

RESEARCH ARTICLE

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Smoking, mental illness and socioeconomic disadvantage: analysis of the Australian National Survey of Mental Health and Wellbeing

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Abstract

Background: High rates of smoking and lower rates of smoking cessation are known to be associated with common mental disorders such as anxiety and depression, and with individual and community measures of socioeconomic status. It is not known to what extent mental illness and socioeconomic status might be jointly associated with smoking behaviour. We set out to examine the relationship between mental illness, measures of socioeconomic disadvantage and both current smoking and smoking cessation rates.

Methods: We used data from the 2007 Australian National Survey of Mental Health and Wellbeing to examine the relationship between mental illness, socioeconomic status and both current smoking and smoking cessation. We used cross-classified tables and logistic regression to examine the relationship between psychosocial and sociodemographic predictors and current smoking. We also used proportional hazards regression to examine the relationship between the factors and smoking cessation.

Results: Both mental illness and socioeconomic status were independently associated with current smoking and with lower likelihood of smoking cessation, with gradients in smoking by mental health status being observed within levels of socioeconomic indicators and vice versa. Having a mental illness in the past 12 months was the most prevalent factor strongly associated with smoking, affecting 20.0% of the population, associated with increased current smoking (OR 2.43; 95% CI: 1.97-3.01) and reduced likelihood of smoking cessation (HR: 0.77; 95% CI: 0.65-0.91).

Conclusions: The association between mental illness and smoking is not explained by the association between mental illness and socioeconomic status. There are strong socioeconomic and psychosocial gradients in both current smoking and smoking cessation. Incorporating knowledge of the other adverse factors in smokers' lives may increase the penetration of tobacco control interventions in population groups that have historically benefitted less from these activities.

Background

There have been enormous declines in smoking rates in Australia and other developed countries since the 1950s [1-3]. There is substantial evidence to show that current smoking and lower rates of smoking cessation are associated with common mental health problems such as anxiety, depression and dependence on alcohol or other drugs, and are also associated with a range of indicators

of socioeconomic disadvantage such as income, educational attainment, and measures of community disadvantage. For instance, it has been estimated that a third of current adult smokers in Australia and the United States have common mental disorders such as anxiety, depression and alcohol and drug use disorders [4,5]. Despite similar levels of wanting to quit, attempting to quit and similar levels of access to smoking cessation therapies, compared with other smokers, people with mental disorders have lower smoking cessation rates, smoke on average for longer durations and suffer increased morbidity and mortality as a result [6,7].

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Both individual and area-level markers of socioeconomic status have been associated with smoking status [8-10]. Lower levels of socioeconomic status are associated with a range of lifestyle risk factors for poor health outcomes, lesser interest in lifestyle changes for health reasons, and reduced access to health care and health services [11,12]. Socioeconomic disadvantage is also associated with poorer mental health, and poor health outcomes in general [13,14].

Knowledge of the sociodemographic and psychosocial characteristics of smokers is helpful in planning future tobacco control activities. Tobacco control policies and programs have been very effective in reducing smoking rates in developed countries, but these programs have been most successful among more highly educated people, and people without other complicating factors such as mental illness [15-17]. Some have suggested that continued reductions in smoking rates will require adapting tobacco control policies to the specific challenges facing today's smokers [17,18]. Recognition of the changing demographic among current smokers and the need for innovation in tobacco control to address this population is starting to occur with, for instance, the Australian National Preventative Health Taskforce proposing a variety of measures designed to target a range of population sub-groups known to be at high risk of smoking, including prisoners, homeless people, and people living in highly disadvantaged neighbourhoods [19]. Where programs and public health promotions have been designed to address the issue of mental illness, these have almost always focussed on severe mental illness such as schizophrenia, or people living in institutionalised settings or in receipt of specialised mental health treatment [20,21]. Reference to people with common mental disorders living in the community is noticeably absent from major tobacco control policy documents in Australia and the United States [19,22].

While a range of sociodemographic and psychosocial factors has been identified that are associated with current smoking and lower quit rates, it is unknown to what extent these factors interact. It is possible that the relationships observed between smoking and anxiety and depressive disorders merely reflect the higher prevalence of these disorders among population groups with lower levels of socioeconomic status. Alternatively the association with socioeconomic disadvantage may reflect the higher proportion of mental disorders in these groups. It is also plausible that both sets of factors are associated with smoking outcomes, and they may interact in some way.

Using a large population-based sample of Australian adults which assessed smoking status and history along with a comprehensive assessment of mental health status and measurement of a large range of individual and familial markers of socioeconomic status along with a small

area measure of socioeconomic status, we examined the relationship between individual factors and both current smoking and smoking cessation rates, the degree to which these factors co-occur and their joint association with smoking status. We set out to test the null hypothesis that after adjusting for a comprehensive set of markers of socioeconomic disadvantage there would be no independent association between mental health status and smoking.

Methods

Data source

We used data from a large-scale population-representative sample of Australian adults aged between 16–85 years. The Australian National Survey of Mental Health and Wellbeing (NSMHWB) was conducted by the Australian Bureau of Statistics (ABS) between August and December 2007 [23,24]. It comprised a nationally representative sample of 8,841 adults aged 16–85 years living in private dwellings, based on a stratified multistage area-based sample design. The survey was conducted by means of personal interview in the home. While the principal aim of the survey was to measure the prevalence of three major groups of mental disorders — anxiety disorders, affective disorders and substance use disorders — the survey also collected a comprehensive set of sociodemographic indicators, and assessed smoking status and smoking history. Full details of the survey methodology have been published elsewhere [25,26].

As the study consisted of analysis of publicly available confidentialised files, no institutional ethics approval was required.

Measures

Tobacco use

In the NSMHWB, respondents were asked, “have you smoked at least 100 cigarettes in your life?” and “do you currently smoke every day, at least weekly, less than weekly, or not at all?” Current smokers were asked, “at what age did you start smoking every day?” Non-current smokers were asked “have you ever smoked every day?” If so they were asked “at what age did you start smoking every day?” All former smokers were asked “at what age did you stop smoking every day?” Having smoked at least 100 cigarettes is a commonly used measure of being a lifetime ever smoker to rule out teenage experimentation. These questions were used to classify all survey participants as current smokers, former smokers or lifetime non-smokers. For current and former smokers, age started smoking and age ceased smoking for former smokers were used to analyse time to smoking cessation.

Mental illness

Mental disorders were assessed in the NSMHWB using Version 3 of the World Health Organization's Composite

International Diagnostic Interview (CIDI) [27]. The CIDI is a fully structured interview questionnaire which was administered by lay interviewers using computer assisted interviewing software. The CIDI is designed to cover the diagnostic criteria for mental disorders in both the International Classification of Diseases, 10th edition (ICD-10) [28], and the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) [29]. The CIDI includes an initial screener for major symptoms of mental disorders followed by detailed questions on each disorder. The average interview time in the NSMHWB was 90 minutes, with the majority of the time taken up by the administration of the CIDI.

For the purposes of this report, ICD-10 diagnoses were employed, although similar results are found with the DSM-IV diagnoses. Presence of the following disorders was assessed in the survey: anxiety disorder (panic disorder, social phobia, agoraphobia, generalised anxiety disorder, post-traumatic stress disorder or obsessive-compulsive disorder), depressive disorder (depressive episode, dysthymia or bipolar affective disorder), or substance use disorder (alcohol harmful use, alcohol dependence, drug dependence). Both lifetime and past 12-month status were assessed.

Indicators of socioeconomic status

Household income

Household income is derived from the income of all usual residents 15 years and older. For each resident the household spokesperson was asked, "before income tax is taken out how much does he/she receive from all sources in total?" Household incomes were grouped into quintiles.

Education

To determine highest level of educational attainment each respondent was asked, "what was the highest year of primary or secondary school you completed?" followed by, "what is the level of the highest qualification that you have completed?" These questions were combined to create a measure of educational attainment based on highest year of schooling completed for people with no post-school qualification, or otherwise based on level of post-school qualification.

Ever been homeless

All respondents were asked "have you ever been homeless?"

Ever been in gaol, prison or correctional facility

Respondents were asked, "were you ever in gaol, prison or a correctional facility?"

Registered marital status

Respondents were asked, "what is your marital status?" If they reported that they were in a de facto relationship,

single or not married they were asked, "have you ever been in a registered marriage?" and if so, "are you widowed, divorced or separated?"

