Socio-demographic factors drive regional differences in participation in the National Bowel Cancer Screening Program – An ecological analysis

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Abstract

Objective: To examine if geographic variations in the participation rates in the National Bowel Cancer Screening Program (NBCSP) are related to population-level socio-demographic characteristics.

Methods: Data reflecting participation in the NBCSP for 504 Local Government Areas (LGAs) between July 2011 and June 2013 were extracted from the Social Health Atlas of Australia. Logistic regression models were used to examine independent associations (odds ratios [ORs]) between participation, Remoteness Area (RA) and selected socio-demographic variables.

Results: Compared to the participation rate for major cities (33.4%), participation was significantly higher in inner regional areas (36.5%, OR=1.15), but was much lower in remote (27.9%, OR=0.77) or very remote areas (25.0%, OR=0.65). When controlling for study period, gender, proportion of persons aged 65 years and older, Indigenous status, cultural background and socioeconomic status, significantly higher rates were observed in all non-metropolitan areas than in major cities. Indigenous status was strongly related to the poorer participation in remote areas.

Conclusions: Socio-demographic characteristics, particularly Indigenous status, cultural background and population ageing, seem to be more important drivers of regional disparities in NBCSP participation than geographic remoteness.

Implications for public health: This study provides important evidence to understand the regional disparities in participating in the national screening program.

Key words: bowel cancer, colorectal cancer, screening, NBCSP, remoteness

Australia performs exceptionally well in improving the overall survival of people diagnosed with cancer.[1] However, advances in early detection and treatment of cancer may not benefit all Australians equally. Significant disparities in health outcomes – including cancer mortality – continue to exist, most notably among people living in rural, regional and remote areas of Australia and Indigenous Australians.[2-4]

Colorectal cancer (CRC) or bowel cancer is the most common cancer for men and women combined and is the second leading cause of cancer death in Australia.[5] Our systematic review showed that people with CRC living in non-metropolitan Australia have poorer survival rates compared to those living in metropolitan areas.[6] Although this may be due to an interplay of numerous personal, community and health system influences, evidence suggests early detection may play an important role.[7,8] CRC cases in rural and remote areas are more often detected at a later stage than metropolitan CRC cases,[9,10] which subsequently relates to poorer survival.[7,8] This suggests the potential to address inequalities in early detection as a means to reducing survival differences.

Population screening for CRC using the faecal occult-blood test (FOBT) reduces CRC mortality.[11-13] Some data also indicate a reduction in CRC incidence by removing high-risk polyps.[14,15] The Australian National Health and Medical Research Council (NHMRC) recommends FOBT screening at least every two years for people over the age of 50.[16] In 2006, the National Bowel Cancer Screening Program (NBCSP) began providing free FOBT screening to people turning 55 and 65 years of age, with more ages added subsequently. The program will be extended by 2020 to all Australians aged between 50 and 74 years who will be offered free screening every two years.[17]

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Early data from the NBCSP have shown that FOBT screening has an impact on CRC stage at diagnosis, with NBCSP-detected cases diagnosed at an earlier stage than symptomatic cases.[18] Another study based on NBCSP data showed a 15% reduction in CRC mortality among the screened population versus the control cohort.[19] The expansion of the program is expected to further these benefits to alleviate the total CRC burden;[20] however, there may be inequalities in the survival benefit derived from the program. For example, people living in remote areas are less likely to participate in the NBCSP and to complete the diagnostic assessment when required,[17] which may translate to a reduced survival benefit. Therefore, there is a risk that the full rollout of the program may widen the existing gap in CRC mortality. Understanding the existing differences in screening behaviours and their underlying causes is essential for informing future implementation of the program, particularly in minimising differentials in survival benefit.

