BMJ open

Children, smoking households and exposure to home environmental tobacco smoke in rural Australia – what's the story?

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003128
Article Type:	Research
Date Submitted by the Author:	26-Apr-2013
Complete List of Authors:	Longman, Jo; University of Sydney, Sch of Public Health (University Centre for Rural Health - North Coast) Passey, Megan; University of Sydney, University Centre for Rural Health - North Coast
Primary Subject Heading:	Public health
Secondary Subject Heading:	Public health
Keywords:	Environmental Tobacco Smoke, Secondhand smoke, Children, Rural, Australia

Children, smoking households and exposure to home environmental tobacco smoke in rural Australia – what's the story?

Jo M Longman[1*] and Megan E Passey[1]

[1] University Centre for Rural Health, University of Sydney School of Public Health, PO Box 3074, Lismore, NSW 2480, Australia

[*]Corresponding Author: email: jo.longman@ucrh.edu.au; T:02 66207570; F: 02 66207270

Keywords: environmental tobacco smoke; secondhand smoke; children; rural; Australia

Wordcount: 3,465

ARTICLE SUMMARY

Focus

Given that children's environmental tobacco smoke (ETS) exposure is such an important public health concern, as well as the higher prevalence of smoking in rural areas in Australia, this paper addresses two questions: 1. Are there rural/urban differences in a) smoking within households with children and b) home ETS exposure in children?; and 2. If so, is this due to socioeconomic disadvantage or other factors unique to 'rurality'?

Key Messages

43.6% of rural households with children contained a smoker. Both household smoking and home ETS exposure were significantly more common for rural children than for urban dwelling children. Rurality remained associated with smoking households but did not remain associated with home ETS, when confounding factors were controlled for. Children's home ETS exposure is driven by larger household size, low socio-economic status and being a single parent household.

Strengths and Limitations

No previous studies have explored rural/urban differences in smoking in households with children in Australia. This study used data from a representative national household survey to explore the association of rurality with household smoking and with home ETS exposure. The study had limited potential household level confounding variables available for inclusion in the analysis, and was limited by potential response bias leading to a possible under-reporting of household smoking status.

ABSTRACT

Introduction

Smoking is more prevalent in rural than urban Australia, but few studies have explored rural/urban differences in home environmental tobacco smoke (ETS) exposure and none have explored these differences amongst children in Australia. Both household smoking and home ETS exposure are

harmful to children. This paper aimed to explore the association between rurality and a) household smoking status and b) home ETS exposure, in households with children aged 0-14.

Method

Data from the 2010 National Drug Strategy Household survey were analysed to explore prevalence of household smoking and home ETS exposure in rural and urban households with children. Multivariable logistic regression was used to explore the association of rurality with household smoking and with home ETS exposure, controlling for potential confounders.

Results

Households with children were more likely to be smoking households (35.4%) than households without children (32.1%) (p=<0.001). Both household smoking (43.6% vs 31.4% p = <0.001) and home ETS exposure (8% vs 5.2% p=<0.001) were significantly more common for rural children. In multivariate analyses controlling for confounding factors, rurality remained associated with smoking households (OR= 1.21 95%CI:1.07, 1.37), whereas it did not remain associated with children's home ETS exposure (OR=1.07 95%CI:0.85, 1.35). Larger household size, low socio-economic status, and being a single parent household were the main drivers of home ETS exposure.

Conclusion

The proportion of smoking households with children, and the number of children regularly exposed to home ETS remain important public health concerns. Smoking cessation support and tobacco control policies might benefit from targeting larger and/or socio-economically disadvantaged households including single-parent households.

BACKGROUND

The negative impact of children's exposure to smoking behaviour and environmental tobacco smoke (ETS) in their homes is extensive. Due to the higher breathing rates per body weight, and the size and immaturity of their organs, children are particularly vulnerable to the effects of ETS exposure on their physical health 1-3. They are also particularly vulnerable to the corollaries of those effects such as missing more time at school, and compromised academic performance 3. In addition, children whose parents smoke are more likely to become smokers themselves, growing up with smoking as a normalised behaviour 4, 5.

The site where most ETS exposure in children happens is their home 2, 6. Children are not able to control their environment to minimise their exposure and are effectively 'trapped' in smoking environments. Children who live in homes where there is no indoor smoking are afforded some protection from ETS exposure even when a parent smokes 6, 7. However, for adults, negotiating smoke-free home environments can be challenging due to the social and familial relationship aspects of smoking behaviour in the home 2, 8.

Whilst it may be considered an infringement of individual civil liberties to legislate against ETS exposure in the home, the notion of a smoke-free home is an extension of the protection offered from comprehensive smoke-free legislation. In Australia this began in the mid-1980s, and has covered public transport, the workplace, public spaces, smoking in cars containing children, and, most recently, proposed legislation on multi-unit dwellings, supported by an active campaign from Action on Smoking and Health Australia 3.

This legislative environment reflects the importance of protecting the public from ETS exposure. Efforts to protect children from the effects of ETS exposure respond directly to Article 8 of the WHO Framework Convention on Tobacco Control requiring smoke-free measures by those countries ratifying the Treaty, including Australia 9.

Educational campaigns focusing on smoke-free homes have been in place since the early 2000s and continue to form a regular part of tobacco campaigning in Australia. These campaigns have promoted quitting or smoking outside to protect children from the harms of home ETS exposure 10and appear to have been 'moderately helpful' in increasing the number of smoke-free homes 3. In 2006, 43% of Australian households with smokers reported totally banning smoking indoors 11, and data from both NSW and Victoria show declines in household indoor smoking over recent years 3. One of the main outcome indicators in Australia's draft National Tobacco Strategy 2004-2009 is that fewer people will be exposed to home ETS 12.

Is there an urban/rural divide in children's exposure to home ETS?

In Australia around one third of the population lives outside major cities, with rural areas more socio-economically disadvantaged than urban areas 13. The prevalence of tobacco smoking in this rural population is significantly higher than in urban areas 14. Smoking continues to be disproportionately represented among socio-economically disadvantaged populations, and these disparities are increasing over time 15.

We identified only three studies exploring the difference between home ETS exposure in children in rural compared to urban areas 16-18, with none from Australia. Two are American (one showing higher home ETS exposure in rural areas 18 and one from Alaska showing lower home ETS exposure in very remote areas 17), and one from Germany reporting lower home ETS exposure in children in rural areas 16. One study from China describes ETS exposure in respondents' homes (all homes, not just homes with children) that is higher in rural areas (73%) compared with urban areas (60%) 19. One further American study focuses on home smoking bans, and reported fewer home smoking bans in rural households compared to urban households 20.

Given that ETS exposure is such an important public health concern, particularly in children, as well as the higher prevalence of smoking in rural areas in Australia, this paper addresses two questions: 1. Are there rural/urban differences in a) smoking within households with children and b) home ETS exposure in children?; and 2. If so, is this due to socioeconomic disadvantage or other factors unique to 'rurality'?

METHODS

The 2010 National Drug Strategy Household Survey

The Australian Institute of Health and Welfare (AIHW) the National Drug Strategy Household Survey (NDSHS) every three years to measure behaviour, knowledge and attitudes towards drugs in Australia. The 2010 sample was a multi-stage random sample of households stratified by region with some over-sampling in certain states and territories, representative of the national population. Respondents were the person aged 12 or older in each household who was next to have a birthday. Questions were asked via drop and collect self-completion questionnaires. Questions were asked of the respondent about themselves, e.g. their own smoking status, as well as questions about the

household. Data were collected between April and September 2010. The survey has been conducted on nine previous occasions 21.

The NDSHS was chosen because it provided data on household behaviour, rather than just individual behaviour, as well as the number and age of children within a household. Non-identifiable data were sourced from the AIHW with a signed agreement to protect the confidentiality and management of the data.

Weighting

Weights were applied to the data to adjust for the complex sampling design while not inflating the overall sample size. Following Gartner et al 15, we proportionally adjusted the absolute weight for households provided by the AIHW in order to bring the overall number of households down to the effective sample size.

Measures

Rurality

The rurality variable was based on the Australian Standard Geographical Classification remoteness areas. The variable was coded: major cities, inner regional, outer regional and remote/very remote. We recoded the variable into Urban/Rural (where urban was 'major cities' and rural was a combination of the remaining categories) as some cells contained small numbers with the initial categorisation.

Households with Children

We defined households with children as those with children 0-14 years old. The questionnaire asked "*Of all the dependent children, how many are in each of these age categories?*" 22, and offered two-year blocks up to 12-14 with the last category being 15+. As "*dependent children*" was defined to include children older than 14 "*who are still financially dependent, such as full-time students*"22 we did not include the final category which may have contained substantial numbers of dependent children over 18.

Outcome variables

Smoking households

We defined smoking households as any household containing a smoker regardless of where that person smoked, i.e. answering "*Yes, inside the home*" or "*No, only smoke outside the home*" to the question "*In the last 12 months, have you or any other member of your household smoked at least one cigarette, cigar or pipe of tobacco per day in the home?"*. The other response option was "*No-one at home regularly smokes*" 22.

Home ETS exposure

Home ETS exposure is different to smoking households as it is a measure of whether a household contains a smoker who smokes inside the home. This was determined as those households where the answer *"Yes, inside the home*" was given to the question "*In the last 12 months, have you or any other member of your household smoked at least one cigarette, cigar or pipe of tobacco per day in the home?"* 22. We recoded this into a binary variable: "yes smokes inside the home" or "no does not smoke inside the home". The "no does not smoke inside the home" category included

households answering either *"No, only smoke outside the home",* or *"no-one at home regularly smokes*".

Potential confounders

The data contained limited household level variables. Within these confines, the following variables were considered potential confounders in the association between home ETS exposure and rurality: socio-economic status 2, 15; number of people in the household 15; household structure 3, 16; and main language used in the household 3. These are defined below.

Socio-economic status

We defined socio-economic status using the area-level socio-economic index for areas (SEIFA) provided in the data (the Index of Relative Socio-economic Advantage and Disadvantage, measured at Census Collection District areas) 23. This index includes variables on: income; education; employment; occupation; housing and other variables such as disability, car ownership, internet access and single parents.

Household size

The number of people in the household was recoded from 1,2,3,4,5 or more, to 3 categories: 1-2, 3-4 and 5 or more, as some cells contained small numbers with the initial categorisation.

Household structure

Household structure was coded as single with dependents, couple with dependents, parents with non-dependent children, singles without children, couple without children, and other. We recoded this to single with dependents, couple with dependents, and other (included all other categories).

Main language used in the household

We maintained the original binary coding for this variable of English, and language other than English.

Analysis

Analyses were performed using Stata V9.2. Records with missing data on household smoking status were excluded from the analysis (31 households with children 0-14). Summary statistics of household characteristics were obtained and univariate associations with rurality were examined using the Pearson's chi-square test. Initial analyses included all households with data on smoking status. Subsequent analyses were restricted to households with children 0-14. Multivariable logistic regression was used to explore the association of rurality with household smoking and with home ETS exposure, controlling for potential confounders. Initially all variables with a p-value <0.25 in the univariate analyses were included in the models, with stepwise removal of variables based on the p-value from the likelihood ratio test, with variables with a p-value <0.1 retained in the model. Rurality was retained in both multivariable models regardless of statistical significance.

RESULTS

The sample

Weighting the sample to take account of the complex sampling 15, gave a total sample size of 15,978 households (the effective sample size). Household smoking status was recorded for 15,745 of these households, which were included in the analysis.

In all households i.e. those with children and those without children, 33% contained a smoker. Rural households were significantly more likely to contain a smoker than urban households (36.5% versus 31.4%; p=<0.001), and were significantly more likely to contain a smoker who smoked indoors (home ETS exposure) (11.7% versus 9.2%, p<0.001). Households with children 0-14 years were more likely to be smoking households (35.4%) than households without children (32.1%) (p=<0.001).

For all subsequent reported analyses, we selected only those households with children aged 0-14 years. This provided a sample of 4,669 households.

Smoking households with children

Table 1 presents the demographic and smoking behaviour characteristics of households with children aged 0-14.

