7	67.6	114.2
≥85	29.0	50.7	74.3	29.6	46.1	93.4

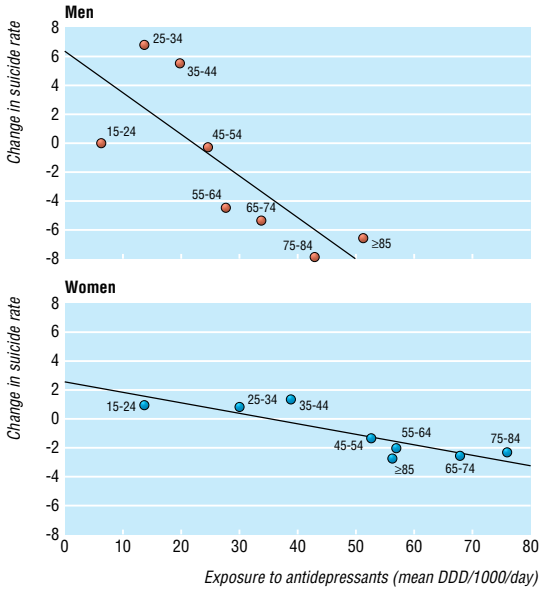

Fig 1 Change in suicide rate by level of exposure to antidepressants in each age group among men and women aged >15 years

are supported by other evidence, both negative and positive. Negative evidence supports the implausibility of alternative explanations of the association. Positive evidence supports a causal explanation of the observed association—for example, by supporting a mechanism that would explain the association.

Excluding plausible alternative explanations

Systematic errors in the data on suicide or antidepressants may have biased the results. Suicides, for example, are under-reported, and there are likely to be errors in using general practice prescription profiles to estimate sex and age differences in use from sales data. It is unlikely, however, that under-reporting of suicide should have changed over time or that such under-reporting, or any errors in the general practice survey data, would both vary by age and sex in the ways required to explain the patterns in our data.

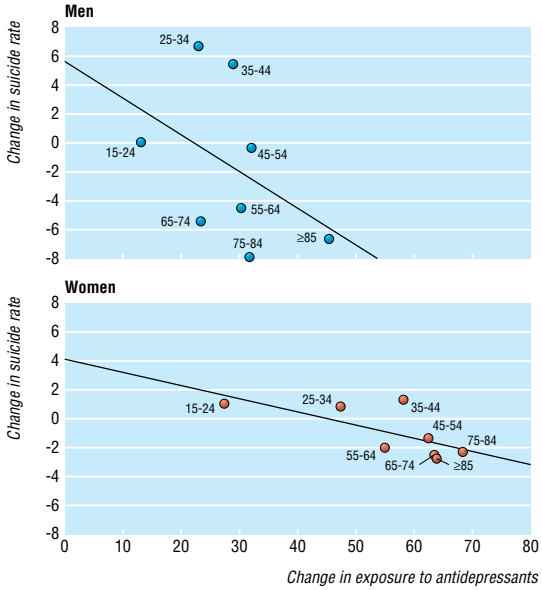

Fig 2 Change in suicide rate by change (from 1991 to 2000) in level of exposure to antidepressants for each age group among men and women aged >15 years

Trends in risk factors for suicide, such as unemployment and per capita alcohol consumption, may explain the decline in suicide. Per capita alcohol consumption (calculated from sales data) shows a substantial decline in the early 1990s in Australia, but it remained steady throughout the remainder of the 1990s.[12] This was mirrored by trends in alcohol related injuries.[13]

Among older men unemployment increased during the study period,[14] excluding this as an explanation for the reduction in suicide among men in this age group. Increases in unemployment in younger men may have contributed to the rising suicide rate in this age group.[15] There is no evidence of marked changes in method of suicide that would explain the different rates of decline in suicide between age groups.[7] We can also exclude the possibility that the declines in suicide rates reflect education campaigns to reduce suicide because in Australia these campaigns have focused on suicide among young men.