Although regional variations in NBCSP participation have been well-documented, with poorer rates in remote areas but higher rates in inner regional areas,[17] the reasons for these disparities are unknown. It is not clear if these disparities are due to location-related factors, such as access to mail services, which are essential for distributing and returning the FOBT kit, or differences in socio-demographic backgrounds of the local population. The proportion of Indigenous Australians is much higher in remote areas (28%) than in major cities (1.5%) and regional areas (5%),[2] and Indigenous Australians are known to have very low participation rates in NBCSP.[22] Therefore, the observed lower rates in remote communities may be a manifestation of the lower rates found in Indigenous Australians. If this is true, interventions targeting this population as a whole (rather than geographic locations) may have the potential to more effectively improve screening uptake.

Similarly, regional variations in screening could also be explained by other socio-demographic factors that are known to be associated with NBCSP participation, such as age, gender, socioeconomic status and cultural background.[17,22,23]

The purpose of this study was to examine if regional variations in NBCSP participation rates are associated with differences in the population with respect to selected socio-demographic factors including age, gender, indigeneity, socioeconomic status and cultural background.

Methods

Data sources

The current study is an ecological analysis based on data from the Social Health Atlas of Australia,[24] a collection of health-related and socio-demographic indicators published annually by the Public Health Information Development Unit (PHIDU), Torrens University Australia.[24]

In this study, we extracted NBCSP gender-specific participation data (numbers of people who participated and numbers of people who were invited) for the periods July 2011–June 2012, and July 2012–June 2013.[24] Within both periods, Australian residents turning 50, 55 or 65 years of age who were in the Medicare enrolment file, or registered with a Department of Veterans' Affairs gold card, were invited and sent an FOBT kit by mail.[25,26] Participation was defined as returning a completed screening test kit.[25,26] Data were organised by Local Government Area (LGA). NBCSP data were initially provided by the Department of Health. It should be noted that formal publication and reporting of the NBCSP data is undertaken by the Australian Institute of Health and Welfare on behalf of the Department of Health.

We also extracted LGA-specific socio-demographic variables from the Social Health Atlas of Australia (2016 release).[24]

Variables

The unit of analysis was LGA. The dependent variable was percentage participation in the NBCSP within each LGA. The primary predictor variable was the Remoteness Area (RA) based on the Australian Statistical Geography Standard Remoteness Structure.[27] We used a correspondence table[28] to assign one of the five RA categories (major cities, inner regional, outer regional, remote and very remote) to each LGA. For LGAs covering more than one RA, the RA with the highest coverage within the LGA was used. The majority (78%, n=404) of LGAs were matched to a single RA with 90–100% of coverage. The remaining LGAs were allocated to the dominant RA with 50–89% of coverage.

Other predictor variables included proportion of the invitees in each LGA who were female, proportion of persons aged 65 years and above in 2014 (a measure of population ageing), the proportion of Indigenous Australians in 2015, the proportion of persons in the 2011 census who were born overseas in predominantly non-English speaking countries (a measure for Culturally and Linguistically Diverse [CALD] status), and the rank of the Socio-Economic Indexes for Areas (SEIFA) among all LGAs (2011 data) as a measure of socioeconomic status.[24]

Statistical analysis

Analyses were performed with R (version 3.3.0).[29] We calculated participation rates and their 95% confidence intervals (CIs) based on assumed binomial distribution. Measures for ageing, Indigenous Australians, CALD and SEIFA were treated as continuous variables and were described using means and standard deviations (SDs).

A chi-square test was used to examine the differences in participation across RA groups and between genders. One-way ANOVA was performed to test the differences in continuous variables. Significance level for these tests was defined as $\alpha=0.05$.

A series of logistic regression analyses were conducted to examine the independent association with participation, expressed as odds ratios (ORs) and 95% CIs. Continuous variables were standardised before entering these models. These regression models were then repeated individually for any Australian states that had all RA categories (New South Wales [NSW], Queensland [QLD], South Australia [SA] and Western Australia [WA]) to investigate potential state-level differences. In the state-level analyses, remote and very remote regions were combined because of small numbers.

Results

RA-related differences in participation and socio-demographic characteristics

Data were available for 519 LGAs. We excluded the LGAs with a population less than 500 people (n=4) and LGA-years' data with a number of invitations <20 (n=11), leaving 504 LGAs for analysis. Among these, 139 (27.6%) were classified as major cities, 137 (27.2%) inner regional, 147 (29.2%) outer regional, 45 (8.9%) remote, and 36 (7.1%) as very remote. The majority (72.5%) of the population lived in major cities (Table 1).