Table 1– Demographic characteristics and smoking behaviour in households with children, by rurality

	Rural n= 1515 n (%)	**Urban n= 3154** n (%)	**P value**
Smoking households	661 (43.6)	989 (31.4)	<0.001
Home ETS exposure	121 (8.0%)	163 (5.2%)	<0.001
Socio-economic status (SEIFA quintile):			<0.001
1 (lowest)	437 (28.8%)	376 (11.9%)	
2	458 (30.2%)	416 (13.2%)	
3	342 (22.6%)	590 (18.7%)	
4	225 (14.8%)	855 (27.1%)	
5 (highest)	54 (3.6%)	917 (29.1%)	
Household size:			0.022
1-2	901 (59.5%)	1939 (61.5%)	
3-4	528 (34.9%)	991 (31.4%)	
5+	86 (5.7%)	225 (7.1%)	
Household structure[a]:			<0.001
Single with dependents	190 (12.6%)	259 (8.3%)	
Couple with dependents	1028 (68.1%)	2281 (72.8%)	
Other	291 (19.3%)	593 (18.9%)	
Main language[b]:			<0.001
English	1487 (98.3%)	2729 (86.8%)	
Language other than English	25 (1.7%)	416 (13.2%)	

[a] 1509 rural observations and 3133 urban; [b] 1512 rural observations and 3145 urban

Note: Results may not add up to totals because of the adjustment of the effective sample size calculation

Overall, 35.4% of households with children were smoking households, and 6.1% of households with children contained a smoker who smoked inside the home (home ETS exposure). The proportion of households which were smoking households was greater in rural (43.6%) then urban (31.4%) areas (p<0.001). The proportion of households with home ETS exposure was also significantly greater in rural (8.0%) than urban (5.2%) households with children (p=<0.001).

Rural and urban households were also different on all potential confounders: the proportion of households in each SEIFA quintile (p=<0.001); household size, with rural households having a smaller proportion of larger households (p=0.022); household structure, with rural households having a larger proportion of households with a single adult with dependent children (p=<0.001); and main language with a much lower proportion of rural households speaking a language other than English (p=<0.001) than urban households.

Associations of smoking behaviour with rurality

Household smoking

Table 2 reports the results of the logistic regression model exploring the association of rurality with smoking households among households with children 0-14, controlling for potential confounders.

Table 2 – Logistic regression model of factors significantly associated with smoking households among households with children

Variable	**OR (95% CI)**
Rurality:	
Urban	1.00
Rural	1.21 (1.07, 1.37)
Socio-economic status (SEIFA quintile):	
1 (lowest)	1.00
2	0.70 (0.59, 0.84)
3	0.56 (0.47, 0.67)
4	0.47 (0.40, 0.57)
5 (highest)	0.28 (0.23, 0.34)
Household size:	
1-2 people	1.00
3-4 people	1.20 (1.06, 1.36)
5+ people	1.36 (1.08, 1.72)
Household structure:	
Single with dependents	1.00
Couple with dependents	0.47 (0.40, 0.56)
Other	0.70 (0.56, 0.87)

Amongst households with children, rurality continued to be associated with being a smoking household when socio-economic status, household size and household structure were controlled for. Main language used in the household was not retained in the model.

Home ETS exposure

Results of the logistic regression model to explore the association between rurality and home ETS exposure in households with children, controlling for potential confounders are shown in Table 3.

Table 3 Logistic regression model of factors associated with home ETS exposure among households with children

Variable	OR (95% CI)
Rurality:	
Urban	1.00
Rural	1.07 (0.85, 1.35)
Socio-economic status (SEIFA quintile):	
1 (lowest)	1.00
2	0.55 (0.41, 0.74)
3	0.52 (0.38, 0.70)
4	0.27 (0.19, 0.38)
5 (highest)	0.25 (0.17, 0.37)
Household size:	
1-2 people	1.00
3-4 people	1.83 (1.42, 2.35)
5+ people	2.71 (1.84, 4.00)
Household structure:	
Single with dependents	1.00
Couple with dependents	0.25 (0.19, 0.33)
Other	0.52 (0.38, 0.73)

In households with children, home ETS exposure was not significantly associated with rurality once other factors were controlled for. Socio-economic status, household size and household structure remained strongly associated with home ETS exposure. Main language used in the household was not retained in the model.

DISCUSSION

One third of all Australian households were smoking households. In univariate analysis both smoking households and home ETS exposure were significantly more common for rural households with children than for urban households with children. In a multivariate analysis among households with children, rurality remained associated with smoking households when confounding factors were controlled for, whereas rurality did not remain associated with home ETS exposure after controlling for potential confounders.

Smoking households

Overall, smoking prevalence is in decline in Australia, estimated at 15.9% of adults smoking daily in 2010 3. Given this, it is surprising that 33% of all Australian households contain a daily smoker. Smoking is even more common in households containing children with 35.4% of households with children aged 0-14 containing a smoker, rising to 43.6% of rural households with children (p =<0.001).

It is possible that a focus on individual smoking behaviour and not on household behaviours, children and/or rurality has masked recognition of this high proportion of rural households with

children containing a smoker. The exploration of smoking at household level is supported by the importance of the social and relational environment for smoking, and smoking cessation 24.

In households with children, rurality continued to be associated with smoking households when other factors were controlled for. This suggests there might be something particular about rural smoking households that warrants further investigation, and that support for smoking cessation might be rurally targeted.

Home ETS exposure

Home ETS exposure was significantly more common for rural (8%) than urban (5.2% p=<0.001) households with children. Using the NDSHS data, this equates to 54,123 rural households with at least one child containing a daily smoker who smokes inside the home. The few studies of children's home ETS exposure in rural compared to urban areas provide a mixed picture, and comparison is compromised by differences in defining home ETS. A German study 16 exploring rural-urban comparisons of home ETS in households with children reported higher levels of home ETS in urban areas. This probably reflects the higher prevalence of smoking in urban than rural areas in European countries25, the reverse of Australia, Canada and China. One American study of states containing Appalachian counties used a similar definition of home ETS exposure to our own, and reports rural home ETS exposure of children (under 18) as 12.5% compared to urban exposure of 6.5% 18. By contrast, urban Alaskan households have higher levels of home ETS exposure than the most extremely rural regions 17.

The main drivers of home ETS exposure for children in rural households were the same as for urban i.e. low socio-economic status, larger household size and being a single parent household. Home ETS exposure is highest for children from disadvantaged families as their parents are more likely to smoke and smoke heavily 2, and to smoke in the home 16. The NDSHS data highlight the stark contrast between rural and urban households in terms of their socio-economic status, with only 3.6% of rural households in the least disadvantaged SEIFA category compared to 29.1% of urban households.

Another factor driving the higher prevalence of home ETS exposure in rural households compared to urban households is the significantly greater proportion of single parent families in rural areas. The finding of higher home ETS exposure among single parent families has been reported in Australia previously 26. Given single parenthood is closely intertwined with disadvantage 3 we must continue with efforts to address smoking in lower SES populations groups.

Our finding that home ETS does not remain associated with rurality once confounders are adjusted for matches the Alaskan study described earlier 17. Whilst rurality does not remain associated with home ETS exposure in households with children once other factors are controlled for, rural children experience more home ETS exposure because of these factors which place them at additional disadvantage (low socioeconomic status and single parent households). Socio-economic status and household structure were the strongest drivers of both household smoking and home ETS.

Given the progressive adoption of smoke-free public places legislation in Australia and other high income countries, the relative importance of home ETS exposure is increasing. As living in a smoke-free home offers children some protection from home ETS exposure, continuing the decline in homes with smokers who smoke inside the house is key. However, one Swedish study of young

children demonstrated that 'smoking outdoors' even with the door shut resulted in higher urinary cotinine levels when compared to an age-matched non-smoking household control group 7. These findings are supported by a UK study which reported children from smoking parents in households which were smoke-free had less salivary cotinine than children with smoking parents in households which were not smoke-free, but more than children with non-smoking parents in smoke-free households 6. Therefore, whilst living in a household with no indoor smoking offers children some protection, children from households without smokers are the most protected.

The data explored in this study did not include children's ETS exposure outside their own home, for example in cars, visiting other families, social outings etc. but as rural children are more likely to live in a smoking household (even if the smoker/s smoke outside the home), we would anticipate it is likely that they are also more frequently exposed to ETS in other non-home settings. In a study of infants in urban NSW Australia for example, Daly et al report that 10% were exposed in the home, and 22% at a friend or relative's house 26.

Limitations of this study

This study has several limitations.

The NDSHS is subject to response bias from self-report. Whilst there is some evidence demonstrating self-report of smoking in the home is moderately correlated to environmental and biomedical markers 27, it remains an inferior replacement for such measures 26. It is likely that home ETS exposure from this survey is therefore a conservative estimate.

In addition to respondents under-reporting what is clearly a socially undesirable behaviour (smoking indoors in a household with children), there have been several studies exploring what people actually mean when they talk about household smoking rules i.e. how people define (to themselves and others) 'smoke indoors' and 'smoke outdoors' 2, 28. These qualitative studies suggest that defining smoking outdoors might be a somewhat varied and fluctuating category, possibly contributing to further underestimation of home ETS. At present we do not know how defining home smoking status is played out in Australia, or if there are any rural/urban differences in this regard. Gaining an understanding of what people know about children's home ETS exposure, what is meant by smoking outside the home, and what their home smoking behaviour actually is in Australia would both illuminate the findings of this study and contribute to understanding how best to support people in either quitting or making their home smoke-free.

A limited number of potential household level confounders were available in this dataset and there are other important confounders at household level, such as the ages of people in the household, or the number of smokers in the household, that we were unable to control for.

As our analysis was conducted at household level, we did not use data on individuals and therefore did not control for potential individual-level confounders known to be associated with smoking prevalence such as mental health 3. We did not control for Aboriginal status as although there were (very limited) data available, Aboriginal status is nonsensical as a household-level variable, although an important individual-level confounder given the smoking prevalence amongst Aboriginal Australians is more than twice that of non-Aboriginal Australians 29. SEIFA is an area level variable. At Census Collection District area (around 100 houses) this may not always apply to individual households.

CONCLUSION

The proportion of smoking households with children remains an important public health concern. The finding that rurality remains associated with smoking households when other factors such as socio-economic status are controlled for, suggests we need to understand more about the context of smoking in rural Australia to provide support targeted to rural households in quitting.

Significant numbers of children continue to be exposed to home ETS and to suffering the lifelong consequences on their physical health, academic performance and their own smoking behaviour in the future. Socio-economic disadvantage continues to be a significant driver of differences in children's home ETS exposure in rural compared to urban areas. Further efforts to support smokers who smoke inside their homes containing children to quit or avoid smoking in the home would benefit these children. Understanding the smoking rules and behaviours inside smoking households, and people's knowledge of children's home ETS exposure, should provide better evidence to support those efforts.

ACKNOWLEDGEMENTS

Our thanks to Dr Coral Gartner for her advice about handling the weighting of the data, and to Dr Judy Singer for her support with the background research for this study.

COMPETING INTERESTS

Dr Passey receives research grant funding from Pfizer Australia, through an Australian Research Council Linkage Grant. The authors declare no conflicts of interest.

WHAT THIS PAPER ADDS

No previous Australian studies have looked at children's home environmental tobacco smoke exposure (ETS) in rural compared to urban areas. We found that 44% of rural households with children in Australia contained a smoker (higher than in urban areas), and that a higher proportion of households exposed children to home ETS in rural households compared to urban households. The drivers of these differences were rurality, household size, socio-economic status, and household structure.

CONTRIBUTORSHIP STATEMENT

Jo Longman obtained, organised and analysed the data, and drafted and revised the paper. Megan Passey designed the study analysed the data and revised the paper.

DATA SHARING STATEMENT

There is no additional data available

References

1 Royal College of Physicians. Passive smoking and children. A report by the Tobacco Advisory Group. London, UK: Royal College of Physicians 2010.

2 Jones LL, Atkinson O, Longman J*, et al.* The motivators and barriers to a smoke-free home among disadvantaged caregivers: identifying the positive levers for change. *Nicotine Tob Res* 2011;**13**:479-486.

3 Scollo M, Winstanley M. *Tobacco in Australia: Facts and Issues*. 2012. http://www.tobaccoinaustralia.org.au (accessed February 2013).