Tenure type

Tenure type was established through a series of questions to respondents. Respondents were asked, "is this dwelling being paid off by you [or your spouse/partner/parent]?" If no, they were asked, "is this dwelling owned outright by you [or your spouse/partner/parent]?" If no, they were asked, "is this dwelling rented by you [or your spouse/partner/parent]?" If no, they were asked, "is this dwelling being purchased under a rent/buy or shared equity scheme by you [or your spouse/partner/parent]?" If none of these questions were endorsed the respondent was asked, "do you [or your spouse/partner/parents] occupy this dwelling under a life tenure scheme?" If no, they were asked, "do you [or your spouse/partner/parents] pay board to live here?" and if no they were asked, "do you [or your spouse/partner/parents] live here rent free?"

Financial difficulties

To determine if the household has had financial difficulties respondents were asked, "over the past 12 months, have any of the following happened to (you/your household) because of a shortage of money?" Respondents were shown a list of seven items which included, "could not pay electricity, gas or telephone bills on time", "could not pay for car registration or insurance on time", "pawned or sold something", "went without meals", "unable to heat my home", "sought assistance from welfare/community organisations" and "sought financial help from friends or family". Households were classified as having experienced financial difficulties in the last 12 months if any of these items was endorsed.

Labour force status

To establish if respondents were employed, unemployed or not in the labour force they were asked, "last week did you do any work at all in a job, business or farm?" and if not, "did you have a job, business or farm that you were away from because of holidays, sickness or any other reason?"

Occupation of main job

Those respondents who were currently employed were asked, "what was your occupation in that job?", "what were your main tasks or duties?", "what kind of business or service is carried out by your employer in the place where you work?" and "what is the name of your employer?" Based on this information occupations were classified according to the Australian and New Zealand Standard Classification of Occupations [30].

Family composition of household

The family composition of the household was derived from all the people usually living in the household and the relationships between them. For each individual the household spokesperson was asked, "What is (your/PERSON'S) relationship to (HOUSEHOLD REFERENCE PERSON/you)?"

Main source of income

Respondents were asked to respond to the question, "what is your main source of income?" by selecting one of the following answers "profit or loss from own unincorporated business or share in a partnership", "profit or loss from rental properties", "dividends or interest", "wages/salary (including from own unincorporated business)", "government pension or allowance (include family tax benefit, if received as payment from centrelink)", "child support or maintenance", "superannuation or annuity", "workers' compensation" or "any other regular source".

Relative socio-economic disadvantage

In addition to these individual and household measures, all respondent addresses were geocoded to the level of census collection districts (CCDs). These are small geographic areas averaging around 200–250 households in size. Based on data collected in the 2006 Australian Census of Population and Housing, all CCDs have been assigned an Index of Relative Socioeconomic Disadvantage. This is based on proportion of people living in that area with low income, low educational attainment, unemployment, and dwellings without motor vehicles [31]. All CCDs in Australia were ranked by this index and grouped into quintiles.

Weighted estimates and standard errors

Survey weights were applied to calculate estimates of totals and proportions. These weights have been calculated to adjust for potential non-response. Standard errors and confidence intervals for the NSMHWB were calculated using the jack-knife method of replicate weighting [32]. For each indicator of socioeconomic status we calculated the proportion of the population that fell into each level of that indicator. Within each level we calculated the proportion of the population within that level that were current smokers, and that had mental illness either in the past 12 months, or in their lifetime but not in the past 12 months. Within each level we also calculated the proportion of the population who were current smokers by whether or not they had mental illness in the past 12 months, lifetime mental illness but not in the past 12 months, or did not meet criteria for lifetime mental illness. Tests of association were performed using the Rao-Scott adjustment for complex sample design [33].

We used logistic regression to assess the association between mental illness, each of the indicators of socioeconomic status, and current smoking status. Proportional hazards regression was used to assess the relationship between mental illness, each of the indicators of socioeconomic status, and time to smoking cessation, among ever smokers. We used age first started smoking as the start time for this analysis. For former smokers, age ceased smoking as used as the event time, while current smokers were censored at their current age. The complex survey design was accounted for using the SURVEYLOGISTIC and SURVEYPHREG procedures within SAS, with variances calculated using the jack-knife method of replicate weighting [32]. All analysis was conducted using Version 9.2 of SAS [34].

Results

Mental illness, indicators of socioeconomic disadvantage, and current smoking

For each socioeconomic indicator we calculated the proportion of the population that fell within each level of that indicator, and then within each level, the proportion of the population who smoked and the proportion who had mental disorder in the past 12 months (Table 1). Overall, the proportion of the adult population who were current smokers was 22.3% (95% CI: 20.9%-23.7%). The prevalence of 12-month mental disorder was estimated to be 20.0% (95% CI: 18.9%-21.1%), prevalence of lifetime disorder without 12-month disorder was 25.5% (95% CI: 24.1%-27.0%), prevalence of no lifetime disorder was 54.5% (53.1%-55.9%).

Most of the indicators of socioeconomic disadvantage were associated with both current smoking status and mental illness. For instance, 24.4% of people in the lowest quintile of household income were current smokers (95% CI: 22.0%-26.8%) and 23.6% had mental illness in the past 12 months (95% CI: 20.9%-26.3%), compared with 18.4% who were current smokers (95% CI: 15.4%-21.4%) and 17.9% who had a 12-month mental illness (95% CI: 15.8%-22.8%) among people in the highest quintile of household income (Figure 1). All of the indicators of socioeconomic status were individually associated with current smoking (Table 1). All of these indicators were also associated with 12-month mental illness. While having ever been homeless or having ever been in a gaol, prison or correctional facility were both low prevalence indicators, each showed strong associations with current smoking and mental illness. Among the 3.0% of the adult population who had ever been homeless, 61.0% were current smokers (95% CI: 53.3%-68.8%), and 53.6% had 12-month mental illness (95% CI: 45.7%-61.5%). Among the 2.4% of the adult population who had ever been in gaol, prison or a correctional facility, 64.9% were current smokers (95% CI: 55.1%-74.8%), and 41.1% had a 12-month mental disorder (95% CI: 30.6%-51.6%).

Table 1 Australian adults 16–85 years: Proportion of population, proportion who smoke and proportion with 12-month mental illness, by socioeconomic factors

Parameter	Proportion of population		Current smokers		12-month mental illness	
	Percent	95% CI	Percent	95% CI	Percent	95% CI
Quintiles of household income—						
Lowest quintile	16.8	15.7 - 17.8	24.4	22.0 - 26.8	23.6	20.9 - 26.3
Second quintile	17.0	15.7 - 18.3	23.1	19.5 - 26.7	20.0	17.0 - 23.1
Third quintile	17.0	15.8 - 18.2	21.9	18.5 - 25.3	21.3	18.0 - 24.5
Fourth quintile	16.8	15.7 - 18.0	22.2	19.5 - 25.0	17.7	14.4 - 20.9
Highest quintile	17.0	15.9 - 18.1	18.4	15.4 - 21.4	17.9	14.9 - 20.9
Not stated	15.4	14.2 - 16.6	23.7	19.3 - 28.2	19.3	15.8 - 22.8
			$\chi^2 = 8.19, p = 0.15$		$\chi^2 = 23.2, p = 0.010$	
Quintiles of relative socioeconomic disadvantage—						
Lowest quintile	16.7	14.6 - 18.8	29.6	26.1 - 33.1	21.4	18.4 - 24.4
Second quintile	18.5	16.1 - 20.9	26.8	23.8 - 29.9	20.9	18.5 - 23.2
Third quintile	20.0	17.7 - 22.3	21.8	19.1 - 24.5	21.3	18.0 - 24.7
Fourth quintile	21.8	19.1 - 24.5	19.8	17.2 - 22.3	21.2	18.7 - 23.7
Highest quintile	23.0	20.8 - 25.2	16.1	13.2 - 19.0	15.9	13.1 - 18.6
			$\chi^2 = 53.5, p < 0.001$		$\chi^2 = 19.8, p = 0.011$	
Education—						
Bachelor degree or higher	20.0	19.4 - 20.5	13.4	10.8 - 16.0	16.9	14.7 - 19.2
Diploma	8.5	8.1 - 8.9	21.4	16.6 - 26.2	21.9	17.9 - 25.8
Certificate I/II/III/IV	25.4	24.4 - 26.3	24.8	22.0 - 27.6	20.2	17.9 - 22.4
Year 12	14.4	13.4 - 15.5	22.2	18.8 - 25.6	22.4	19.2 - 25.5
Year 11	6.7	5.9 - 7.4	25.7	20.1 - 31.3	20.9	16.4 - 25.5
Year 10	13.6	12.6 - 14.6	26.8	23.0 - 30.5	21.9	17.7 - 26.0
Year 9 or below	11.4	10.6 - 12.2	25.5	22.2 - 28.9	17.6	14.4 - 20.7
			$\chi^2 = 50.4, p < 0.001$		$\chi^2 = 24.4, p = 0.017$	
Whether ever been homeless—						
Yes	3.0	2.6 - 3.5	61.0	53.3 - 68.8	53.6	45.7 - 61.5
No	97.0	96.5 - 97.4	21.1	19.7 - 22.4	18.9	17.9 - 20.0
			$\chi^2 = 136.2, p < 0.001$		$\chi^2 = 253.5, p < 0.001$	
Whether ever in gaol, prison or correctional facility—						
Yes	2.4	2.0 - 2.8	64.9	55.1 - 74.8	41.1	30.6 - 51.6
No	97.6	97.2 - 98.0	21.2	19.9 - 22.6	19.4	18.4 - 20.5
			$\chi^2 = 99.3, p < 0.001$		$\chi^2 = 50.8, p < 0.001$	
Registered marital status—						
Never married	32.5	31.3 - 33.7	30.9	28.6 - 33.2	27.9	25.7 - 30.0
Married	53.0	51.7 - 54.4	15.5	13.5 - 17.5	14.5	12.6 - 16.3
Widowed	4.5	4.2 - 4.9	13.3	10.0 - 16.6	16.7	12.0 - 21.4
Divorced	7.5	6.8 - 8.2	32.3	27.2 - 37.4	22.6	18.6 - 26.6
Separated	2.5	2.1 - 2.9	39.5	32.5 - 46.6	31.8	25.5 - 38.1
			$\chi^2 = 193.5, p < 0.001$		$\chi^2 = 164.9, p < 0.001$	
Tenure type—						
Owner without a mortgage	32.5	30.8 - 34.1	13.7	12.0 - 15.3	14.7	13.1 - 16.4
Owner with a mortgage	39.9	38.3 - 41.5	21.1	19.1 - 23.2	20.3	18.0 - 22.5