In the two-year period (July 2011–Jun 2013), the overall participation was 34.0% (95%CI: 33.9-34.0%). For both males and females,

the participation rate was highest in inner regional but lowest in remote/very remote areas ($p<0.001$).

There were significant differences in the selected socio-demographic variables by RA categories ($p<0.001$). The proportion of female invitees was lower in outer regional and remote areas. Inner and outer regional had higher proportions of persons aged 65 years and above. The proportion of Indigenous Australians was much higher in remote and very remote regions. Major cities had the highest proportion of persons with a CALD background and most advantaged SEIFA ranks (Table 1).

Adjusted effect of remoteness on participation

Results of logistic regressions are presented in Table 2. Overall, compared to major cities, there was a 15% higher likelihood of participation in inner regional areas (OR=1.15, 95%CI: 1.14-1.15) and a much lower likelihood in remote (OR=0.77, 95%CI: 0.74-0.79) and very remote (OR=0.65, 95%CI: 0.62-0.69) areas. Participation in outer regional areas was similar to that in major cities (Table 2, Model 1).

In Model 2, we added assessment period and gender. The model showed a 12% decrease in participation (OR=0.88) from 2011/12 to 2012/13, and a 19% lower participation (OR=0.81) among males than females. However, these effects were independent of RA (i.e., ORs for RA groups remained virtually unchanged from Model 1 to Model 2) and remained constant in the subsequent models (Table 2).

In Models 3 and 4, adding ageing and CALD variables altered the ORs for inner and outer regional areas substantially. With major cities again being the reference category, the OR for inner regional dropped from 1.15 in Model 2 to 1.00 in Model 4; the slightly positive association (OR=1.02) with outer regional areas changed to a significantly negative one (OR=0.92). The changes in the ORs for remote and very remote areas were small and not significant (Table 2).

The ORs for remote and very remote areas changed substantially when the proportion of Indigenous Australians was included (from Model 4 to 5). That is, the strong negative associations (ORs = 0.68-0.78) became significantly positive ones (ORs = 1.10-1.15). Significantly higher participation was also observed for inner and outer regional areas (ORs = 1.05-1.06). Lastly, the addition of SEIFA rank only slightly modified the ORs for the RA areas (Model 6, Table 2).

In the final model, where all factors were entered (Model 6), significantly higher rates of participation were observed for all four non-metropolitan areas compared to major cities, with ORs ranging from 1.08 to 1.12 (Table 2, Figure 1). All factors included in the final model were significantly associated with participation. Specifically, participation decreased over time and was lower among men and in communities with a higher proportion of Indigenous Australians, persons with a CALD background or communities with a poorer SEIFA status, but was higher in communities with a higher proportion of elderly individuals (65 years and older), see Table 2.

State-specific analysis

Across the four states (NSW, QLD, SA and WA), crude participation was consistently higher in inner regional areas and much lower in remote/very remote areas. The results of crude and adjusted ORs are illustrated in Supplementary Figures 1-4, available online. Despite the reduced association between RA and participation in all states (ORs moved towards 1 after adjustment), there were important differences. In NSW and WA, significantly higher participation remained for inner and outer regional areas compared to major cities while participation rates in remote areas were not significantly different compared to that for major cities. In SA, participation rates were slightly lower in remote areas in the adjusted model. In Queensland, however, the lower rates of screening participation in outer regional (OR=0.94; 95%CI: 0.91-0.96) and remote areas (OR=0.72; 95%CI: 0.66-0.79) were largely unaffected by including selected socio-demographic factors (See Supplementary Figures 1-4).

Table 1: Variations in participation in the NBCSP in Australia, July 2011 – June 2013 and LGA-level socio-demographic indicators by Remoteness Area.