4 Goldade K, Choi K, Bernat DH*, et al.* Multilevel predictors of smoking initiation among adolescents: Findings from the Minnesota Adolescent Community Cohort (MACC) study. *Prev Med* 2012.

5 de Leeuw R, Engels R, Scholte R. Parental smoking and pretend smoking in young children. *Tob Control* 2010;**19**:201-205.

6 Jarvis MJ, Mindell J, Gilmore A*, et al.* Smoke-free homes in England: prevalence, trends and validation by cotinine in children. *Tob Control* 2009;**18**:491-495.

7 Johansson A, Hermansson G, Ludvigsson J. How should parents protect their children from environmental tobacco-smoke exposure in the home? *Pediatrics* 2004;**113**:e291-e295.

8 Bottorff JL, Johnson JL, Carey J*, et al.* A family affair: Aboriginal women's efforts to limit second-hand smoke exposure at home. *Can J Public Health* 2010;**101**:32-35.

9 World Health Organization. WHO Framework Convention on Tobacco Control. Geneva: World Health Organization; 2003. *World Health Organization The world health report* 2002.

10 Borland R, Mullins R, Trotter L*, et al.* Trends in environmental tobacco smoke restrictions in the home in Victoria, Australia. *Tob Control* 1999;**8**:266-271.

11 Borland R, Yong H, Cummings K*, et al.* Determinants and consequences of smoke-free homes: findings from the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2006;**15**:iii42-iii50.

12 Commonwealth Government of Australia. *Draft for consultation of the National Tobacco Strategy 2012-2018*. 2012. http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/draft-nts-12-18-callsubs (accessed March 2013).

13 Australian Institute of Health and Welfare. *Rural, regional and remote health: indicators of health*. 2005. http://www.aihw.gov.au/publication-detail/?id=6442467718 (accessed February 2013).

14 Australian Bureau of Statistics. *Tobacco smoking in Australia: A snapshot (4831.055.001)*. 2006. http://www.abs.gov.au/ausstats/abs@.nsf/mf/4831.0.55.001 (accessed February 2013).

15 Gartner CE, Hall WD. Is the socioeconomic gap in childhood exposure to secondhand smoke widening or narrowing? *Tob Control* 2012:Available online.

16 Bolte G, Fromme H. Socioeconomic determinants of children's environmental tobacco smoke exposure and family's home smoking policy. *The European Journal of Public Health* 2009;**19**:52-58.

17 Dent C, Maher J, Pizacani B*, et al.* Secondhand smoke exposure in Alaskan households with children. *Rural Remote Health* 2010;**10**.

18 Wiener RC. Secondhand and thirdhand tobacco smoke exposure in children living in states containing Appalachian counties: A surveillance. *Journal of Rural and Tropical Public Health* 2011;**10**:111-118.

19 Xiao L, Yang Y, Li Q*, et al.* Population-based survey of secondhand smoke exposure of children in China. *Biomed Environ Sci* 2010;**23**:430-436.

20 McMillen R, Breen J, Cosby AG. Rural-Urban Differences in the Social Climate Surrounding Environmental Tobacco Smoke: A Report From the 2002 Social Climate Survey of Tobacco Control. *The Journal of Rural Health* 2006;**20**:7-16.

21 Roy Morgan Research. National Drug Strategy Household Survey 2010 Final Technical Report. Canberra: Australian Institute of Health and Welfare and Department of Health and Ageing, 2011.

22 Australian Institute of Health and Welfare. *Australian Data Archieve - National Drug Strategy Household Survey Questionnaire, 2010*. 2010. http://www.ada.edu.au/social-science/01237 (accessed January 2013).

23 Australian Bureau of Statistics. *Australian Standard Geographical Classifciation (ASCG): Socio-economic indexes for areas (SEIFA) - Technical Paper 2006*. 2006. http://www.abs.gov.au/ausstats/abs@.nsf/mf/2039.0.55.001 (accessed January 2013).

24 Siahpush M, Borland R, Scollo M. Factors associated with smoking cessation in a national sample of Australians. *Nicotine Tob Res* 2003;**5**:597-602.

25 Idris BI, Giskes K, Borrell C*, et al.* Higher smoking prevalence in urban compared to non-urban areas: time trends in six European countries. *Health Place* 2007;**13**:702-712.

26 Daly JB, Wiggers JH, Considine RJ. Infant exposure to environmental tobacco smoke: a prevalence study in Australia. *Aust NZ J Public Health* 2001;**25**:132-137.

27 Rumchev K, Jamrozik K, Stick S*, et al.* How free of tobacco smoke are 'smoke-free'homes? *Indoor Air* 2008;**18**:202-208.

28 Robinson J, Kirkcaldy AJ. Disadvantaged mothers, young children and smoking in the home: mothers' use of space within their homes. *Health Place* 2007;**13**:894-903.

29 Hudson L, White A, Roseby R. Tobacco smoke exposure in hospitalised Aboriginal children in Central Australia. *J Paediatr Child Health* 2009;**45**:224-227.

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

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **Yes**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **Yes**
Objectives	3	State specific objectives, including any prespecified hypotheses **Yes**
Methods		
Study design	4	Present key elements of study design early in the paper **Yes**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **Yes**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **Yes**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **Yes**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **Yes**
Bias	9	Describe any efforts to address potential sources of bias **Yes**
Study size	10	Explain how the study size was arrived at **Yes**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **Yes**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **Yes**
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **Yes**
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **Yes**
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **Yes**
		(b) Indicate number of participants with missing data for each variable of interest **Yes**
Outcome data	15*	Report numbers of outcome events or summary measures **Yes**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **Yes**
		(*b*) Report category boundaries when continuous variables were categorized

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives **Yes**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Yes**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **Yes**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Yes**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **Yes**

*Give information separately for exposed and unexposed groups.

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

Children, smoking households and exposure to secondhand smoke in the home in rural Australia – analysis of a national cross-sectional survey

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003128.R1
Article Type:	Research
Date Submitted by the Author:	04-Jun-2013
Complete List of Authors:	Longman, Jo; University of Sydney, Sch of Public Health (University Centre for Rural Health - North Coast) Passey, Megan; University of Sydney, University Centre for Rural Health - North Coast
Primary Subject Heading:	Public health
Secondary Subject Heading:	Smoking and tobacco
Keywords:	Environmental Tobacco Smoke, Secondhand smoke, Children, Rural, Australia

Children, smoking households and exposure to secondhand smoke in the home in rural Australia – analysis of a national cross-sectional survey.

Jo M Longman[1*] and Megan E Passey[1]

[1] University Centre for Rural Health, University of Sydney School of Public Health, PO Box 3074, Lismore, NSW 2480, Australia

[*]Corresponding Author: email: jo.longman@ucrh.edu.au; T:02 66207570; F: 02 66207270

Keywords: environmental tobacco smoke; secondhand smoke; children; rural; Australia

Wordcount: 3753

ARTICLE SUMMARY

Focus

Given that children's exposure to secondhand smoke is such an important public health concern, as well as the higher prevalence of smoking in rural areas in Australia, this paper addresses two questions: 1. Are there rural/urban differences in a) smoking within households with children and b) home secondhand smoke exposure in children?; and 2. If so, is this due to socioeconomic disadvantage or other factors unique to 'rurality'?

Key Messages

43.6% of rural households with children contained a smoker. Both household smoking and home secondhand smoke exposure were significantly more common for rural children than for urban dwelling children. Rurality remained associated with smoking households but did not remain associated with home secondhand smoke exposure, when confounding factors were controlled for. Children's home secondhand smoke exposure was driven by larger household size, low socio-economic status and being a single parent household.

Strengths and Limitations

No previous studies have explored rural/urban differences in smoking in households with children in Australia. This study used data from a representative national household survey to explore the association of rurality with household smoking and with home secondhand smoke exposure. The study had limited potential household level confounding variables available for inclusion in the analysis, and was limited by potential response bias leading to a possible under-reporting of household smoking status.

ABSTRACT

Introduction

Smoking is more prevalent in rural than urban Australia, but few studies have explored rural/urban differences in home secondhand smoke exposure and none have explored these differences amongst children in Australia. Both household smoking and home secondhand smoke exposure are

harmful to children. This paper aimed to explore the association between rurality and a) household smoking status and b) home secondhand smoke exposure, in households with children aged 0-14.

Method

Data from the 2010 National Drug Strategy Household survey were analysed to explore prevalence of household smoking and home secondhand smoke exposure in rural and urban households with children. Multivariable logistic regression was used to explore the association of rurality with household smoking and with home secondhand smoke exposure, controlling for potential confounders.

Results

Households with children were more likely to be smoking households (35.4% 95%CI:34.2%, 36.5%) than households without children (32.1% 95%CI:31.3%, 32.8%). Both household smoking (43.6% (95%CI:41.5%, 45.7%) vs 31.4% (95%CI:30.0%, 32.8%)) and home secondhand smoke exposure (8.0% (95%CI:6.8%, 9.1%) vs 5.2% (95%CI:4.5%, 5.8%)) were significantly more common for rural children. In multivariate analyses controlling for confounding factors, rurality remained associated with smoking households (OR= 1.21 95%CI:1.07, 1.37), whereas it did not remain associated with children's home secondhand smoke exposure (OR=1.07 95%CI:0.85, 1.35). Larger household size, low socio-economic status, and being a single parent household were the main drivers of home secondhand smoke exposure.

Conclusion

The proportion of smoking households with children, and the number of children regularly exposed to secondhand smoke in their homes remain important public health concerns. Smoking cessation support and tobacco control policies might benefit from targeting larger and/or socio-economically disadvantaged households including single-parent households.

BACKGROUND

The negative impact of children's exposure to smoking behaviour and to secondhand smoke in their homes is extensive. Due to the higher breathing rates per body weight, and the size and immaturity of their organs, children are particularly vulnerable to the effects of secondhand smoke exposure on their physical health 1-3. They are also particularly vulnerable to the corollaries of those effects such as missing more time at school, and compromised academic performance 3. In addition, children whose parents smoke are more likely to become smokers themselves, growing up with smoking as a normalised behaviour 4, 5.

The site where most secondhand smoke exposure in children happens is their home 2, 6. Children are not able to control their environment to minimise their exposure and are effectively 'trapped' in smoking environments. Children who live in homes where there is no indoor smoking are afforded some protection from secondhand smoke exposure even when a parent smokes 6, 7. However, for adults, negotiating smoke-free home environments can be challenging due to the social and familial relationship aspects of smoking behaviour in the home 2, 8.

Whilst it may be considered an infringement of individual civil liberties to legislate against secondhand smoke exposure in the home, the notion of a smoke-free home is an extension of the protection offered from comprehensive smoke-free legislation. In Australia this began in the mid-

1980s, and has covered public transport, the workplace, public spaces, smoking in cars containing children, and, most recently, proposed legislation on multi-unit dwellings, supported by an active campaign from Action on Smoking and Health Australia 3.

This legislative environment reflects the importance of protecting the public from secondhand smoke exposure. Efforts to protect children from the effects of secondhand smoke exposure respond directly to Article 8 of the WHO Framework Convention on Tobacco Control requiring smoke-free measures by those countries ratifying the Treaty, including Australia 9.

Educational campaigns focusing on smoke-free homes have been in place since the early 2000s and continue to form a regular part of tobacco campaigning in Australia. These campaigns have promoted quitting or smoking outside to protect children from the harms of home secondhand smoke exposure 10and appear to have been 'moderately helpful' in increasing the number of smoke-free homes 3. In 2006, 43% of Australian households with smokers reported totally banning smoking indoors 11, and data from both NSW and Victoria show declines in household indoor smoking over recent years 3. One of the main outcome indicators in Australia's draft National Tobacco Strategy 2004-2009 is that fewer people will be exposed to secondhand smoke in their homes 12.

Is there an urban/rural divide in children's exposure to home secondhand smoke ?

In Australia around one third of the population lives outside major cities, with rural areas more socio-economically disadvantaged than urban areas 13. The prevalence of tobacco smoking in this rural population is significantly higher than in urban areas 14. Smoking continues to be disproportionately represented among socio-economically disadvantaged populations, and these disparities are increasing over time 15.