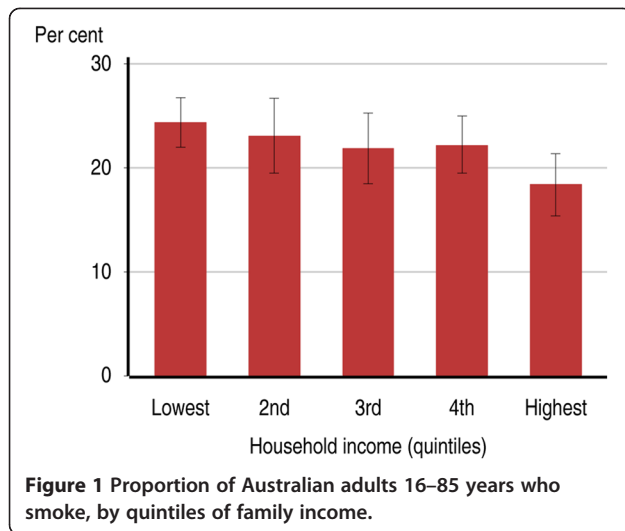
Table 1 Australian adults 16–85 years: Proportion of population, proportion who smoke and proportion with 12-month mental illness, by socioeconomic factors (Continued)

Renter	24.7	23.2 - 26.1	34.9	32.0 - 37.8	26.5	24.1 - 28.8
Other	2.9	2.5 - 3.4	26.2	19.0 - 33.5	19.1	12.6 - 25.6
			$\chi^2 = 178.5, p < 0.001$		$\chi^2 = 96.3, p < 0.001$	
Financial difficulties—						
Yes	14.5	13.4 - 15.6	39.8	35.3 - 44.2	39.1	35.3 - 42.8
No	85.5	84.4 - 86.6	19.3	18.0 - 20.7	16.7	15.5 - 17.9
			$\chi^2 = 101.3, p < 0.001$		$\chi^2 = 172.9, p < 0.001$	
Labour force status—						
Employed	65.2	64.8 - 65.6	23.4	21.7 - 25.1	20.3	18.7 - 21.8
Unemployed	2.6	2.5 - 2.7	50.8	38.9 - 62.6	29.4	20.3 - 38.4
Not in the labour force	32.2	31.8 - 32.5	17.6	15.6 - 19.7	18.6	16.9 - 20.3
			$\chi^2 = 54.7, p < 0.001$		$\chi^2 = 23.9, p < 0.001$	
Occupation of main job—						
Managers	8.9	8.0 - 9.9	17.6	14.4 - 20.8	18.7	14.9 - 22.4
Professionals	13.2	12.2 - 14.3	13.9	10.8 - 17.0	18.6	15.4 - 21.8
Technicians and Trades Workers	9.2	8.3 - 10.1	28.9	23.7 - 34.2	21.1	16.2 - 25.9
Community & Personal Services	6.0	5.4 - 6.7	24.9	19.8 - 30.0	22.5	17.0 - 28.1
Clerical and Administrative Workers	10.0	9.1 - 11.0	23.7	19.4 - 28.1	22.0	18.6 - 25.3
Sales Workers	6.4	5.6 - 7.2	20.7	15.3 - 26.1	20.8	16.2 - 25.4
Machinery Operators And Drivers	3.9	3.2 - 4.6	34.4	26.9 - 41.8	19.1	11.9 - 26.2
Labourers	7.1	6.3 - 7.9	36.6	30.8 - 42.5	20.6	15.2 - 25.9
Not applicable	35.3	34.9 - 35.7	20.1	18.0 - 22.1	19.3	17.7 - 21.0
			$\chi^2 = 89.9, p < 0.001$		$\chi^2 = 32.6, p = 0.008$	
Family composition of household—						
Couple with dependent children	33.4	32.1 - 34.7	17.6	15.0 - 20.2	18.7	16.1 - 21.3
One parent with dependent children	4.7	4.1 - 5.2	30.7	25.0 - 36.4	33.8	26.9 - 40.7
Couple only	27.3	26.5 - 28.0	16.7	15.1 - 18.3	14.4	13.0 - 15.9
Other one family households	14.5	13.1 - 15.9	33.0	28.4 - 37.6	23.5	18.8 - 28.2
Multiple family households	2.9	2.3 - 3.5	29.0	17.1 - 40.9	22.1	12.2 - 32.1
Lone person household	13.2	12.9 - 13.4	25.1	23.0 - 27.1	22.8	21.0 - 24.5
Group household	4.1	3.3 - 4.9	37.0	27.6 - 46.4	28.5	19.8 - 37.3
			$\chi^2 = 95.9, p < 0.001$		$\chi^2 = 57.7, p < 0.001$	
Main source of income—						
Employee cash income	55.5	54.5 - 56.6	23.6	21.6 - 25.5	20.5	19.0 - 22.0
Unincorporated business cash income	5.7	4.9 - 6.5	19.3	13.6 - 25.0	16.2	11.2 - 21.2
Government pensions and allowances	22.5	21.7 - 23.2	24.9	22.0 - 27.8	23.1	21.0 - 25.2
Other cash income	10.3	9.2 - 11.3	13.9	10.1 - 17.7	14.8	11.1 - 18.5
None of the above	6.0	5.3 - 6.7	17.5	12.4 - 22.6	15.7	10.8 - 20.6
			$\chi^2 = 23.4, p < 0.001$		$\chi^2 = 44.6, p < 0.001$	

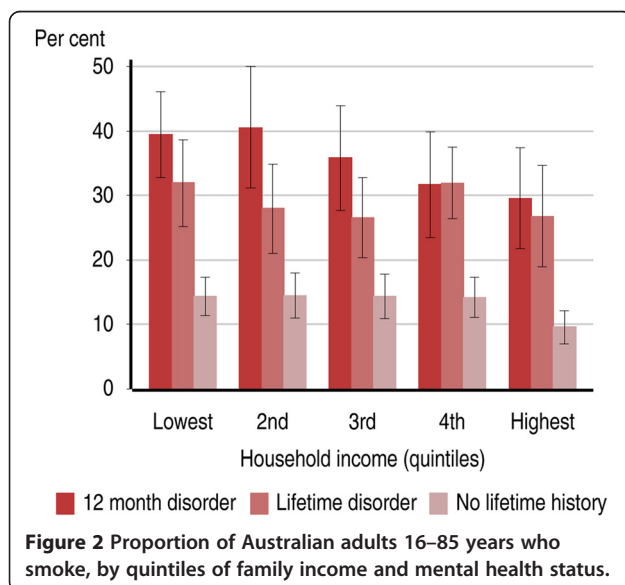
Combined association of mental illness and socioeconomic status

Within each quintile of household income, there was a strong association between mental illness status and current smoking rates (Figure 2). For instance, in the

lowest quintile of household income, 39.5% of those with 12-month mental illness were current smokers (95% CI: 32.8%-46.2%) while only 14.4% of those with no lifetime mental illness were current smokers (95% CI: 11.4%-17.3%). In the highest quintile of household income,