	Major cities	Inner regional	Outer regional	Remote	Very remote	Australia
Number (%) of LGAs	139 (27.6%)	137 (27.2%)	147 (29.2%)	45 (8.9%)	36 (7.1%)	504 (100%)
Total population (2014 ERP)	16,978,034	4,147,090	1,888,558	262,917	132,014	23,408,613
% of national total	72.5	17.7	8.1	1.1	0.6	100
Participation						
Males						
N of invitations	647,224	182,710	85,403	10,295	3,521	929,154
Participation %	31.2	33.8	30.9	25.9	24.1	31.6
95%CI	31.1–31.4	33.6–34.0	30.6–31.3	25.0–26.7	22.7–25.5	31.5–31.7
Females						
N of invitations	652,287	182,081	79,891	8,912	2,876	926,047
Participation %	35.6	39.2	36.7	30.2	26.0	36.3
95%CI	35.5–35.7	39.0–39.4	36.4–37.0	29.2–31.1	24.4–27.6	36.2–36.4
Persons						
N of invitations	1,299,512	364,791	165,293	19,207	6,397	1,855,201
Participation %	33.4	36.5	33.7	27.9	25.0	34.0
95%CI	33.3–33.5	36.4–36.7	33.5–34.0	27.3–28.5	23.9–26.0	33.9–34.0
Population characteristics						
Gender (female)[a]	50%	50%	48%	46%	45%	50%
Aging[b]	14.31 (3.42)	18.99 (4.83)	19.19 (4.66)	14.04 (6.17)	12.16 (5.44)	16.89 (5.27)
CALD[b]	20.05 (11.74)	4.17 (1.71)	3.98 (2.56)	4.24 (3.05)	4.34 (4.76)	8.68 (9.81)
Indigenous[b]	1.36 (1.16)	3.62 (2.46)	6.99 (7.45)	14.57 (15.91)	25.84 (27.29)	6.18 (10.97)
SEIFA[b]	146.36 (132.62)	287.46 (129.15)	340.46 (123.77)	297.23 (150.15)	340.37 (164.06)	266.28 (154.41)

Note: NBCSP: the National Bowel Cancer Screening Program; LGA: Local Government Area; ERP: Estimated Residential Population; CI: Confidence interval; SD: Standard deviation; Aging: the proportion (%) of persons aged 65 years or above; CALD: the proportion (%) of persons who were born in predominantly non-English speaking countries; Indigenous: the proportion (%) of Indigenous Australians; SEIFA: the rank of the Socio-Economic Indexes for Areas among all LGAs

a: the percentage of female invitees among all invitees

b: SDs are in brackets. They were calculated using the point values of the proportions (or rank) as continuous variables. The total estimates for Australia indicated the average levels across all LGAs rather than true national estimates.

All differences between regions in participation rates and population characteristics were statistically significant based on Chi-squared test or ANOVA when appropriate, $p<0.001$

Discussion

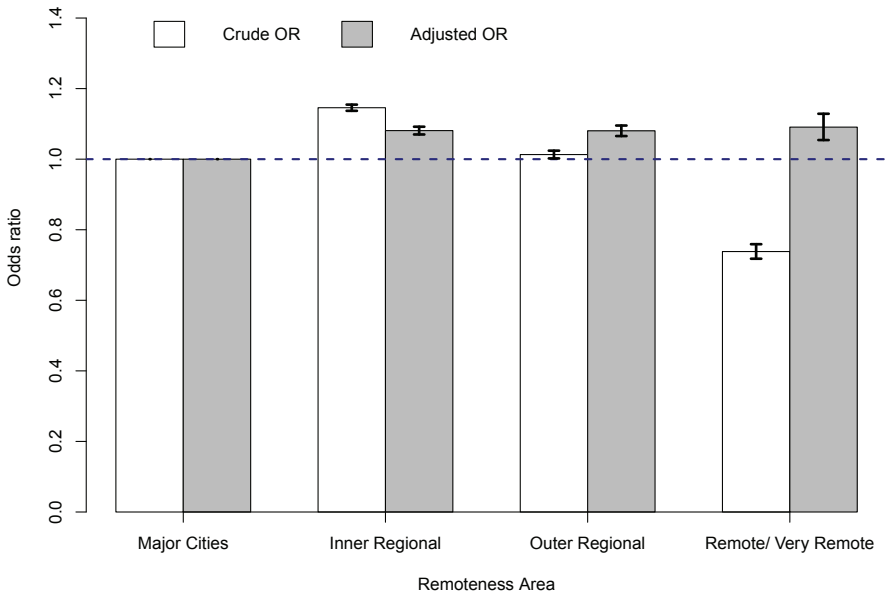
The NBCSP is planned to expand to include all people aged 50–74 years by 2020. There is an urgent need to understand the reasons for differences in participation rates and this analysis provides some original evidence to suggest that the regional disparities in NBCSP participation may be largely due to differences in the socio-demographic factors of the population. Most notably, the lower participation in remote areas is likely to be a reflection of poor uptake by Indigenous Australians. Higher participation rates in inner regional areas may be partly explained by a higher proportion of elderly individuals and a lower proportion of people with a CALD background in these areas.