We identified only three studies exploring the difference between home secondhand smoke exposure in children in rural compared to urban areas 16-18, with none from Australia. Two are North American (one showing higher home secondhand smoke exposure in rural areas 18 and one from Alaska showing lower home secondhand smoke exposure in very remote areas 17), and one from Germany reporting lower home secondhand smoke exposure in children in rural areas 16. One study from China describes secondhand smoke exposure in respondents' homes (all homes, not just homes with children) that is higher in rural areas (73%) compared with urban areas (60%) 19. One further North American study focuses on home smoking bans, and reports fewer home smoking bans in rural households compared to urban households 20.

Given that secondhand smoke exposure is such an important public health concern, particularly in children, as well as the higher prevalence of smoking in rural areas in Australia, this paper addresses two questions: 1. Are there rural/urban differences in a) smoking within households with children and b) home secondhand smoke exposure in children?; and 2. If so, is this due to socioeconomic disadvantage or other factors unique to 'rurality'?

METHODS

The 2010 National Drug Strategy Household Survey

The Australian Institute of Health and Welfare (AIHW) conducts the National Drug Strategy Household Survey (NDSHS) every three years to measure behaviour, knowledge and attitudes

towards drugs in Australia. The 2010 sample was a multi-stage random sample of households stratified by region with some over-sampling in certain states and territories, representative of the national population. Respondents were the person aged 12 or older in each household who was next to have a birthday. Questions were asked via drop and collect self-completion questionnaires. Questions were asked of the respondent about themselves, e.g. their own smoking status, as well as questions about the household. Data were collected between April and September 2010. The survey has been conducted on nine previous occasions 21.

The NDSHS was chosen because it provided data on household behaviour, rather than just individual behaviour, as well as the number and age of children within a household. Non-identifiable data were sourced from the AIHW with a signed agreement to protect the confidentiality and management of the data.

Weighting

Weights were applied to the data to adjust for the complex sampling design while not inflating the overall sample size. Weights for each household record were provided by the AIHW to adjust the number of households in the dataset to the number of households in the Australian population. Applying these rates would have overinflated the sample size for statistical analyses. Following Gartner et al 15, we proportionally adjusted the absolute weight for households provided by the AIHW in order to bring the overall number of households down to the effective sample size. Each weight provided by the AIHW was multiplied by an adjustment factor, and then applied to the data, to bring the total number of households down to the effective sample size provided by the AIHW.

Measures

Rurality

The rurality variable was based on the Australian Standard Geographical Classification remoteness areas 22. This classification was designed to facilitate quantitative comparison between 'city' and 'country' Australia, and is based on distance to services and goods. The variable was coded: major cities, inner regional, outer regional and remote/very remote. The inner regional code includes locations close to major cities e.g. Port Stephens, an hour's drive away from Newcastle (a major city), and outer regional includes locations such as Biloela in Queensland, 550km away from the nearest major city (Brisbane). For more information please see the map of Australia at http://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure#Anchor2e illustrating the remoteness structure. This classification system is recommended by the Australian Government's Institute of Health and Welfare (a statutory body established to report to the nation on health), particularly for use at aggregated national level 23, and is widely used in the academic literature, for example Kelly et al 24. We recoded the variable into Urban/Rural where urban was 'major cities' and rural was a combination of the remaining categories, as some cells contained small numbers with the initial categorisation.

Households with Children

We defined households with children as those with children 0-14 years old. The questionnaire asked "*Of all the dependent children, how many are in each of these age categories?*" 25, and offered two-year blocks up to 12-14 with the last category being 15+. As "*dependent children*" was defined to include children older than 14 "*who are still financially dependent, such as full-time students*"25 we

did not include the final category which may have contained substantial numbers of dependent children over 18.

Outcome variables

Smoking households

We defined smoking households as any household containing a smoker regardless of where that person smoked, i.e. answering "*Yes, inside the home*" or "*No, only smoke outside the home*" to the question "*In the last 12 months, have you or any other member of your household smoked at least one cigarette, cigar or pipe of tobacco per day in the home?"*. The other response option was "*No-one at home regularly smokes*" 25.

Home secondhand smoke exposure

Home secondhand smoke exposure is different to smoking households as it is a measure of whether a household contains a smoker who smokes inside the home. This was determined as those households where the answer *"Yes, inside the home*" was given to the question "*In the last 12 months, have you or any other member of your household smoked at least one cigarette, cigar or pipe of tobacco per day in the home?"* 25. We recoded this into a binary variable: "yes smokes inside the home" or "no does not smoke inside the home". The "no does not smoke inside the home" category included households answering either *"No, only smoke outside the home",* or *"no-one at home regularly smokes*".

Potential confounders

The data contained limited household level variables. Within these confines, the following variables were considered potential confounders in the association between home secondhand smoke exposure and rurality: socio-economic status 2, 15; number of people in the household 15; household structure 3, 16; and main language used in the household 3. These are defined below.

Socio-economic status

We defined socio-economic status using the area-level socio-economic index for areas (SEIFA) provided in the data (the Index of Relative Socio-economic Advantage and Disadvantage, measured at Census Collection District areas) 26. This index includes variables on: income; education; employment; occupation; housing and other variables such as disability, car ownership, internet access and single parents.

Household size

The number of people in the household was recoded from 1,2,3,4,5 or more, to 3 categories: 1-2, 3-4 and 5 or more, as some cells contained small numbers with the initial categorisation.

Household structure

Household structure was coded as single with dependents, couple with dependents, parents with non-dependent children, singles without children, couple without children, and other. We recoded this to single with dependents, couple with dependents, and other (included all other categories).

Main language used in the household

We maintained the original binary coding for this variable of English, and language other than English.

Analysis

Analyses were performed using Stata V9.2. Records with missing data on household smoking status were excluded from the analysis (31 households with children 0-14). Summary statistics of household characteristics were obtained and univariate associations with rurality were examined using the Pearson's chi-square test. Initial analyses included all households with data on smoking status. Subsequent analyses were restricted to households with children 0-14. Multivariable logistic regression was used to explore the association of rurality with household smoking and with home secondhand smoke exposure, controlling for potential confounders. Initially all variables with a p-value <0.25 in the univariate analyses were included in the models, with stepwise removal of variables based on the p-value from the likelihood ratio test, with variables with a p-value <0.1 retained in the model. Rurality was retained in both multivariable models regardless of statistical significance.

RESULTS

The sample

Weighting the sample to take account of the complex sampling 15, gave a total sample size of 15,978 households (the effective sample size). Household smoking status was recorded for 15,745 of these households, which were included in the analysis.

In all households i.e. those with children and those without children, 33% (95%CI:32.4%, 33.7%) contained a smoker. Rural households were significantly more likely to contain a smoker than urban households (36.5% (95%CI:35.4%, 37.5%) versus 31.4% (95%CI:30.6%, 32.1%), and were significantly more likely to contain a smoker who smoked indoors (home secondhand smoke exposure) (11.7% (95%CI:11.0%, 12.5%) versus 9.2% (95%CI:8.7%, 9.6%). Households with children 0-14 years were more likely to be smoking households (35.4%; 95%CI:34.2%, 36.5%) than households without children (32.1%; 95%CI:31.3%, 32.8%).

For all subsequent reported analyses, we selected only those households with children aged 0-14 years. This provided a sample of 4,669 households.

Smoking households with children

Table 1 presents the demographic and smoking behaviour characteristics of households with children aged 0-14.

Table 1– Demographic characteristics and smoking behaviour in households with children, by rurality

	Rural n= 1515 n (%)	Urban n= 3154 n (%)	P value
Smoking households	661 (43.6)	989 (31.4)	<0.001
Home secondhand smoke exposure	121 (8.0%)	163 (5.2%)	<0.001
Socio-economic status (SEIFA quintile):			<0.001
1 (lowest)	437 (28.8%)	376 (12.0%)	
2	458 (30.2%)	416 (13.2%)	
3	342 (22.6%)	590 (18.7%)	
4	225 (14.9%)	855 (27.1%)	
5 (highest)	54 (3.6%)	917 (29.1%)	
Household size:			0.022
1-2	901 (59.5%)	1939 (61.4%)	
3-4	528 (34.8%)	991 (31.5%)	
5+	86 (5.7%)	225 (7.1%)	
Household structure[a]:			<0.001
Single with dependents	190 (12.7%)	259 (8.3%)	
Couple with dependents	1028 (67.9%)	2281 (72.6%)	
Other	291 (19.4%)	593 (19.0%)	
Main language[b]:			<0.001
English	1487 (98.3%)	2729 (86.8%)	
Language other than English	25 (1.7%)	416 (13.2%)	

[a] 1509 rural observations and 3133 urban; [b] 1512 rural observations and 3145 urban
Note: Results may not add up to totals because of the adjustment of the effective sample size calculation

Overall, 35.4% (95%CI:34.2%, 36.5%) of households with children were smoking households, and 6.1% (95%CI:5.5%, 6.7%) of households with children contained a smoker who smoked inside the home (home secondhand smoke exposure). The proportion of households which were smoking households was greater in rural (43.6% 95%CI: 41.5%, 45.7%) than urban (31.4% 95%CI:30.0%, 32.8%) areas. The proportion of households with home secondhand smoke exposure was also significantly greater in rural (8.0% 95%CI:6.8%, 9.1%) than urban (5.2% 95%CI:4.5%, 5.8%) households with children.

Rural and urban households were also different on all potential confounders: the proportion of households in each SEIFA quintile (p=<0.001); household size, with rural households having a smaller proportion of larger households (p=0.022); household structure, with rural households having a larger proportion of households with a single adult with dependent children (p=<0.001); and main language with a much lower proportion of rural households speaking a language other than English (p=<0.001) than urban households.

Associations of smoking behaviour with rurality

Household smoking

Table 2 reports the results of the logistic regression model exploring the association of rurality with smoking households among households with children 0-14, controlling for potential confounders.

Table 2 – Logistic regression model of factors significantly associated with smoking households among households with children

Variable	**OR (95% CI)**
Rurality:	
Urban	1.00
Rural	1.21 (1.07, 1.37)
Socio-economic status (SEIFA quintile):	
1 (lowest)	1.00
2	0.70 (0.59, 0.84)
3	0.56 (0.47, 0.67)
4	0.47 (0.40, 0.57)
5 (highest)	0.28 (0.23, 0.34)
Household size:	
1-2 people	1.00
3-4 people	1.20 (1.06, 1.36)
5+ people	1.36 (1.08, 1.72)
Household structure:	
Single with dependents	1.00
Couple with dependents	0.47 (0.40, 0.56)
Other	0.70 (0.56, 0.87)

Amongst households with children, rurality continued to be associated with being a smoking household when socio-economic status, household size and household structure were controlled for. Main language used in the household was not retained in the model.

Home secondhand smoke exposure

Results of the logistic regression model to explore the association between rurality and home secondhand smoke exposure in households with children, controlling for potential confounders are shown in Table 3.

Table 3 Logistic regression model of factors associated with home secondhand smoke exposure among households with children

Variable	OR (95% CI)
Rurality:	
Urban	1.00
Rural	1.07 (0.85, 1.35)
Socio-economic status (SEIFA quintile):	
1 (lowest)	1.00
2	0.55 (0.41, 0.74)
3	0.52 (0.38, 0.70)
4	0.27 (0.19, 0.38)
5 (highest)	0.25 (0.17, 0.37)
Household size:	
1-2 people	1.00
3-4 people	1.83 (1.42, 2.35)
5+ people	2.71 (1.84, 4.00)
Household structure:	
Single with dependents	1.00
Couple with dependents	0.25 (0.19, 0.33)
Other	0.52 (0.38, 0.73)

In households with children, home secondhand smoke exposure was not significantly associated with rurality once other factors were controlled for. Socio-economic status, household size and household structure remained strongly associated with home secondhand smoke exposure. Main language used in the household was not retained in the model.

DISCUSSION

One third of all Australian households were smoking households. In univariate analysis both smoking households and home secondhand smoke exposure were significantly more common for rural households with children than for urban households with children. In a multivariate analysis among households with children, rurality remained associated with smoking households when confounding factors were controlled for, whereas rurality did not remain associated with home secondhand smoke exposure after controlling for potential confounders.