29.6% of those with 12-month mental illness were current smokers (95% CI: 21.8%-37.4%) while only 9.6% of those with no lifetime mental illness were current smokers (95% CI: 7.0%-12.1%). Similarly there is a large difference in smoking rates by household tenure type (Figure 3). An estimated 34.9% of adults living in rented accommodation were current smokers (95% CI: 32.0%-37.8%), while only 13.7% of people living in a home owned outright were current smokers (95% CI: 12.0%-15.3%). When split by mental illness status, this same gradient can be seen within those with and without mental illness, but there are significant differences in smoking rates by mental illness status for each household tenure type (Figure 4). Among people with 12-month mental illness, 48.2% of adults living in rented accommodation were current smokers (95% CI: 42.8%-

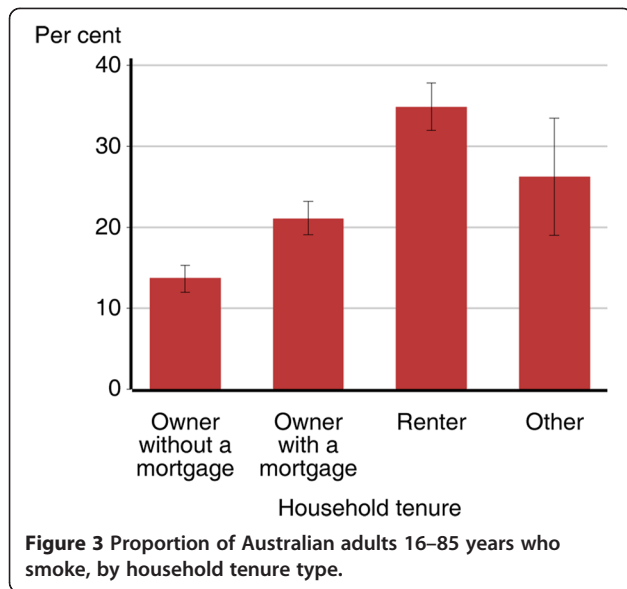


53.5%) compared with 26.8% of adults living in a home owned outright (95% CI: 20.2%-33.5%). Among people with no lifetime mental disorder 21.6% of adults living in rented accommodation were current smokers (95% CI: 17.9%-25.4%) compared with 8.2% of adults living in a home owned outright (95% CI: 6.5%-9.9%). With the exception of household income, within each of these indicators of socioeconomic status, there remained a strong association between mental illness status and current smoking (Table 2).

Factors associated with current smoking

We fitted a series of univariate logistic regression models with current smoking as the outcome measure to estimate the association with mental illness or socioeconomic status. Each of these models also adjusted for the age and sex of the respondent. After adjusting for age and sex, each of the indicators was significantly associated with current smoking status. Strongest univariate associations were observed for having ever been homeless (OR 5.45; 95% CI: 3.91-7.60), and whether ever been in gaol, prison or a correctional facility (OR 6.54; 95% CI: 4.10-10.30). These are relatively low prevalence factors. Most of the higher prevalence risk factors showed more modest associations, with the strongest of these being for the 20.0% of the adult population with 12-month mental illness (OR: 3.26; 95% CI: 2.69-3.95) (Table 3).

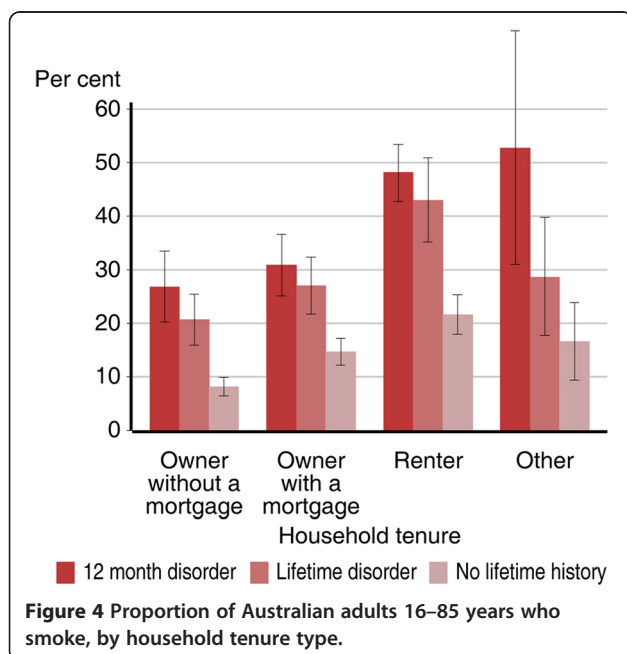
We also fitted a multivariate model considering the indicators simultaneously. We eliminated non-significant variables to develop a most parsimonious model, as some of the indicators of socioeconomic status were highly correlated. Household income, main source of cash income and relative socioeconomic disadvantage were highly correlated. Relative socioeconomic disadvantage was retained in the model as the most strongly associated of the three once the other indicators were included in the model. In the full model before these variables were eliminated from the model, household income ($p = 0.961$), and main source of household income ($p = 0.506$) were not significantly associated with smoking status. The univariate associations were all attenuated in the multivariate model reflecting the associations between the various indicators. The strongest risk factors for current smoking were ever being in gaol, prison or correctional facility (OR 2.64; 95% CI: 1.44-4.87; 2.4% of the population), having a mental illness in the past 12 months (OR 2.43; 95% CI: 1.97-3.01; 20.0% of the population), or having lifetime mental illness but not in the past 12 months (OR 2.15; 95% CI: 1.72-2.70; 25.5% of the population), being unemployed (OR 2.25; 95% CI: 1.12-4.54; 2.6% of the population), being separated (OR 2.09; 95% CI: 1.35-3.22; 2.5% of the population), and



living in rented accommodation (OR 1.96; 95% CI: 1.52-2.52, 24.7% of the population).

Factors associated with smoking cessation

We fitted a series of proportional hazards regression models for ever smokers with time to smoking cessation as the outcome measure to estimate the association with mental illness or socioeconomic status. Each of these models also adjusted for the age and sex of the respondent. After adjusting for age and sex, each of the indicators was significantly associated with time to quit smoking. Comparably sized associations with smoking cessation



were seen for most of the indicators (Table 4). Those with a 12-month mental disorder were less likely to quit smoking (HR 0.64; 95% CI: 0.55-0.75), as were those living in the lowest quintile of relative socioeconomic disadvantage (HR: 0.55; 95% CI: 0.44-0.70), and those in the lowest quintile of household income (HR: 0.53; 95% CI: 0.42-0.66). Several of the indicators were eliminated in the final multivariate model including household income ($p = 0.533$), whether ever homeless ($p = 0.749$), family composition ($p = 0.433$), main source of income ($p = 0.638$) and labour force status ($p = 0.929$). The strongest hazards for not quitting smoking were associated with renters compared with those living in homes owned outright (HR: 0.64; 95% CI: 0.52-0.78), labourers compared with managers (HR: 0.65; 95% CI: 0.46-0.92), and 12-month mental illness (HR: 0.77; 95% CI: 0.65-0.91) or lifetime mental illness (HR: 0.77; 95% CI: 0.64-0.92).

Discussion

There are substantial socioeconomic gradients in rates of both current smoking and smoking cessation among adults, with people in more disadvantaged groups both more likely to be current smokers, and have lower quit rates. When considered in multivariate models, independent associations were found between a range of markers of disadvantage and smoking status. In terms of current smoking, our results on socioeconomic indicators are consistent with prior research, although psychosocial variables such as mental health status typically have not been included in this research previously [35-38].

Our findings do not support our original null hypothesis that there would be no independent association between mental health status and smoking after adjusting for a comprehensive set of markers of socioeconomic disadvantage. Indeed mental illness was the most prevalent risk factor with a strong independent association with current smoking and reduced likelihood of smoking cessation. This supports previous findings indicating the high burden of smoking associated with mental disorders such as depression and anxiety [4-6], which may be the most prevalent risk factor strongly associated with smoking behaviours. These results indicate that previous findings were not merely presenting a confounded relationship with socioeconomic status. While these data do not address the question of whether this association is causal and if so, in what direction, they do raise the question as to whether efforts to control tobacco use and to promote smoking cessation in this group would be more effective if the impacts of mental illness were explicitly incorporated into their design.