Participation in the NBCSP among Indigenous Australians is estimated to be 2.3 times lower than non-Indigenous individuals.[22] The proportion of Indigenous Australians is about 3% nationally but is as high as 28% in remote/ very remote areas, compared to 1.5% in major cities.[21] Results from this study strongly suggest that these differences contributed to the lower participation rates in remote areas.

The exact reasons for the poor participation among Indigenous Australians are unclear but are thought to be associated with the way the program is implemented.[22] For example, enrolment with Australia's universal health insurance program (Medicare) is required to receive a screening kit; however, the enrolment rate is lower among Indigenous Australians.[22] Further, delivering the FOBT kit by post may disadvantage those who do not have a valid postal address registered with Medicare, which is more common among Indigenous Australians and other groups of low socioeconomic status. Modification of the national program may be required to improve its reach to Indigenous Australians, for example, by delivering the kits through Aboriginal Medical Services or Aboriginal Health Workers in addition to using mail delivery.[22] Indigenous Australians are also more likely to engage in risky health behaviours and to have poorer health outcomes, such as higher mortality and shorter life expectancy.[3] Thus, it would seem that there are factors specific to Indigenous status that may impact on screening participation, and that needs to be considered in order to improve the effectiveness of the screening program among this group.

Participation in CRC screening has previously been found to be lower among people with a CALD background and of a younger age.[17,30,31] Consistent with this, we found lower rates in areas with higher proportions of people with a CALD background and higher rates in populations with more elderly people (aged 65 years and older). Moreover, our results suggest this could partly explain some of the regional variations in NBCSP participation. Specifically, these factors

Figure 1: Crude and adjusted* associations (ORs and 95% CIs) of Remoteness Area with NBCSP participation in Australia, July 2011–June 2013.



Note. OR = Odds ratio; CI = confidence interval. NBCSP: the National Bowel Cancer Screening Program

** adjusted for assessment period, gender, the proportions of persons aged ≥ 65 years, the proportion of persons who were born overseas in non-English speaking countries, the proportion of Indigenous Australians and SEIFA rank*