Smoking households

Overall, smoking prevalence is in decline in Australia, estimated at 15.9% of adults smoking daily in 2010 3. Given this, it is surprising that 33% of all Australian households contain a daily smoker. Smoking is even more common in households containing children with 35.4% of households with children aged 0-14 containing a smoker, rising to 43.6% of rural households with children (p =<0.001).

It is possible that a focus on individual smoking behaviour and not on household behaviours, children and/or rurality has masked recognition of this high proportion of rural households with

children containing a smoker. The exploration of smoking at household level is supported by the importance of the social and relational environment for smoking, and smoking cessation 27.

In households with children, rurality continued to be associated with smoking households when other factors were controlled for. This suggests there might be something particular about rural smoking households that warrants further investigation, and that support for smoking cessation might be rurally targeted.

Home secondhand smoke exposure

Home secondhand smoke exposure was significantly more common for rural (8%) than urban (5.2% p=<0.001) households with children. Using the NDSHS data, this equates to 54,123 rural households with at least one child containing a daily smoker who smokes inside the home. The few studies of children's home secondhand smoke exposure in rural compared to urban areas provide a mixed picture, and comparison is compromised by differences in defining home secondhand smoke . A German study 16 exploring rural-urban comparisons of home secondhand smoke in households with children reported higher levels of home secondhand smoke in urban areas. This probably reflects the higher prevalence of smoking in urban than rural areas in European countries28, the reverse of Australia, Canada and China. One North American study of states containing Appalachian counties used a similar definition of home secondhand smoke exposure to our own, and reports rural home secondhand smoke exposure of children (under 18) as 12.5% compared to urban exposure of 6.5% 18. By contrast, urban Alaskan households have higher levels of home secondhand smoke exposure than the most extremely rural regions 17.

The main drivers of home secondhand smoke exposure for children in rural households were the same as for urban i.e. low socio-economic status, larger household size and being a single parent household. Home secondhand smoke exposure is highest for children from disadvantaged families as their parents are more likely to smoke and smoke heavily 2, and to smoke in the home 16. The NDSHS data highlight the stark contrast between rural and urban households in terms of their socio-economic status, with only 3.6% of rural households in the least disadvantaged SEIFA category compared to 29.1% of urban households.

Another factor driving the higher prevalence of home secondhand smoke exposure in rural households compared to urban households is the significantly greater proportion of single parent families in rural areas. The finding of higher home secondhand smoke exposure among single parent families has been reported in Australia previously 29. Given single parenthood is closely intertwined with disadvantage 3 we must continue with efforts to address smoking in lower SES populations groups.

Our finding that home secondhand smoke does not remain associated with rurality once confounders are adjusted for matches the Alaskan study described earlier 17. Whilst rurality does not remain associated with home secondhand smoke exposure in households with children once other factors are controlled for, rural children experience more home secondhand smoke exposure because of these factors which place them at additional disadvantage (low socioeconomic status and single parent households). Socio-economic status and household structure were the strongest drivers of both household smoking and home secondhand smoke.

Given the progressive adoption of smoke-free public places legislation in Australia and other high income countries, the relative importance of home secondhand smoke exposure is increasing. As living in a smoke-free home offers children some protection from home secondhand smoke exposure, continuing the decline in homes with smokers who smoke inside the house is key. However, one Swedish study of young children demonstrated that 'smoking outdoors' even with the door shut resulted in higher urinary cotinine levels when compared to an age-matched non-smoking household control group 7. These findings are supported by a UK study which reported children from smoking parents in households which were smoke-free had less salivary cotinine than children with smoking parents in households which were not smoke-free, but more than children with non-smoking parents in smoke-free households 6. Therefore, whilst living in a household with no indoor smoking offers children some protection, children from households without smokers are the most protected.

The data explored in this study did not include children's secondhand smoke exposure outside their own home, for example in cars, visiting other families, social outings etc. but as rural children are more likely to live in a smoking household (even if the smoker/s smoke outside the home), we would anticipate it is likely that they are also more frequently exposed to secondhand smoke in other non-home settings. In a study of infants in urban NSW Australia for example, Daly et al report that 10% were exposed in the home, and 22% at a friend or relative's house 29.

Limitations of this study

This study has several limitations.

The NDSHS is subject to response bias from self-report. Whilst there is some evidence demonstrating self-report of smoking in the home is moderately correlated to environmental and biomedical markers 30, it remains an inferior replacement for such measures 29. It is likely that home secondhand smoke exposure from this survey is therefore a conservative estimate.

In addition to respondents under-reporting what is clearly a socially undesirable behaviour (smoking indoors in a household with children), there have been several studies exploring what people actually mean when they talk about household smoking rules i.e. how people define (to themselves and others) 'smoke indoors' and 'smoke outdoors' 2, 31. These qualitative studies suggest that defining smoking outdoors might be a somewhat varied and fluctuating category, possibly contributing to further underestimation of home secondhand smoke exposure. At present we do not know how defining home smoking status is played out in Australia, or if there are any rural/urban differences in this regard. Gaining an understanding of what people know about children's home secondhand smoke exposure, what is meant by smoking outside the home, and what their home smoking behaviour actually is in Australia would both illuminate the findings of this study and contribute to understanding how best to support people in either quitting or making their home smoke-free.

A limited number of potential household level confounders were available in this dataset and there are other important confounders at household level, such as the ages of people in the household, or the number of smokers in the household, that we were unable to control for.

As our analysis was conducted at household level, we did not use data on individuals and therefore did not control for potential individual-level confounders known to be associated with smoking

prevalence such as mental health 3. We did not control for Aboriginal status as although there were (very limited) data available, Aboriginal status is nonsensical as a household-level variable, although an important individual-level confounder given the smoking prevalence amongst Aboriginal Australians is more than twice that of non-Aboriginal Australians 32. SEIFA is an area level variable. At Census Collection District area (around 100 houses) this may not always apply to individual households.

CONCLUSION

The proportion of smoking households with children remains an important public health concern. The finding that rurality remains associated with smoking households when other factors such as socio-economic status are controlled for, suggests we need to understand more about the context of smoking in rural Australia to provide support targeted to rural households in quitting.

Significant numbers of children continue to be exposed to secondhand smoke in their homes and to suffering the lifelong consequences on their physical health, academic performance and their own smoking behaviour in the future. Socio-economic disadvantage continues to be a significant driver of differences in children's home secondhand smoke exposure in rural compared to urban areas. Further efforts to support smokers who smoke inside their homes containing children to quit or avoid smoking in the home would benefit these children. Understanding the smoking rules and behaviours inside smoking households, and people's knowledge of children's home secondhand smoke exposure, should provide better evidence to support those efforts.

ACKNOWLEDGEMENTS

Our thanks to Dr Coral Gartner for her advice about handling the weighting of the data, and to Dr Judy Singer for her support with the background research for this study.

COMPETING INTERESTS

Dr Passey receives research grant funding from Pfizer Australia, through an Australian Research Council Linkage Grant. The authors declare no conflicts of interest.

WHAT THIS PAPER ADDS

No previous Australian studies have looked at children's home secondhand smoke exposure in rural compared to urban areas. We found that 44% of rural households with children in Australia contained a smoker (higher than in urban areas), and that a higher proportion of households exposed children to home secondhand smoke in rural households compared to urban households. The drivers of these differences were rurality, household size, socio-economic status, and household structure.

reprints, include within collections and create summaries, extracts and/or, abstracts of the Contribution, iii) create any other derivative work(s) based on the Contribution, iv) to exploit all subsidiary rights in the Contribution, v) the inclusion of electronic links from the Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above.

CONTRIBUTORSHIP STATEMENT

Jo Longman obtained, organised and analysed the data, and drafted and revised the paper. Megan Passey designed the study analysed the data and revised the paper.

DATA SHARING STATEMENT

There are no additional data available.

References

1 Royal College of Physicians. Passive smoking and children. A report by the Tobacco Advisory Group. London, UK: Royal College of Physicians 2010.

2 Jones LL, Atkinson O, Longman J*, et al.* The motivators and barriers to a smoke-free home among disadvantaged caregivers: identifying the positive levers for change. *Nicotine Tob Res* 2011;**13**:479-486.

3 Scollo M, Winstanley M. *Tobacco in Australia: Facts and Issues*. 2012. http://www.tobaccoinaustralia.org.au (accessed February 2013).

4 Goldade K, Choi K, Bernat DH*, et al.* Multilevel predictors of smoking initiation among adolescents: Findings from the Minnesota Adolescent Community Cohort (MACC) study. *Prev Med* 2012.

5 de Leeuw R, Engels R, Scholte R. Parental smoking and pretend smoking in young children. *Tob Control* 2010;**19**:201-205.

6 Jarvis MJ, Mindell J, Gilmore A*, et al.* Smoke-free homes in England: prevalence, trends and validation by cotinine in children. *Tob Control* 2009;**18**:491-495.

7 Johansson A, Hermansson G, Ludvigsson J. How should parents protect their children from environmental tobacco-smoke exposure in the home? *Pediatrics* 2004;**113**:e291-e295.

8 Bottorff JL, Johnson JL, Carey J*, et al.* A family affair: Aboriginal women's efforts to limit second-hand smoke exposure at home. *Can J Public Health* 2010;**101**:32-35.

9 World Health Organization. WHO Framework Convention on Tobacco Control. Geneva: World Health Organization; 2003. *World Health Organization The world health report* 2002.

10 Borland R, Mullins R, Trotter L*, et al.* Trends in environmental tobacco smoke restrictions in the home in Victoria, Australia. *Tob Control* 1999;**8**:266-271.

11 Borland R, Yong H, Cummings K*, et al.* Determinants and consequences of smoke-free homes: findings from the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2006;**15**:iii42-iii50.

12 Commonwealth Government of Australia. *Draft for consultation of the National Tobacco Strategy 2012-2018*. 2012. http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/draft-nts-12-18-callsubs (accessed March 2013).

13 Australian Institute of Health and Welfare. *Rural, regional and remote health: indicators of health*. 2005. http://www.aihw.gov.au/publication-detail/?id=6442467718 (accessed February 2013).

14 Australian Bureau of Statistics. *Tobacco smoking in Australia: A snapshot (4831.055.001)*. 2006. http://www.abs.gov.au/ausstats/abs@.nsf/mf/4831.0.55.001 (accessed February 2013).

15 Gartner CE, Hall WD. Is the socioeconomic gap in childhood exposure to secondhand smoke widening or narrowing? *Tob Control* 2012:Available online.

16 Bolte G, Fromme H. Socioeconomic determinants of children's environmental tobacco smoke exposure and family's home smoking policy. *The European Journal of Public Health* 2009;**19**:52-58.

17 Dent C, Maher J, Pizacani B*, et al.* Secondhand smoke exposure in Alaskan households with children. *Rural Remote Health* 2010;**10**.

18 Wiener RC. Secondhand and thirdhand tobacco smoke exposure in children living in states containing Appalachian counties: A surveillance. *Journal of Rural and Tropical Public Health* 2011;**10**:111-118.

19 Xiao L, Yang Y, Li Q*, et al.* Population-based survey of secondhand smoke exposure of children in China. *Biomed Environ Sci* 2010;**23**:430-436.

20 McMillen R, Breen J, Cosby AG. Rural-Urban Differences in the Social Climate Surrounding Environmental Tobacco Smoke: A Report From the 2002 Social Climate Survey of Tobacco Control. *The Journal of Rural Health* 2006;**20**:7-16.