Similarly the reverse hypothesis, that there would be no independent association between socioeconomic status and smoking after adjusting for mental health status is not supported by these data. Even in those with no

Table 2 Australian adults 16–85 years: proportion who smoke by mental health status and socioeconomic factors

Parameter	12 month mental illness		Lifetime mental illness		No mental illness	
	Percent	95% CI	Percent	95% CI	Percent	95% CI
Quintiles of household income—						
Lowest quintile	39.5	32.8 - 46.2	32.0	25.2 - 38.7	14.4	11.4 - 17.3
Second quintile	40.6	31.2 - 50.0	28.0	21.0 - 34.9	14.5	11.0 - 18.0
Third quintile	35.9	27.7 - 44.0	26.6	20.4 - 32.8	14.4	10.9 - 17.8
Fourth quintile	31.7	23.5 - 39.9	31.9	26.4 - 37.5	14.2	11.1 - 17.3
Highest quintile	29.6	21.8 - 37.4	26.8	18.9 - 34.7	9.6	7.0 - 12.1
Not stated	38.2	29.1 - 47.3	35.4	20.4 - 50.5	14.7	10.4 - 19.0
	$\chi^2 = 5.83, p = 0.320$		$\chi^2 = 3.60, p = 0.612$		$\chi^2 = 7.09, p = 0.218$	
Quintiles of relative socioeconomic disadvantage—						
Lowest quintile	44.9	36.4 - 53.4	38.1	30.1 - 46.0	18.9	14.9 - 22.9
Second quintile	45.1	37.3 - 53.0	32.2	26.3 - 38.2	16.5	13.1 - 20.0
Third quintile	36.7	28.7 - 44.7	29.2	21.6 - 36.8	12.1	9.1 - 15.2
Fourth quintile	29.4	22.8 - 36.1	25.1	19.5 - 30.7	13.5	10.1 - 17.0
Highest quintile	26.0	18.0 - 34.0	26.1	17.8 - 34.3	9.6	7.2 - 12.0
	$\chi^2 = 19.4, p < 0.001$		$\chi^2 = 8.58, p = 0.072$		$\chi^2 = 20.4, p < 0.001$	
Education—						
Bachelor degree or higher	23.5	16.7 - 30.3	18.4	11.8 - 25.0	7.7	5.4 - 10.1
Diploma	38.5	26.3 - 50.7	25.2	12.1 - 38.3	12.9	7.9 - 17.8
Certificate I/II/III/IV	39.4	32.7 - 46.0	32.7	27.4 - 38.1	14.7	11.2 - 18.2
Year 12	29.0	21.8 - 36.2	31.7	19.4 - 44.0	15.9	11.5 - 20.3
Year 11	44.0	29.6 - 58.3	29.8	17.1 - 42.4	16.7	9.5 - 24.0
Year 10	41.8	31.5 - 52.1	39.7	30.2 - 49.1	15.2	11.3 - 19.0
Year 9 or below	45.0	33.4 - 56.7	35.9	26.6 - 45.1	15.7	12.1 - 19.3
	$\chi^2 = 19.0, p = 0.004$		$\chi^2 = 17.4, p = 0.008$		$\chi^2 = 17.2, p = 0.008$	
Whether ever been homeless—						
Yes	63.6	51.6 - 75.7	67.7	58.1 - 77.3	31.5	12.5 - 50.5
No	33.7	30.1 - 37.4	28.2	24.8 - 31.6	13.5	12.1 - 15.0
	$\chi^2 = 23.6, p < 0.001$		$\chi^2 = 61.8, p < 0.001$		$\chi^2 = 7.2, p = 0.007$	
Whether ever in gaol, prison or correctional facility—						
Yes	80.0	70.1 - 89.9	63.3	46.6 - 80.1	35.5	5.9 - 65.0
No	33.9	30.4 - 37.4	28.5	25.1 - 32.0	13.5	12.1 - 14.9
	$\chi^2 = 67.5, p < 0.001$		$\chi^2 = 19.0, p < 0.001$		$\chi^2 = 5.75, p = 0.016$	
Registered marital status—						
Never married	46.3	41.4 - 51.3	40.5	33.9 - 47.1	17.4	15.1 - 19.8
Married	25.0	19.2 - 30.8	22.2	17.4 - 27.0	10.3	8.6 - 12.0
Widowed	16.1	3.5 - 28.8	19.0	9.2 - 28.9	10.8	8.2 - 13.5
Divorced	37.5	28.2 - 46.8	40.1	30.3 - 49.8	23.6	16.1 - 31.0
Separated	44.4	35.2 - 53.6	38.0	22.5 - 53.5	36.6	24.4 - 48.8
	$\chi^2 = 55.3, p < 0.001$		$\chi^2 = 39.7, p < 0.001$		$\chi^2 = 79.7, p < 0.001$	
Tenure type—						
Owner without a mortgage	26.8	20.2 - 33.5	20.7	15.9 - 25.5	8.2	6.5 - 9.9
Owner with a mortgage	30.9	25.1 - 36.6	27.0	21.7 - 32.4	14.6	12.1 - 17.1
Renter	48.2	42.8 - 53.5	43.0	35.2 - 50.9	21.6	17.9 - 25.4

Table 2 Australian adults 16–85 years: proportion who smoke by mental health status and socioeconomic factors (Continued)

Other	52.8	31.0 - 74.6	28.7	17.7 - 39.8	16.6	9.4 - 23.9
	$\chi^2 = 31.3, p < 0.001$		$\chi^2 = 33.7, p < 0.001$		$\chi^2 = 55.7, p < 0.001$	
Financial difficulties—						
Yes	50.1	43.7 - 56.6	41.9	35.2 - 48.7	25.8	18.1 - 33.5
No	30.7	26.6 - 34.7	27.6	23.8 - 31.4	12.5	11.2 - 13.8
	$\chi^2 = 27.9, p < 0.001$		$\chi^2 = 14.4, p < 0.001$		$\chi^2 = 20.9, p < 0.001$	
Labour force status—						
Employed	36.0	31.6 - 40.5	30.4	26.9 - 34.0	14.9	12.8 - 16.9
Unemployed	57.8	40.2 - 75.3	74.3	44.8 - 100.0	31.1	18.8 - 43.4
Not in the labour force	33.7	26.9 - 40.5	23.7	19.4 - 27.9	10.5	8.8 - 12.1
	$\chi^2 = 6.21, p = 0.045$		$\chi^2 = 23.2, p < 0.001$		$\chi^2 = 27.6, p < 0.001$	
Occupation of main job—						
Managers	26.3	16.3 - 36.4	20.4	14.7 - 26.1	12.9	8.6 - 17.1
Professionals	21.9	13.6 - 30.2	21.0	12.3 - 29.7	7.6	5.2 - 10.1
Technicians and Trades Workers	44.7	34.8 - 54.5	36.9	26.4 - 47.4	17.5	11.8 - 23.3
Community and Personal Services	39.3	26.4 - 52.3	21.8	13.0 - 30.7	20.2	12.9 - 27.5
Clerical and Administrative Workers	33.3	22.9 - 43.8	35.3	23.5 - 47.1	13.2	8.8 - 17.6
Sales Workers	38.4	25.1 - 51.7	19.8	9.5 - 30.0	14.9	7.9 - 21.9
Machinery Operators And Drivers	39.0	17.4 - 60.6	41.5	27.9 - 55.2	27.2	17.3 - 37.2
Labourers	55.9	45.3 - 66.4	53.9	41.4 - 66.3	20.1	11.7 - 28.5
Not applicable	36.7	30.5 - 42.8	28.0	22.5 - 33.5	11.6	9.8 - 13.4
	$\chi^2 = 26.7, p < 0.001$		$\chi^2 = 42.1, p < 0.001$		$\chi^2 = 36.5, p < 0.001$	
Family composition of household—						
Couple with dependent children	32.9	25.9 - 40.0	23.5	18.3 - 28.7	10.2	7.7 - 12.7
One parent with dependent children	36.0	25.4 - 46.6	32.4	20.4 - 44.4	25.0	16.2 - 33.9
Couple only	27.9	21.7 - 34.2	24.2	20.8 - 27.6	10.3	8.7 - 12.0
Other one family households	44.8	33.6 - 56.1	44.8	33.6 - 56.0	21.7	16.1 - 27.3
Multiple family households	38.4	15.5 - 61.2	40.5	1.6 - 79.3	20.3	9.1 - 31.5
Lone person household	38.2	34.2 - 42.3	33.8	29.2 - 38.5	15.1	13.0 - 17.1
Group household	49.9	34.2 - 65.6	39.6	13.1 - 66.1	25.3	14.6 - 36.0
	$\chi^2 = 14.3, p = 0.030$		$\chi^2 = 20.3, p = 0.002$		$\chi^2 = 55.0, p < 0.001$	
Main source of income—						
Employee cash income	35.7	31.3 - 40.2	31.3	26.9 - 35.7	15.0	12.8 - 17.3
Unincorporated business cash income	31.9	16.3 - 47.6	23.1	9.9 - 36.4	12.1	7.7 - 16.5
Government pensions & allowances	43.4	36.9 - 49.9	32.9	25.6 - 40.2	13.1	10.5 - 15.6
Other cash income	25.8	11.4 - 40.2	19.7	10.6 - 28.9	9.0	5.7 - 12.4
None of the above	22.1	8.8 - 35.4	28.4	9.6 - 47.1	13.4	7.8 - 19.1
	$\chi^2 = 10.7, p = 0.030$		$\chi^2 = 5.39, p = 0.250$		$\chi^2 = 8.4, p = 0.079$	

lifetime mental illness, gradients in both current smoking status and smoking cessation can be observed for several indicators of socioeconomic status. Living in rented accommodation remaining strongly associated with both current smoking and smoking cessation in the multivariate models, and being unemployed or ever

having been in gaol, prison or a correctional facility strongly associated with current smoking.