Declining suicide rates in older Australian adults may reflect a general improvement in quality of life among older Australians. This is not supported by surveys of self reported quality of life in Australia in 1981-9 and 1996-7.[16] There was no change in quality of life over this period and no differences in change in quality of life between older and younger Australians.[16]

Positive evidence for a causal interpretation

There are several reasons for believing that increased antidepressant prescribing may have contributed to the decline in suicide. Firstly, depression is a risk factor for suicide, and antidepressants reduce suicidal ideation. There is little direct evidence that antidepressants reduce the suicide rate because suicide is rare even among clinically depressed people, and even large clinical trials of antidepressants have had limited power to detect a reduction. None the less, there is reasonable epidemiological evidence that antidepressants reduce suicide rates in depressed patients.[17]

Secondly, the prescription of antidepressant drugs is also often accompanied by other assessments (such as asking about suicide risk, giving information to family members) and clinical interventions (counselling, support, ongoing clinical review). These interventions, in combination with medication, may reduce suicidal behaviour.[18]

Thirdly, the introduction of selective serotonin reuptake inhibitors may have been responsible for increased prescribing and other interventions for depression in primary care. These drugs have a lower rate of sedation, postural hypotension, and cardiac changes, fewer serious drug interactions, and greater safety in overdose than older types of antidepressant.[19] These characteristics have reduced doctors' reluctance to prescribe such drugs to older patients,[20] patients with other medical problems or who are using other medications, and working patients for whom sedation is a major limitation. General practitioners are now more likely to prescribe antidepressant drugs without referring patients to a specialist.[18]

What is already known on this topic

There has been a substantial increase in antidepressant prescribing by general practitioners in Australia since the introduction of selective serotoin reuptake inhibitors in the early 1990s

Previous studies have indicated an association between increased antidepressant prescribing and reduced suicide rate

What this study adds

In Australia the rate of suicide fell in older people, the age group most heavily exposed to antidepressants

Most antidepressants are now prescribed by general practitioners

The association may indicate the improved treatment of depression by general practitioners

Finally, formulations of selective serotonin reuptake inhibitors (for example, one tablet once a day) improve compliance with treatment. While some patients are reluctant to start antidepressant treatment,[21] experiences with the safety, tolerability, and benefits of selective serotonin reuptake inhibitors may be changing attitudes towards drug treatment for depression,[21] which may, in turn, have increased treatment seeking and compliance in older men and women.[18]

We think that antidepressant prescribing is a proxy measure for exposure to psychosocial and pharmacological interventions delivered by a general pracitioner for depression, anxiety, and other comorbid psychological disorders. Data from Australian general practice surveys indicate that general practitioners identify a wide range of psychological disorders, provide more non-pharmacological than pharmacological interventions, and, when they use pharmacological treatments, rarely provide them without psychosocial assessment and support.[11 18 22]

Recognition of psychological disorders in general practice and general practitioners' use of psychosocial and pharmacological treatments for depression may have improved.[23] Given these trends in general practice, the association we observed between antidepressant prescribing and suicide may reflect increased recognition, diagnosis, and treatment of depression by general practitioners as much as any pharmacological effects of antidepressant medication.[18 22] If this proves to be the most plausible explanation of our data, it supports the public policy of encouraging general practitioners to improve community mental health.[18 23 24]

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Competing interests: AM was a consultant on Quality Use of Medicines to Merck, Sharp and Dohme Australia (1997), has been a member of advisory boards for Pfizer and Sanofi-Synthelabo (1999-2000), and was sponsored to attend Global Health Care 2000 Conference (Eli-Lilly). PBM has received research funding and honorariums in the past five years from several pharmaceutical companies that manufacture antidepressant medications. IBH has received research funding and honorariums in the past five years from several pharmaceutical companies for conduct of general practice training programmes and from Wyeth for participation in international meetings detailing the economic and social costs of depression.

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