21 Roy Morgan Research. National Drug Strategy Household Survey 2010 Final Technical Report. Canberra: Australian Institute of Health and Welfare and Department of Health and Ageing, 2011.
22 Australian Bureau of Statistics. *Australian Standard Geographical Classification (ASGC) Remoteness Structure (RA) Digital Boundaries, Australia, 2006* 2006. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DirClassManualsbyTopic/9A784FB979765947CA25738C0012C5BA (accessed May 2012).
23 Australian Institute of Health and Welfare. *Remoteness Classifications*. http://www.aihw.gov.au/rural-health-remoteness-classifications/ (accessed May 2013).
24 Kelly BJ, Stain HJ, Coleman C*, et al.* Mental health and well-being within rural communities: The Australian Rural Mental Health Study. *Aust J Rural Health* 2010;**18**:16-24.
25 Australian Institute of Health and Welfare. *Australian Data Archieve - National Drug Strategy Household Survey Questionnaire, 2010*. 2010. http://www.ada.edu.au/social-science/01237 (accessed January 2013).
26 Australian Bureau of Statistics. *Australian Standard Geographical Classifciation (ASCG): Socio-economic indexes for areas (SEIFA) - Technical Paper 2006*. 2006. http://www.abs.gov.au/ausstats/abs@.nsf/mf/2039.0.55.001 (accessed January 2013).
27 Siahpush M, Borland R, Scollo M. Factors associated with smoking cessation in a national sample of Australians. *Nicotine Tob Res* 2003;**5**:597-602.
28 Idris BI, Giskes K, Borrell C*, et al.* Higher smoking prevalence in urban compared to non-urban areas: time trends in six European countries. *Health Place* 2007;**13**:702-712.
29 Daly JB, Wiggers JH, Considine RJ. Infant exposure to environmental tobacco smoke: a prevalence study in Australia. *Aust NZ J Public Health* 2001;**25**:132-137.
30 Rumchev K, Jamrozik K, Stick S*, et al.* How free of tobacco smoke are 'smoke-free'homes? *Indoor Air* 2008;**18**:202-208.
31 Robinson J, Kirkcaldy AJ. Disadvantaged mothers, young children and smoking in the home: mothers' use of space within their homes. *Health Place* 2007;**13**:894-903.
32 Hudson L, White A, Roseby R. Tobacco smoke exposure in hospitalised Aboriginal children in Central Australia. *J Paediatr Child Health* 2009;**45**:224-227.

Children, smoking households and exposure to secondhand smoke in the home in rural Australia – analysis of a national cross-sectional survey. ~~Children, smoking households and exposure to home environmental tobacco smoke in rural Australia – what's the story?~~

Jo M Longman[1*] and Megan E Passey[1]

[1] University Centre for Rural Health, University of Sydney School of Public Health, PO Box 3074, Lismore, NSW 2480, Australia

[*]Corresponding Author: email: jo.longman@ucrh.edu.au; T:02 66207570; F: 02 66207270

Keywords: environmental tobacco smoke; secondhand smoke; children; rural; Australia

Wordcount: ~~3,465~~3,753

ARTICLE SUMMARY

Focus

Given that children's exposure to ~~environmental tobacco smoke (ETS~~secondhand smoke ~~)~~ ~~exposure~~ is such an important public health concern, as well as the higher prevalence of smoking in rural areas in Australia, this paper addresses two questions: 1. Are there rural/urban differences in a) smoking within households with children and b) home ~~ETS~~secondhand smoke exposure in children?; and 2. If so, is this due to socioeconomic disadvantage or other factors unique to 'rurality'?

Key Messages

43.6% of rural households with children contained a smoker. Both household smoking and home ~~ETS~~secondhand smoke exposure were significantly more common for rural children than for urban dwelling children. Rurality remained associated with smoking households but did not remain associated with home ~~ETS~~secondhand smoke exposure, when confounding factors were controlled for. Children's home ~~ETS~~secondhand smoke exposure ~~i~~was ~~s~~ driven by larger household size, low socio-economic status and being a single parent household.

Strengths and Limitations

No previous studies have explored rural/urban differences in smoking in households with children in Australia. This study used data from a representative national household survey to explore the association of rurality with household smoking and with home ~~ETS~~secondhand smoke exposure. The study had limited potential household level confounding variables available for inclusion in the analysis, and was limited by potential response bias leading to a possible under-reporting of household smoking status.

ABSTRACT

Introduction

Smoking is more prevalent in rural than urban Australia, but few studies have explored rural/urban differences in home ~~environmental tobacco smoke (ETS~~secondhand smoke ~~)~~ exposure and none have explored these differences amongst children in Australia. Both household smoking and home ~~ETS~~secondhand smoke exposure are harmful to children. This paper aimed to explore the association between rurality and a) household smoking status and b) home ~~ETS~~secondhand smoke exposure, in households with children aged 0-14.

Method

Data from the 2010 National Drug Strategy Household survey were analysed to explore prevalence of household smoking and home ~~ETS~~secondhand smoke exposure in rural and urban households with children. Multivariable logistic regression was used to explore the association of rurality with household smoking and with home ~~ETS~~secondhand smoke exposure, controlling for potential confounders.

Results

Households with children were more likely to be smoking households (35.4% 95%CI:34.2%, 36.5%) than households without children (32.1% 95%CI:31.3%, 32.8%) ~~(p=<0.001)~~. Both household smoking (43.6% (95%CI:41.5%, 45.7%) vs 31.4% (95%CI:30.0%, 32.8%)~~p = <0.001~~) and home ~~ETS~~secondhand smoke exposure (8.0% (95%CI:6.8%, 9.1%) vs 5.2% ~~p=<0.001~~(95%CI:4.5%, 5.8%)) were significantly more common for rural children. In multivariate analyses controlling for confounding factors, rurality remained associated with smoking households (OR= 1.21 95%CI:1.07, 1.37), whereas it did not remain associated with children's home ~~ETS~~secondhand smoke exposure (OR=1.07 95%CI:0.85, 1.35). Larger household size, low socio-economic status, and being a single parent household were the main drivers of home ~~ETS~~secondhand smoke exposure.

Conclusion

The proportion of smoking households with children, and the number of children regularly exposed to secondhand smoke in their homes ~~ETS~~ remain important public health concerns. Smoking cessation support and tobacco control policies might benefit from targeting larger and/or socio-economically disadvantaged households including single-parent households.

BACKGROUND

The negative impact of children's exposure to smoking behaviour and ~~environmental tobacco smoke (ETS~~ to secondhand smoke~~)~~ in their homes is extensive. Due to the higher breathing rates per body weight, and the size and immaturity of their organs, children are particularly vulnerable to the effects of ~~ETS~~secondhand smoke exposure on their physical health 1-3. They are also particularly vulnerable to the corollaries of those effects such as missing more time at school, and compromised academic performance 3. In addition, children whose parents smoke are more likely to become smokers themselves, growing up with smoking as a normalised behaviour 4, 5.

The site where most ~~ETS~~secondhand smoke exposure in children happens is their home 2, 6. Children are not able to control their environment to minimise their exposure and are effectively 'trapped' in smoking environments. Children who live in homes where there is no indoor smoking

are afforded some protection from ~~ETS~~secondhand smoke exposure even when a parent smokes 6, 7. However, for adults, negotiating smoke-free home environments can be challenging due to the social and familial relationship aspects of smoking behaviour in the home 2, 8.

Whilst it may be considered an infringement of individual civil liberties to legislate against ~~ETS~~secondhand smoke exposure in the home, the notion of a smoke-free home is an extension of the protection offered from comprehensive smoke-free legislation. In Australia this began in the mid-1980s, and has covered public transport, the workplace, public spaces, smoking in cars containing children, and, most recently, proposed legislation on multi-unit dwellings, supported by an active campaign from Action on Smoking and Health Australia 3.

This legislative environment reflects the importance of protecting the public from ~~ETS~~secondhand smoke exposure. Efforts to protect children from the effects of ~~ETS~~secondhand smoke exposure respond directly to Article 8 of the WHO Framework Convention on Tobacco Control requiring smoke-free measures by those countries ratifying the Treaty, including Australia 9.

Educational campaigns focusing on smoke-free homes have been in place since the early 2000s and continue to form a regular part of tobacco campaigning in Australia. These campaigns have promoted quitting or smoking outside to protect children from the harms of home ~~ETS~~secondhand smoke exposure 10and appear to have been 'moderately helpful' in increasing the number of smoke-free homes 3. In 2006, 43% of Australian households with smokers reported totally banning smoking indoors 11, and data from both NSW and Victoria show declines in household indoor smoking over recent years 3. One of the main outcome indicators in Australia's draft National Tobacco Strategy 2004-2009 is that fewer people will be exposed to secondhand smoke in their homes ~~ETS~~ 12.

Is there an urban/rural divide in children's exposure to home ~~ETS~~secondhand smoke?

In Australia around one third of the population lives outside major cities, with rural areas more socio-economically disadvantaged than urban areas 13. The prevalence of tobacco smoking in this rural population is significantly higher than in urban areas 14. Smoking continues to be disproportionately represented among socio-economically disadvantaged populations, and these disparities are increasing over time 15.

We identified only three studies exploring the difference between home ~~ETS~~secondhand smoke exposure in children in rural compared to urban areas 16-18, with none from Australia. Two are North American (one showing higher home ~~ETS~~secondhand smoke exposure in rural areas 18 and one from Alaska showing lower home ~~ETS~~secondhand smoke exposure in very remote areas 17), and one from Germany reporting lower home ~~ETS~~secondhand smoke exposure in children in rural areas 16. One study from China describes ~~ETS~~secondhand smoke exposure in respondents' homes (all homes, not just homes with children) that is higher in rural areas (73%) compared with urban areas (60%) 19. One further North American study focuses on home smoking bans, and reported ~~ed~~ fewer home smoking bans in rural households compared to urban households 20.

Given that ~~ETS~~secondhand smoke exposure is such an important public health concern, particularly in children, as well as the higher prevalence of smoking in rural areas in Australia, this paper addresses two questions: 1. Are there rural/urban differences in a) smoking within households with

children and b) home ~~ETS~~secondhand smoke exposure in children?; and 2. If so, is this due to socioeconomic disadvantage or other factors unique to 'rurality'?

METHODS

The 2010 National Drug Strategy Household Survey

The Australian Institute of Health and Welfare (AIHW) conducts the National Drug Strategy Household Survey (NDSHS) every three years to measure behaviour, knowledge and attitudes towards drugs in Australia. The 2010 sample was a multi-stage random sample of households stratified by region with some over-sampling in certain states and territories, representative of the national population. Respondents were the person aged 12 or older in each household who was next to have a birthday. Questions were asked via drop and collect self-completion questionnaires. Questions were asked of the respondent about themselves, e.g. their own smoking status, as well as questions about the household. Data were collected between April and September 2010. The survey has been conducted on nine previous occasions 21.

The NDSHS was chosen because it provided data on household behaviour, rather than just individual behaviour, as well as the number and age of children within a household. Non-identifiable data were sourced from the AIHW with a signed agreement to protect the confidentiality and management of the data.

Weighting

Weights were applied to the data to adjust for the complex sampling design while not inflating the overall sample size. Weights for each household record were provided by the AIHW to adjust the number of households in the dataset to the number of households in the Australian population. Applying these rates would have overinflated the sample size for statistical analyses. Following Gartner et al 15, we proportionally adjusted the absolute weight for households provided by the AIHW in order to bring the overall number of households down to the effective sample size. Each weight provided by the AIHW was multiplied by an adjustment factor, then applied to the data, to bring the total number of households down to the effective sample size provided by the AIHW.

Measures

Rurality

The rurality variable was based on the Australian Standard Geographical Classification remoteness areas 22. This classification was designed to facilitate quantitative comparison between 'city' and 'country' Australia, and is based on distance to services and goods. The variable was coded: major cities, inner regional, outer regional and remote/very remote. The inner regional code includes locations close to major cities e.g. Port Stephens, an hour's drive away from Newcastle (a major city), and outer regional includes locations such as Biloela in Queensland, 550km away from the nearest major city (Brisbane). For more information please see the map of Australia at http://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure#Anchor2e illustrating the remoteness structure. This classification system is recommended by the Australian Government's Institute of Health and Welfare (a statutory body established to report to the nation on health), particularly for use at aggregated national level 23, and is widely used in the academic literature, for example Kelly et al 24. We recoded the variable into Urban/Rural ~~(~~where urban was

'major cities' and rural was a combination of the remaining categories~~),~~ as some cells contained small numbers with the initial categorisation.

Households with Children

We defined households with children as those with children 0-14 years old. The questionnaire asked "*Of all the dependent children, how many are in each of these age categories?*" 25, and offered two-year blocks up to 12-14 with the last category being 15+. As "*dependent children*" was defined to include children older than 14 "*who are still financially dependent, such as full-time students*"25 we did not include the final category which may have contained substantial numbers of dependent children over 18.