There are several possible mechanisms that may explain an independent association between smoking and common mental disorders [5]. Mental illness may be a factor in smoking initiation or addiction to nicotine. Smoking

Table 3 Australian adults 16–18 years: Univariate and multivariate odds ratios for smoking, associated with socioeconomic factors and mental illness

Parameter	Univariate odds ratios (a)		Multivariate odds ratios (b)	
	Odds ratio	95% CI	Odds ratio	95% CI
Mental health status—				
12 month disorder	3.26	2.69 - 3.95	2.43	1.97 - 3.01
Lifetime disorder	2.52	2.04 - 3.12	2.15	1.72 - 2.70
No mental illness	1.00		1.00	
Quintiles of household income—				
Lowest quintile	2.29	1.76 - 3.00	(c)	
Second quintile	1.64	1.22 - 2.21		
Third quintile	1.36	1.02 - 1.81		
Fourth quintile	1.28	0.99 - 1.65		
Highest quintile	1.00			
Not stated	1.56	1.14 - 2.13		
Quintiles of relative socioeconomic disadvantage—				
Lowest quintile	2.26	1.72 - 2.96	1.23	0.92 - 1.63
Second quintile	2.01	1.51 - 2.67	1.27	0.97 - 1.68
Third quintile	1.46	1.17 - 1.83	1.05	0.81 - 1.35
Fourth quintile	1.25	0.96 - 1.63	0.97	0.76 - 1.23
Highest quintile	1.00		1.00	
Education—				
Bachelor degree or higher	0.35	0.26 - 0.48	0.48	0.34 - 0.68
Diploma	0.68	0.47 - 0.98	0.81	0.56 - 1.17
Certificate I/II/III/IV	0.80	0.63 - 1.02	0.83	0.63 - 1.09
Year 12	0.62	0.48 - 0.82	0.72	0.54 - 0.95
Year 11	0.81	0.56 - 1.16	0.94	0.63 - 1.40
Year 10	1.00		1.00	
Year 9 or below	1.44	1.12 - 1.85	1.28	0.98 - 1.67
Whether ever been homeless—				
Yes	5.45	3.91 - 7.60	1.82	1.23 - 2.69
No	1.00		1.00	
Whether ever in gaol, prison or correctional facility—				
Yes	6.54	4.10 - 10.30	2.64	1.44 - 4.87
No	1.00		1.00	
Registered marital status—				
Never married	2.49	2.00 - 3.10	1.60	1.25 - 2.06
Married	1.00		1.00	
Widowed	1.52	1.04 - 2.24	1.32	0.85 - 2.05
Divorced	2.70	2.07 - 3.51	1.81	1.29 - 2.53
Separated	3.48	2.49 - 4.86	2.09	1.35 - 3.22
Tenure type—				
Owner without a mortgage	1.00		1.00	
Owner with a mortgage	1.27	1.04 - 1.54	1.32	1.08 - 1.61
Renter	2.60	2.10 - 3.21	1.96	1.52 - 2.52
Other	1.85	1.17 - 2.92	1.78	1.15 - 2.75

Table 3 Australian adults 16–18 years: Univariate and multivariate odds ratios for smoking, associated with socioeconomic factors and mental illness (Continued)

Financial difficulties—				
Yes	2.51	2.05 - 3.06	1.41	1.11 - 1.80
No	1.00		1.00	
Labour force status—				
Employed	1.00		1.00	
Unemployed	3.27	2.07 - 5.17	2.25	1.12 - 4.54
Not in the labour force	1.10	0.88 - 1.37	0.93	0.42 - 2.05
Occupation of main job—				
Managers	1.00		1.00	
Professionals	0.77	0.55 - 1.08	0.79	0.55 - 1.16
Technicians and Trades Workers	1.72	1.20 - 2.45	1.24	0.88 - 1.74
Community and Personal Service Workers	1.67	1.19 - 2.35	1.07	0.73 - 1.58
Clerical and Administrative Workers	1.57	1.12 - 2.21	1.18	0.85 - 1.64
Sales Workers	1.28	0.83 - 1.98	1.00	0.65 - 1.54
Machinery Operators And Drivers	2.32	1.46 - 3.68	1.32	0.81 - 2.14
Labourers	2.72	1.99 - 3.73	1.70	1.25 - 2.30
Not applicable	1.84	1.38 - 2.44	1.01	0.42 - 2.42
Family composition of household—				
Couple family with dependent children	0.65	0.53 - 0.81	0.70	0.57 - 0.87
One parent family with dependent children	1.53	1.16 - 2.03	0.66	0.46 - 0.94
Couple only	1.00		1.00	
Other one family households	1.92	1.49 - 2.46	1.65	1.24 - 2.18
Multiple family households	1.63	0.91 - 2.92	1.50	0.76 - 2.96
Lone person household	1.64	1.41 - 1.91	0.87	0.69 - 1.09
Group household	1.81	1.11 - 2.94	1.13	0.67 - 1.90
Main source of income—				
Employee cash income	1.00		(c)	
Unincorporated business cash income	0.82	0.55 - 1.21		
Government cash pensions and allowances	1.91	1.51 - 2.41		
Other cash income	0.98	0.65 - 1.46		
None of the above	0.73	0.50 - 1.07		

(a) Univariate odds ratios adjusting for age and sex.

(b) Multivariate odds ratios adjusting for all variables shown and age and sex.

(c) Not significantly associated with smoking status in multivariate model and eliminated from final model.

may be a risk factor for onset of mental illness. Alternatively both smoking and mental illness could be linked to common genetic, biological or environmental factors. There is some evidence to support each of these possible mechanisms [39]. Depression and anxiety in teenagers have been found to be strong predictors of smoking experimentation and the transition to daily smoking [40-42]. Smoking has also been associated with the onset of psychiatric symptoms in teenagers [42,43]. While it is possible that separate causal mechanisms may operate in both directions, other studies have identified common risk factors to both smoking and mental illness [44-47].

There are well-established biological mechanisms that help explain why smoking may be linked to mental illness. Nicotine is a psychostimulant that affects several neuroregulators that influence both mood and behaviour [48,49]. Early reports suggested that nicotine cessation can also precipitate depressive symptoms, particularly in people with a history of major depression [50,51]. Nicotine administration can relieve symptoms of both depression and anxiety [52-54]. Levels of cortisol, a component of the hypothalamic-pituitary-adrenal axis system that responds to stress, can be affected by nicotine [39,55]. More recent studies have suggested that

Table 4 Hazard ratios for smoking cessation, by mental health status and socioeconomic factors

Parameter	Univariate hazard ratios (a)		Multivariate hazard ratios (b)	
	Hazard ratio	95% CI	Hazard ratio	95% CI
Mental health status—				
12 month disorder	0.64	0.55 - 0.75	0.77	0.65 - 0.91
Lifetime disorder	0.72	0.61 - 0.84	0.77	0.64 - 0.92
No mental illness	1.00		1.00	
Quintiles of household income—				
Lowest quintile	0.53	0.42 - 0.66	(c)	
Second quintile	0.64	0.51 - 0.81		
Third quintile	0.74	0.59 - 0.94		
Fourth quintile	0.72	0.58 - 0.89		
Highest quintile	1.00			
Not stated	0.58	0.46 - 0.73		
Quintiles of relative socioeconomic disadvantage—				
Lowest quintile	0.55	0.44 - 0.70	0.80	0.63 - 1.02
Second quintile	0.61	0.50 - 0.74	0.80	0.65 - 0.98
Third quintile	0.71	0.59 - 0.85	0.84	0.69 - 1.02
Fourth quintile	0.74	0.60 - 0.91	0.85	0.69 - 1.05
Highest quintile	1.00		1.00	
Education—				
Bachelor degree or higher	1.66	1.28 - 2.16	1.31	0.98 - 1.73
Diploma	1.81	1.37 - 2.41	1.50	1.13 - 1.98
Certificate I/II/III/IV	1.17	0.97 - 1.42	1.07	0.87 - 1.33
Year 12	1.37	1.11 - 1.69	1.19	0.95 - 1.51
Year 11	1.23	0.86 - 1.76	1.14	0.78 - 1.67
Year 10	1.00		1.00	
Year 9 or below	0.79	0.65 - 0.96	0.80	0.64 - 0.99
Whether ever been homeless—				
Yes	0.49	0.37 - 0.65	(c)	
No	1.00			
Whether ever in gaol, prison or correctional facility—				
Yes	0.49	0.35 - 0.68	0.70	0.49 - 1.01
No	1.00		1.00	
Registered marital status—				
Never married	0.62	0.51 - 0.75	0.76	0.62 - 0.93
Married	1.00		1.00	
Widowed	0.64	0.53 - 0.78	0.73	0.59 - 0.90
Divorced	0.65	0.53 - 0.80	0.77	0.62 - 0.96
Separated	0.58	0.45 - 0.73	0.78	0.59 - 1.02
Tenure type—				
Owner without a mortgage	1.00		1.00	
Owner with a mortgage	0.90	0.77 - 1.05	0.84	0.70 - 1.00
Renter	0.54	0.45 - 0.65	0.64	0.52 - 0.78
Other	0.58	0.43 - 0.79	0.57	0.42 - 0.78

Table 4 Hazard ratios for smoking cessation, by mental health status and socioeconomic factors (Continued)

Financial difficulties—				
Yes	0.63	0.51 - 0.77	0.84	0.66 - 1.08
No	1.00		1.00	
Labour force status—				
Employed	1.00		(c)	
Unemployed	0.60	0.38 - 0.95		
Not in the labour force	0.81	0.69 - 0.94		
Occupation of main job—				
Managers	1.00		1.00	
Professionals	1.22	0.87 - 1.70	1.15	0.82 - 1.61
Technicians and Trades Workers	0.75	0.57 - 0.98	0.89	0.68 - 1.16
Community and Personal Service Workers	0.70	0.49 - 0.99	0.76	0.52 - 1.12
Clerical and Administrative Workers	0.86	0.62 - 1.20	0.85	0.58 - 1.23
Sales Workers	0.98	0.67 - 1.45	1.11	0.75 - 1.65
Machinery Operators And Drivers	0.62	0.45 - 0.87	0.74	0.50 - 1.11
Labourers	0.52	0.38 - 0.71	0.65	0.46 - 0.92
Not applicable	0.65	0.53 - 0.81	0.83	0.64 - 1.07
Family composition of household—				
Couple family with dependent children	1.28	1.09 - 1.51	(c)	
One parent family with dependent children	0.85	0.56 - 1.30		
Couple only	1.00			
Other one family households	0.69	0.55 - 0.86		
Multiple family households	0.76	0.42 - 1.40		
Lone person household	0.67	0.60 - 0.75		
Group household	0.73	0.50 - 1.06		
Main source of income—				
Employee cash income	1.00		(c)	
Unincorporated business cash income	1.05	0.80 - 1.39		
Government cash pensions and allowance	0.69	0.58 - 0.82		
Other cash income	1.02	0.80 - 1.30		
None of the above	0.89	0.70 - 1.13		

(a) Univariate hazard ratios adjusting for age and sex.

(b) Multivariate hazard ratios adjusting for all variables shown and age and sex.

(c) Not significantly associated with smoking cessation in multivariate model and eliminated from final model.

nicotine withdrawal symptoms can be quite similar to symptoms of anxiety and depression which may further reinforce smoking behaviours in people with these disorders [54,56]. The knowledge that people with mental illness may perceive there to be some therapeutic benefit from nicotine led to the self-medication hypothesis, which suggests that people with mental illness may choose to smoke as it is a simple and readily accessible means to control symptoms of mental illness [57]. However, levels of anxiety and depression in ex-smokers after the withdrawal period may be lower than immediately after smoking in current smokers suggesting that perceived benefit of smoking for people with depression

and anxiety may merely reflect the similarity between nicotine withdrawal symptoms and symptoms of anxiety or depression [39,58].

The finding that smoking rates are higher among disadvantaged groups is not new. However, to the best of our knowledge, the finding that strong gradients in smoking, and smoking cessation, are observed by mental illness status within both disadvantaged and non-disadvantaged groups has not previously been reported. We also found that smoking cessation rates are lower in socioeconomically disadvantaged groups and in those with common mental disorders, and that significantly lower cessation rates are observed in disadvantaged

groups after controlling for mental illness. This is a more controversial finding.

Other reports have suggested that while smoking initiation rates may be higher in disadvantaged groups, smoking cessation rates are equal in all groups, although these reports tend to rely on coarse measures, and flawed interpretations of broad population measures. Two measures commonly cited to suggest that quit rates are equal across demographic groups are the proportion of population groups who are ex-smokers [19,59-61], and the absolute percentage point reduction in smoking rates in various groups [19,62]. For example, Australia's National Preventative Health Taskforce reported that:

"Most disparities in smoking rates between socioeconomic groups in Australia result from differences in uptake rather than in cessation...around 30% of people can be classified as ex-smokers, regardless of the level of neighbourhood disadvantage." [19, p. 12]

However, the proportion of ex-smokers is not a reliable estimate of cessation rate as the denominator is all persons, not smokers. Consider the following hypothetical example. Suppose two groups of 100 smokers are followed for a period of time, and 20 people quit smoking in each group. However group A comes from a relatively disadvantaged group with a total population of 200 people while the less disadvantaged group B has a total population of 400 people. In group A 20 of 200 people, or 10% are ex-smokers, while only 5% of group B are ex-smokers, despite both groups having the same smoking cessation rate. Indeed, if only 10 people had quit smoking in group A, both groups would have shown the same proportion of ex-smokers despite the smoking cessation rate being half that in group A compared with group B. As smoking rates are substantially higher in areas of high neighbourhood disadvantage, the data presented by Australia's National Preventative Health Taskforce are consistent with our findings, as equivalent proportions of ex-smokers imply lower smoking cessation in groups with higher smoking initiation rates. However, these data have not previously been interpreted in this way. In a similar vein, the National Preventative Health Taskforce also reported that smoking rates had declined between 1989-90 and 2004-5 from 33% to 29% in areas in the highest quintile of socioeconomic disadvantage, and from 23% to 17% in areas in the lowest quintile of socioeconomic disadvantage [19]. The argument that graphs of time trends in smoking rates in different groups are represented by approximately parallel trend lines has been advanced to suggest that cessation rates are equal in different groups [19,59,62]. However, again this does not account for the

differences in smoking prevalence in the groups. If cessation rates were equal in different groups, trend lines in smoking prevalence, if linear, would be expected to converge to the same point, not be parallel. Considering again our hypothetical example, with the same smoking cessation rate in each group the smoking rate declines by 10 percentage points, from 50% to 40% in group A, and by 5 percentage points, from 25% to 20% in group B. If group A had only half the smoking cessation rate of group B, the decline in smoking rate would have been 5 percentage points from 50% to 45%.

The results of our study support the general principle of developing tobacco control strategies that specifically address the needs of disadvantaged groups with high smoking rates. There were substantial gradients in smoking rates observed across many of the indicators included in this study. These reflect not only the high relative burden of smoking associated with various forms of disadvantage, but the extent to which broad-based tobacco control efforts have had their greatest success among those who have fewer additional disadvantages in their lives. The strongly skewed sociodemographic of current smokers now has emerged from a much more homogeneous population of smokers thirty or forty years ago, when smoking was actually more common among the more affluent and well-educated [63-65].

For affluent adults with no history of mental illness, current smoking rates are now below 10% while rates are over 40% for those with 12-month mental illness and one of several indicators of socioeconomic disadvantage.

There are a number of programmes that have been developed that address smoking within mental health treatment settings, such as the Tobacco and Mental Illness project in South Australia [66], and Mental Health Tobacco Recovery in New Jersey [67]. While these programmes include components to assist with the transition to community-based living, including the use of peer support workers [68], they focus on people with serious mental illness and generally recruit from specialist psychiatric services.

A number of strategies have been proposed as to how to address the high rate of smoking among disadvantaged groups and people with common mental illnesses [20,57,69]. Broadly these can be considered as either programmes that work with individuals or in small groups to support smoking cessation, and approaches that modify broad population health interventions to more specifically target disadvantaged groups. An intermediary approach is exemplified by the *Tackling Tobacco* programme initiated by the New South Wales Cancer Council. This programme is based on the likelihood that many people from disadvantaged backgrounds are in contact with health or social services for other reasons as a result of that disadvantage. This may then be a way

of targeting this group. The programme seeks to integrate tobacco control into the services provided by a range of social and community sector organisations [70]. As such it seeks to denormalise smoking in sectors working with disadvantaged people where smoking behaviours are commonplace, and to increase the impact of brief interventions and support for cessation beyond the health sector. So far this programme has been piloted and qualitatively reviewed [71,72] and a randomised controlled trial is underway to investigate the effectiveness of this type of approach in achieving smoking cessation within disadvantaged groups [73]. Preliminary data suggest that both the organisations and their clients are enthusiastic to have smoking cessation activities provided through these services [71,72,74].