Outcome variables

Smoking households

We defined smoking households as any household containing a smoker regardless of where that person smoked, i.e. answering "*Yes, inside the home*" or "*No, only smoke outside the home*" to the question "*In the last 12 months, have you or any other member of your household smoked at least one cigarette, cigar or pipe of tobacco per day in the home?"*. The other response option was "*No-one at home regularly smokes*" 25.

Home ~~ETS~~secondhand smoke exposure

Home ~~ETS~~secondhand smoke exposure is different to smoking households as it is a measure of whether a household contains a smoker who smokes inside the home. This was determined as those households where the answer *"Yes, inside the home*" was given to the question "*In the last 12 months, have you or any other member of your household smoked at least one cigarette, cigar or pipe of tobacco per day in the home?"* 25. We recoded this into a binary variable: "yes smokes inside the home" or "no does not smoke inside the home". The "no does not smoke inside the home" category included households answering either *"No, only smoke outside the home",* or *"no-one at home regularly smokes*".

Potential confounders

The data contained limited household level variables. Within these confines, the following variables were considered potential confounders in the association between home ~~ETS~~secondhand smoke exposure and rurality: socio-economic status 2, 15; number of people in the household 15; household structure 3, 16; and main language used in the household 3. These are defined below.

Socio-economic status

We defined socio-economic status using the area-level socio-economic index for areas (SEIFA) provided in the data (the Index of Relative Socio-economic Advantage and Disadvantage, measured at Census Collection District areas) 26. This index includes variables on: income; education; employment; occupation; housing and other variables such as disability, car ownership, internet access and single parents.

Household size

The number of people in the household was recoded from 1,2,3,4,5 or more, to 3 categories: 1-2, 3-4 and 5 or more, as some cells contained small numbers with the initial categorisation.

Household structure

Household structure was coded as single with dependents, couple with dependents, parents with non-dependent children, singles without children, couple without children, and other. We recoded this to single with dependents, couple with dependents, and other (included all other categories).

Main language used in the household

We maintained the original binary coding for this variable of English, and language other than English.

Analysis

Analyses were performed using Stata V9.2. Records with missing data on household smoking status were excluded from the analysis (31 households with children 0-14). Summary statistics of household characteristics were obtained and univariate associations with rurality were examined using the Pearson's chi-square test. Initial analyses included all households with data on smoking status. Subsequent analyses were restricted to households with children 0-14. Multivariable logistic regression was used to explore the association of rurality with household smoking and with home ~~ETS~~secondhand smoke exposure, controlling for potential confounders. Initially all variables with a p-value <0.25 in the univariate analyses were included in the models, with stepwise removal of variables based on the p-value from the likelihood ratio test, with variables with a p-value <0.1 retained in the model. Rurality was retained in both multivariable models regardless of statistical significance.

RESULTS

The sample

Weighting the sample to take account of the complex sampling 15, gave a total sample size of 15,978 households (the effective sample size). Household smoking status was recorded for 15,745 of these households, which were included in the analysis.

In all households i.e. those with children and those without children, 33% (95%CI:32.4%, 33.7%) contained a smoker. Rural households were significantly more likely to contain a smoker than urban households (36.5% (95%CI:35.4%, 37.5%) versus 31.4% (95%CI:30.6%, 32.1%~~; p=<0.001~~), and were significantly more likely to contain a smoker who smoked indoors (home ~~ETS~~secondhand smoke exposure) (11.7% (95%CI:11.0%, 12.5%) versus 9.2%~~,~~ (95%CI:8.7%, 9.6%~~ p<0.001~~). Households with children 0-14 years were more likely to be smoking households (35.4%; 95%CI:34.2%, 36.5%) than households without children (32.1%~~;~~) 95%CI:31.3%, 32.8%)~~(p=<0.001)~~.

For all subsequent reported analyses, we selected only those households with children aged 0-14 years. This provided a sample of 4,669 households.

Smoking households with children

Table 1 presents the demographic and smoking behaviour characteristics of households with children aged 0-14.

Table 1– Demographic characteristics and smoking behaviour in households with children, by rurality

	Rural n= 1515 n (%)	Urban n= 3154 n (%)	P value
Smoking households	661 (43.6)	989 (31.4)	<0.001
Home ~~ETS~~secondhand smoke exposure	121 (8.0%)	163 (5.2%)	<0.001
Socio-economic status (SEIFA quintile):			<0.001
1 (lowest)	437 (28.8%)	376 (12.0%)	
2	458 (30.2%)	416 (13.2%)	
3	342 (22.6%)	590 (18.7%)	
4	225 (14.9%)	855 (27.1%)	
5 (highest)	54 (3.6%)	917 (29.1%)	
Household size:			0.022
1-2	901 (59.5%)	1939 (61.4%)	
3-4	528 (34.8%)	991 (31.5%)	
5+	86 (5.7%)	225 (7.1%)	
Household structure[a]:			<0.001
Single with dependents	190 (12.7%)	259 (8.3%)	
Couple with dependents	1028 (67.9%)	2281 (72.6%)	
Other	291 (19.4%)	593 (19.0%)	
Main language[b]:			<0.001
English	1487 (98.3%)	2729 (86.8%)	
Language other than English	25 (1.7%)	416 (13.2%)	

[a] 1509 rural observations and 3133 urban; [b] 1512 rural observations and 3145 urban
Note: Results may not add up to totals because of the adjustment of the effective sample size calculation

Overall, 35.4% (95%CI:34.2%, 36.5%) of households with children were smoking households, and 6.1% (95%CI:5.5%, 6.7%) of households with children contained a smoker who smoked inside the home (home ~~ETS~~secondhand smoke exposure). The proportion of households which were smoking households was greater in rural (43.6% 95%CI: 41.5%, 45.7%) th~~a~~en urban (31.4% 95%CI:30.0%, 32.8%) areas ~~(p<0.001)~~. The proportion of households with home ~~ETS~~secondhand smoke exposure was also significantly greater in rural (8.0% 95%CI:6.8%, 9.1%) than urban (5.2% 95%CI:4.5%, 5.8%) households with children ~~(p=<0.001)~~.

Rural and urban households were also different on all potential confounders: the proportion of households in each SEIFA quintile (p=<0.001); household size, with rural households having a smaller proportion of larger households (p=0.022); household structure, with rural households having a larger proportion of households with a single adult with dependent children (p=<0.001); and main language with a much lower proportion of rural households speaking a language other than English (p=<0.001) than urban households.

Associations of smoking behaviour with rurality

Household smoking

Table 2 reports the results of the logistic regression model exploring the association of rurality with smoking households among households with children 0-14, controlling for potential confounders.

Table 2 – Logistic regression model of factors significantly associated with smoking households among households with children

Variable	**OR (95% CI)**
Rurality:	
Urban	1.00
Rural	1.21 (1.07, 1.37)
Socio-economic status (SEIFA quintile):	
1 (lowest)	1.00
2	0.70 (0.59, 0.84)
3	0.56 (0.47, 0.67)
4	0.47 (0.40, 0.57)
5 (highest)	0.28 (0.23, 0.34)
Household size:	
1-2 people	1.00
3-4 people	1.20 (1.06, 1.36)
5+ people	1.36 (1.08, 1.72)
Household structure:	
Single with dependents	1.00
Couple with dependents	0.47 (0.40, 0.56)
Other	0.70 (0.56, 0.87)

Amongst households with children, rurality continued to be associated with being a smoking household when socio-economic status, household size and household structure were controlled for. Main language used in the household was not retained in the model.

Home ~~ETS~~secondhand smoke exposure

Results of the logistic regression model to explore the association between rurality and home ~~ETS~~secondhand smoke exposure in households with children, controlling for potential confounders are shown in Table 3.

Table 3 Logistic regression model of factors associated with home ~~ETS~~secondhand smoke exposure among households with children

Variable	OR (95% CI)
Rurality:	
Urban	1.00
Rural	1.07 (0.85, 1.35)
Socio-economic status (SEIFA quintile):	
1 (lowest)	1.00
2	0.55 (0.41, 0.74)
3	0.52 (0.38, 0.70)
4	0.27 (0.19, 0.38)
5 (highest)	0.25 (0.17, 0.37)
Household size:	
1-2 people	1.00
3-4 people	1.83 (1.42, 2.35)
5+ people	2.71 (1.84, 4.00)
Household structure:	
Single with dependents	1.00
Couple with dependents	0.25 (0.19, 0.33)
Other	0.52 (0.38, 0.73)

In households with children, home ~~ETS~~secondhand smoke exposure was not significantly associated with rurality once other factors were controlled for. Socio-economic status, household size and household structure remained strongly associated with home ~~ETS~~secondhand smoke exposure. Main language used in the household was not retained in the model.

DISCUSSION

One third of all Australian households were smoking households. In univariate analysis both smoking households and home ~~ETS~~secondhand smoke exposure were significantly more common for rural households with children than for urban households with children. In a multivariate analysis among households with children, rurality remained associated with smoking households when confounding factors were controlled for, whereas rurality did not remain associated with home ~~ETS~~secondhand smoke exposure after controlling for potential confounders.

Smoking households

Overall, smoking prevalence is in decline in Australia, estimated at 15.9% of adults smoking daily in 2010 3. Given this, it is surprising that 33% of all Australian households contain a daily smoker. Smoking is even more common in households containing children with 35.4% of households with children aged 0-14 containing a smoker, rising to 43.6% of rural households with children (p =<0.001).

It is possible that a focus on individual smoking behaviour and not on household behaviours, children and/or rurality has masked recognition of this high proportion of rural households with

children containing a smoker. The exploration of smoking at household level is supported by the importance of the social and relational environment for smoking, and smoking cessation 27.

In households with children, rurality continued to be associated with smoking households when other factors were controlled for. This suggests there might be something particular about rural smoking households that warrants further investigation, and that support for smoking cessation might be rurally targeted.

Home ~~ETS~~secondhand smoke exposure

Home ~~ETS~~secondhand smoke exposure was significantly more common for rural (8%) than urban (5.2% p=<0.001) households with children. Using the NDSHS data, this equates to 54,123 rural households with at least one child containing a daily smoker who smokes inside the home. The few studies of children's home ~~ETS~~secondhand smoke exposure in rural compared to urban areas provide a mixed picture, and comparison is compromised by differences in defining home ~~ETS~~secondhand smoke. A German study 16 exploring rural-urban comparisons of home ~~ETS~~secondhand smoke in households with children reported higher levels of home ~~ETS~~secondhand smoke in urban areas. This probably reflects the higher prevalence of smoking in urban than rural areas in European countries28, the reverse of Australia, Canada and China. One North American study of states containing Appalachian counties used a similar definition of home ~~ETS~~secondhand smoke exposure to our own, and reports rural home ~~ETS~~secondhand smoke exposure of children (under 18) as 12.5% compared to urban exposure of 6.5% 18. By contrast, urban Alaskan households have higher levels of home ~~ETS~~secondhand smoke exposure than the most extremely rural regions 17.

The main drivers of home ~~ETS~~secondhand smoke exposure for children in rural households were the same as for urban i.e. low socio-economic status, larger household size and being a single parent household. Home ~~ETS~~secondhand smoke exposure is highest for children from disadvantaged families as their parents are more likely to smoke and smoke heavily 2, and to smoke in the home 16. The NDSHS data highlight the stark contrast between rural and urban households in terms of their socio-economic status, with only 3.6% of rural households in the least disadvantaged SEIFA category compared to 29.1% of urban households.

Another factor driving the higher prevalence of home ~~ETS~~secondhand smoke exposure in rural households compared to urban households is the significantly greater proportion of single parent families in rural areas. The finding of higher home ~~ETS~~secondhand smoke exposure among single parent families has been reported in Australia previously 29. Given single parenthood is closely intertwined with disadvantage 3 we must continue with efforts to address smoking in lower SES populations groups.

Our finding that home ~~ETS~~secondhand smoke does not remain associated with rurality once confounders are adjusted for matches the Alaskan study described earlier 17. Whilst rurality does not remain associated with home ~~ETS~~secondhand smoke exposure in households with children once other factors are controlled for, rural children experience more home ~~ETS~~secondhand smoke exposure because of these factors which place them at additional disadvantage (low socioeconomic status and single parent households). Socio-economic status and household structure were the strongest drivers of both household smoking and home ~~ETS~~secondhand smoke.