Another possible approach to addressing smoking among disadvantaged groups is to adapt population health-based methods. The principal components of population health-based smoking cessation efforts, such as controlling supply, restricting all forms of promotion, increasing price, advertising health consequences and educating young people about them, denormalising or stigmatising smoking, and restricting use in public places, have generally not been tailored for people from specific demographic groups.

The design of population health interventions such as education and denormalisation can be considered within the framework of social marketing [75]. Although targeted approaches, or market segmentation, are widely used in the marketing of commercial products and services, including historically in the promotion of cigarettes [76-78], this approach has not been strongly embraced in population health. Bloom and Novelli note that treating certain groups with special attention "is not consistent with the egalitarian and antidiscriminatory philosophies that pervade many social agencies" and that during program planning and implementation there is "a constant problem about whether to divide limited resources or simply take a general audience route" [79]. This argument has also been made specifically in the area of tobacco control. Indeed, it has been suggested that money spent on targeted anti-smoking efforts is money wasted as it is money taken away from the most successful broad population-based approaches [80]. Alternatively it has been argued that developing both targeted and broad population-based strategies would undermine both as no strategy would then be adequately funded to a level that could have impact [81]. These arguments rest on the assumption that all population subgroups benefit equally from broad reach interventions, which is counter to the increasing burden of smoking concentrated in disadvantaged groups.

Of the various broad-based population-health intervention approaches to smoking cessation, most have greater impact in more advantaged groups [82]. Only price

increases through taxation have been suggested to be more effective in disadvantaged groups [82,83]. However, the data on the effectiveness of taxation increases in reducing smoking in disadvantaged groups is equivocal, and others have questioned this finding [84,85]. The question of whether any one aspect of tobacco control is more or less successful in disadvantaged groups misses the fact that the successes of tobacco control overall have come from the implementation of programs that employ multiple strategies.

While the preference for broad-based programmes may be based on egalitarian principles [79], in fact this focus on broad-reach interventions may promote inequality if these interventions are most successful amongst advantaged subgroups. Two common themes in health promotion in tobacco control are the long-term health consequences of smoking and establishing smoking as a stigmatised behaviour. The promotion of long-term health consequences may be less motivating of behaviour change in people whose ability to project in the longer term is limited by pressing life circumstances or stress or whose cognitive skills are impaired by psychological distress [86,87]. Similarly the impact of the stigmatisation of smoking behaviours may be less motivating in people who are also stigmatised by other forms of disadvantage [88]. Ceci and Papierno have argued that reliance on universal strategies will always result in the widening of gaps between advantaged and disadvantaged groups as the resources, skills and opportunities of advantaged groups act to increase their chances of utilising and benefitting from any universal strategy [89]. Niederdeppe and colleagues point out that mass media campaigns, in particular, are often differentially effective in advantaged groups for multiple reasons: levels of exposure, levels of persuasiveness, opportunities to change, and access to supports all vary by level of disadvantage [90,91].

Marsh and McKay noted that while price increases have played an important part in overall tobacco control, perversely some of the heaviest smokers are also among the poorest and pay a high financial price for their smoking. Yet their levels of addiction, financial literacy and overall decision making result in this strategy yielding lower results among the poorest smokers [92].

There is likely to be an important role for both types of approach in addressing the issue of smoking and disadvantage. Initiatives based around use of services can reach groups where broad-based strategies have little or no penetration, and these services are often the best way of reaching people with the most severe and multiple disadvantages. At the same time, not all disadvantaged smokers are in contact with services, and service-based programmes will only reach a proportion of the target audience. For example, the majority of people with mental disorders such as anxiety or depression are not in contact with services for these problems, although there

is no difference in smoking or smoking cessation rates between those who do and do not use services [6,21]. In responding to the association between markers of disadvantage and smoking, the strategies recommended by Australia's National Preventative Health Taskforce have aimed to target the small proportion of people with very high levels of disadvantage, such as people who are currently homeless or in a correctional facility or long-term residents of psychiatric facilities [19]. While there is no doubt that smoking rates are very high in these groups, our data show that the gradients in smoking status extend to a significantly larger proportion of the population. This has implications for tobacco control efforts. While it is possible to develop programs within institutional settings or that use street workers to target homeless people, targeted population-based strategies will also be required to reach the larger proportion of people living in the community who have more common mental disorders such as anxiety or depression, or who have a history of homelessness or contact with the justice system but aren't currently homeless or in an institution. As these people are less likely to be in touch with services that can deliver programmes directly, strategies with population reach but which are targeted to the concerns and issues faced by people with other disadvantages will also be needed to address the substantially disproportionate burden of smoking that is associated with common mental disorders and socioeconomic disadvantage.

Socioeconomic and psychosocial gradients in smoking are a major contributor to socioeconomic gradients in major health outcomes such as life expectancy and quality of life. The majority of responses to smoking in disadvantaged groups to date have been individually-oriented treatments of tobacco dependence [93]. The factors considered in this paper, common mental disorders and markers of socioeconomic disadvantage, are sufficiently prevalent to suggest policy making and population-based approaches as being a key part of the way forward. This could entail using the tools of population health but adapted to the specific characteristics of these groups, as many of these population groups are too big to reach effectively through individual treatment services.

Monitoring progress in future tobacco control activities, particularly those directed at disadvantaged groups, may require new measurement approaches. For instance, in Australia key indicators are derived from the National Drug Strategy Household Survey [92]. This is a survey conducted by means of a self-complete questionnaire delivered to selected households. The 2010 survey obtained usable responses from around one-third of households selected in the original sample, and under-represented young adults, people who didn't complete year 12

schooling, single person households, and households from low socioeconomic areas. It is quite likely that differences in methodology, and the low response rate and associated participation biases explain why the estimated proportion of current daily smokers derived from the National Drug Strategy Household Survey (15.1% in the most recent survey in 2010, 16.6% in 2007) is substantially lower than the estimate obtained from face to face surveys with higher response rates [94]. The 2007–08 National Health Survey, conducted by the Australian Bureau of Statistics, estimated 18.9% of Australian adults are current daily smokers [95]. This survey achieved a 91% response rate. Some people with severe forms of disadvantage, such as homeless people, people living in institutions such as correctional facilities or mental health facilities who are known to have very high rates of smoking, are not included in any household surveys.

Limitations

Not all markers of socioeconomic disadvantage that have been associated with smoking status have been included in this analysis. Because of sample size considerations and in order to preserve the privacy of individual participants in the study, particularly low prevalence demographic indicators were not included on the unit record file released from the NSMHWB. Because of this we were unable to identify in this sample Aboriginal or Torres Strait Islander peoples, pregnant women or people who do not speak English. These groups represent a very small proportion of the NSMHWB sample. Additionally, to preserve the privacy of individual participants in the study, some continuous demographic measures, such as household income and area-level disadvantage, have been categorised on the unit record file released for the survey. Because of this, we were unable to assess whether there could be linear or non-linear associations between these measures of disadvantage and smoking outcomes, or whether the categorical cut-offs provided on the file are optimal for defining disadvantaged groups in respect to smoking behaviours.

As a population-based household interview survey, the NSMHWB was unable to assess low prevalence mental disorders such as schizophrenia or organic psychoses, nor did it include people living in institutional care. Smoking status in Australian adults with psychotic illness has recently been assessed in the second Australian national survey of people living with psychotic illness conducted in 2010 [96]. This survey found that over two-thirds of adults with psychoses were current smokers, unchanged from the first national survey ten years previous [96,97].

Cross-sectional studies, such as the NSMHWB, describe associations but cannot shed light upon causal pathways. The information collected in the survey pertains to current disadvantage or disadvantage in the past 12 months. We don't have information on the long term

accumulation of disadvantage or the intergenerational transfer of disadvantage.

Conclusions

The association between mental illness and smoking is not explained by the association between mental illness and socioeconomic status. There are strong socioeconomic and psychosocial gradients in both current smoking and smoking cessation. Incorporating knowledge of the other adverse factors in smokers' lives into tobacco control initiatives may increase the penetration of these interventions in population groups that have historically benefitted less from these activities.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DL conceived the original idea for the study. All authors contributed to the development of the study methodology. DL acquired and analysed the data. DL and JH wrote the first draft of the manuscript. All authors edited the paper. All authors read and approved the final manuscript.

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