Given the progressive adoption of smoke-free public places legislation in Australia and other high income countries, the relative importance of home ~~ETS~~secondhand smoke exposure is increasing. As living in a smoke-free home offers children some protection from home ~~ETS~~secondhand smoke exposure, continuing the decline in homes with smokers who smoke inside the house is key. However, one Swedish study of young children demonstrated that 'smoking outdoors' even with the door shut resulted in higher urinary cotinine levels when compared to an age-matched non-smoking household control group 7. These findings are supported by a UK study which reported children from smoking parents in households which were smoke-free had less salivary cotinine than children with smoking parents in households which were not smoke-free, but more than children with non-smoking parents in smoke-free households 6. Therefore, whilst living in a household with no indoor smoking offers children some protection, children from households without smokers are the most protected.

The data explored in this study did not include children's ~~ETS~~secondhand smoke exposure outside their own home, for example in cars, visiting other families, social outings etc. but as rural children are more likely to live in a smoking household (even if the smoker/s smoke outside the home), we would anticipate it is likely that they are also more frequently exposed to ~~ETS~~secondhand smoke in other non-home settings. In a study of infants in urban NSW Australia for example, Daly et al report that 10% were exposed in the home, and 22% at a friend or relative's house 29.

Limitations of this study

This study has several limitations.

The NDSHS is subject to response bias from self-report. Whilst there is some evidence demonstrating self-report of smoking in the home is moderately correlated to environmental and biomedical markers 30, it remains an inferior replacement for such measures 29. It is likely that home ~~ETS~~secondhand smoke exposure from this survey is therefore a conservative estimate.

In addition to respondents under-reporting what is clearly a socially undesirable behaviour (smoking indoors in a household with children), there have been several studies exploring what people actually mean when they talk about household smoking rules i.e. how people define (to themselves and others) 'smoke indoors' and 'smoke outdoors' 2, 31. These qualitative studies suggest that defining smoking outdoors might be a somewhat varied and fluctuating category, possibly contributing to further underestimation of home ~~ETS~~secondhand smoke exposure. At present we do not know how defining home smoking status is played out in Australia, or if there are any rural/urban differences in this regard. Gaining an understanding of what people know about children's home ~~ETS~~secondhand smoke exposure, what is meant by smoking outside the home, and what their home smoking behaviour actually is in Australia would both illuminate the findings of this study and contribute to understanding how best to support people in either quitting or making their home smoke-free.

A limited number of potential household level confounders were available in this dataset and there are other important confounders at household level, such as the ages of people in the household, or the number of smokers in the household, that we were unable to control for.

As our analysis was conducted at household level, we did not use data on individuals and therefore did not control for potential individual-level confounders known to be associated with smoking

prevalence such as mental health 3. We did not control for Aboriginal status as although there were (very limited) data available, Aboriginal status is nonsensical as a household-level variable, although an important individual-level confounder given the smoking prevalence amongst Aboriginal Australians is more than twice that of non-Aboriginal Australians 32. SEIFA is an area level variable. At Census Collection District area (around 100 houses) this may not always apply to individual households.

CONCLUSION

The proportion of smoking households with children remains an important public health concern. The finding that rurality remains associated with smoking households when other factors such as socio-economic status are controlled for, suggests we need to understand more about the context of smoking in rural Australia to provide support targeted to rural households in quitting.

Significant numbers of children continue to be exposed to secondhand smoke in their homes ~~ETS~~ and to suffering the lifelong consequences on their physical health, academic performance and their own smoking behaviour in the future. Socio-economic disadvantage continues to be a significant driver of differences in children's home ~~ETS~~secondhand smoke exposure in rural compared to urban areas. Further efforts to support smokers who smoke inside their homes containing children to quit or avoid smoking in the home would benefit these children. Understanding the smoking rules and behaviours inside smoking households, and people's knowledge of children's home ~~ETS~~secondhand smoke exposure, should provide better evidence to support those efforts.

ACKNOWLEDGEMENTS

Our thanks to Dr Coral Gartner for her advice about handling the weighting of the data, and to Dr Judy Singer for her support with the background research for this study.

COMPETING INTERESTS

Dr Passey receives research grant funding from Pfizer Australia, through an Australian Research Council Linkage Grant. The authors declare no conflicts of interest.

WHAT THIS PAPER ADDS

No previous Australian studies have looked at children's home ~~environmental tobacco smoke exposure (ETS~~secondhand smoke ~~)~~ exposure in rural compared to urban areas. We found that 44% of rural households with children in Australia contained a smoker (higher than in urban areas), and that a higher proportion of households exposed children to home ~~ETS~~secondhand smoke in rural households compared to urban households. The drivers of these differences were rurality, household size, socio-economic status, and household structure.

reprints, include within collections and create summaries, extracts and/or, abstracts of the Contribution, iii) create any other derivative work(s) based on the Contribution, iv) to exploit all subsidiary rights in the Contribution, v) the inclusion of electronic links from the Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above.

CONTRIBUTORSHIP STATEMENT

Jo Longman obtained, organised and analysed the data, and drafted and revised the paper. Megan Passey designed the study analysed the data and revised the paper.

DATA SHARING STATEMENT

There is no additional data available

References

1 Royal College of Physicians. Passive smoking and children. A report by the Tobacco Advisory Group. London, UK: Royal College of Physicians 2010.

2 Jones LL, Atkinson O, Longman J*, et al.* The motivators and barriers to a smoke-free home among disadvantaged caregivers: identifying the positive levers for change. *Nicotine Tob Res* 2011;**13**:479-486.

3 Scollo M, Winstanley M. *Tobacco in Australia: Facts and Issues*. 2012. http://www.tobaccoinaustralia.org.au (accessed February 2013).

4 Goldade K, Choi K, Bernat DH*, et al.* Multilevel predictors of smoking initiation among adolescents: Findings from the Minnesota Adolescent Community Cohort (MACC) study. *Prev Med* 2012.

5 de Leeuw R, Engels R, Scholte R. Parental smoking and pretend smoking in young children. *Tob Control* 2010;**19**:201-205.

6 Jarvis MJ, Mindell J, Gilmore A*, et al.* Smoke-free homes in England: prevalence, trends and validation by cotinine in children. *Tob Control* 2009;**18**:491-495.

7 Johansson A, Hermansson G, Ludvigsson J. How should parents protect their children from environmental tobacco-smoke exposure in the home? *Pediatrics* 2004;**113**:e291-e295.

8 Bottorff JL, Johnson JL, Carey J*, et al.* A family affair: Aboriginal women's efforts to limit second-hand smoke exposure at home. *Can J Public Health* 2010;**101**:32-35.

9 World Health Organization. WHO Framework Convention on Tobacco Control. Geneva: World Health Organization; 2003. *World Health Organization The world health report* 2002.

10 Borland R, Mullins R, Trotter L*, et al.* Trends in environmental tobacco smoke restrictions in the home in Victoria, Australia. *Tob Control* 1999;**8**:266-271.

11 Borland R, Yong H, Cummings K*, et al.* Determinants and consequences of smoke-free homes: findings from the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2006;**15**:iii42-iii50.

12 Commonwealth Government of Australia. *Draft for consultation of the National Tobacco Strategy 2012-2018*. 2012. http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/draft-nts-12-18-callsubs (accessed March 2013).

13 Australian Institute of Health and Welfare. *Rural, regional and remote health: indicators of health*. 2005. http://www.aihw.gov.au/publication-detail/?id=6442467718 (accessed February 2013).

14 Australian Bureau of Statistics. *Tobacco smoking in Australia: A snapshot (4831.055.001)*. 2006. http://www.abs.gov.au/ausstats/abs@.nsf/mf/4831.0.55.001 (accessed February 2013).

15 Gartner CE, Hall WD. Is the socioeconomic gap in childhood exposure to secondhand smoke widening or narrowing? *Tob Control* 2012:Available online.

16 Bolte G, Fromme H. Socioeconomic determinants of children's environmental tobacco smoke exposure and family's home smoking policy. *The European Journal of Public Health* 2009;**19**:52-58.

17 Dent C, Maher J, Pizacani B*, et al.* Secondhand smoke exposure in Alaskan households with children. *Rural Remote Health* 2010;**10**.

18 Wiener RC. Secondhand and thirdhand tobacco smoke exposure in children living in states containing Appalachian counties: A surveillance. *Journal of Rural and Tropical Public Health* 2011;**10**:111-118.

19 Xiao L, Yang Y, Li Q*, et al.* Population-based survey of secondhand smoke exposure of children in China. *Biomed Environ Sci* 2010;**23**:430-436.

20 McMillen R, Breen J, Cosby AG. Rural-Urban Differences in the Social Climate Surrounding Environmental Tobacco Smoke: A Report From the 2002 Social Climate Survey of Tobacco Control. *The Journal of Rural Health* 2006;**20**:7-16.

21 Roy Morgan Research. National Drug Strategy Household Survey 2010 Final Technical Report. Canberra: Australian Institute of Health and Welfare and Department of Health and Ageing, 2011.
22 Australian Bureau of Statistics. *Australian Standard Geographical Classification (ASGC) Remoteness Structure (RA) Digital Boundaries, Australia, 2006* 2006. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DirClassManualsbyTopic/9A784FB979765947CA25738C0012C5BA (accessed May 2012).
23 Australian Institute of Health and Welfare. *Remoteness Classifications*. http://www.aihw.gov.au/rural-health-remoteness-classifications/ (accessed May 2013).
24 Kelly BJ, Stain HJ, Coleman C*, et al.* Mental health and well-being within rural communities: The Australian Rural Mental Health Study. *Aust J Rural Health* 2010;**18**:16-24.
25 Australian Institute of Health and Welfare. *Australian Data Archieve - National Drug Strategy Household Survey Questionnaire, 2010*. 2010. http://www.ada.edu.au/social-science/01237 (accessed January 2013).
26 Australian Bureau of Statistics. *Australian Standard Geographical Classifciation (ASCG): Socio-economic indexes for areas (SEIFA) - Technical Paper 2006*. 2006. http://www.abs.gov.au/ausstats/abs@.nsf/mf/2039.0.55.001 (accessed January 2013).
27 Siahpush M, Borland R, Scollo M. Factors associated with smoking cessation in a national sample of Australians. *Nicotine Tob Res* 2003;**5**:597-602.
28 Idris BI, Giskes K, Borrell C*, et al.* Higher smoking prevalence in urban compared to non-urban areas: time trends in six European countries. *Health Place* 2007;**13**:702-712.
29 Daly JB, Wiggers JH, Considine RJ. Infant exposure to environmental tobacco smoke: a prevalence study in Australia. *Aust NZ J Public Health* 2001;**25**:132-137.
30 Rumchev K, Jamrozik K, Stick S*, et al.* How free of tobacco smoke are 'smoke-free'homes? *Indoor Air* 2008;**18**:202-208.
31 Robinson J, Kirkcaldy AJ. Disadvantaged mothers, young children and smoking in the home: mothers' use of space within their homes. *Health Place* 2007;**13**:894-903.
32 Hudson L, White A, Roseby R. Tobacco smoke exposure in hospitalised Aboriginal children in Central Australia. *J Paediatr Child Health* 2009;**45**:224-227.

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

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **Yes**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **Yes**
Objectives	3	State specific objectives, including any prespecified hypotheses **Yes**
Methods		
Study design	4	Present key elements of study design early in the paper **Yes**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **Yes**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **Yes**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **Yes**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **Yes**
Bias	9	Describe any efforts to address potential sources of bias **Yes**
Study size	10	Explain how the study size was arrived at **Yes**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **Yes**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **Yes**
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **Yes**
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **Yes**
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **Yes**
		(b) Indicate number of participants with missing data for each variable of interest **Yes**
Outcome data	15*	Report numbers of outcome events or summary measures **Yes**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **Yes**
		(*b*) Report category boundaries when continuous variables were categorized

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives **Yes**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Yes**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **Yes**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Yes**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **Yes**

*Give information separately for exposed and unexposed groups.

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