Table 2: Associations between Remoteness Area and selected socio-demographic factors with NBCSP participation in Australia, July 2011 – June 2013.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.50 (0.50–0.50)	0.59 (0.59–0.60)	0.63 (0.62–0.63)	0.65 (0.64–0.65)	0.58 (0.57–0.58)	0.57 (0.57–0.58)
Remoteness						
Major cities	1	1	1	1	1	1
Inner regional	1.15 (1.14–1.15)	1.15 (1.14–1.16)	1.04 (1.03–1.05)	1.00 (0.99–1.01)	1.05 (1.04–1.06)	1.08 (1.07–1.09)
Outer regional	1.01 (1.00–1.02)	1.02 (1.01–1.03)	0.96 (0.95–0.97)	0.92 (0.91–0.94)	1.06 (1.05–1.08)	1.08 (1.07–1.10)
Remote	0.77 (0.74–0.79)	0.78 (0.76–0.81)	0.82 (0.79–0.84)	0.78 (0.75–0.80)	1.10 (1.06–1.14)	1.08 (1.04–1.12)
Very remote	0.65 (0.62–0.69)	0.67 (0.63–0.71)	0.72 (0.68–0.76)	0.68 (0.64–0.72)	1.15 (1.08–1.22)	1.12 (1.05–1.19)
Covariates						
Period 2012/13 (ref = 2011/12)		0.88 (0.87–0.89)	0.88 (0.88–0.89)	0.88 (0.88–0.89)	0.88 (0.88–0.89)	0.88 (0.88–0.89)
Female gender (ref=male)		0.81 (0.81–0.82)	0.81 (0.81–0.82)	0.81 (0.81–0.82)	0.81 (0.81–0.82)	0.81 (0.81–0.82)
Aging[a]			1.13 (1.12–1.13)	1.11 (1.11–1.12)	1.09 (1.08–1.09)	1.10 (1.10–1.11)
CALD[a]				0.97 (0.96–0.97)	0.95 (0.95–0.96)	0.96 (0.96–0.97)
Indigenous[a]					0.76 (0.75–0.77)	0.80 (0.78–0.81)
SEIFA[a]						0.97 (0.96–0.97)

Note: NBCSP: the National Bowel Cancer Screening Program; ref: referent group; Aging: the proportion (%) of persons aged 65 years or above; CALD: the proportion (%) of persons who were born in predominantly non-English speaking countries; Indigenous: the proportion (%) of Indigenous Australians; SEIFA: the rank of the Socio-Economic Indexes for Areas among all LGAs; ref: referent group

a: These variables were standardised before entering these models

may have contributed to the higher rates in inner regional areas where there are lower proportions of people with a CALD background and higher proportions of elderly residents. Interventions targeting these two groups are likely to reduce some of the differences in participation that exist between major cities and regional areas.

Consistent with previous reports,[17,25] we also identified that participation is lower among males and in communities with a more disadvantaged SEIFA rank. However, these associations seem to be largely independent of remoteness-related disparities. Interventions targeting these groups will improve overall participation but may have little effect on the regional disparities in cancer screening.

Our state-level analyses show that the national pattern is largely reflected in most states, where much of the regional variation is explained by the included variables. In Queensland, however, significant disparities in participation remain in outer regional and remote areas after adjustment for all other factors, suggesting that there are other important determinants of screening participation in the Queensland population, either on an individual or area level, in addition to the factors included in this analysis. Further analyses based on smaller geographic areas or with individual-level data are warranted. In addition, Queensland has a much higher representation of rural and remote population (18% of the total Queensland population live in outer regional and remote areas compared to the national average of 12%).[32] Mortality burden due to CRC is higher and participation rates in the NBCSP is lower in Queensland than national averages.[17] These findings further highlight the importance of more research in this population.

Screening for bowel cancer is not limited to the NBCSP. Data from the 2011-2012 national health survey (NHS) show 30.3% of all persons aged 50 years and over had ever been tested for bowel cancer,[33] which suggests that many screening tests are performed outside of the national program. The 2011-12 Victorian Population Health Survey found about 30% of people who were 50 years and older did not complete the FOBT test received as part of the NBCSP because they had already completed another bowel cancer screening test.[34] This percentage was higher in metropolitan areas (33%) than in rural regions (25%),[34] which may help to explain our observed lower rates in major cities after controlling for selected factors. This finding also indicates a need to study screening behaviours both inside and outside the NBCSP in order to predict the future performance of the program as it expands, and its impact on CRC mortality.

The current study is an ecological study and therefore our results may be subject to ecological fallacy.[35] That is, the associations may not be true at an individual level. However, all factors included in this study are known to influence bowel cancer screening participation. The relationships newly identified in this study, including the interactions between RA effects and other factors, need to be further examined using individual-level data. Additionally, we only analysed data from the NBCSP, and therefore our results may not accurately reflect the overall screening behaviours.

Nevertheless, this study generates some novel evidence regarding the reasons for regional variation in NBCSP participation. Reported geographic disparities in bowel cancer screening are strongly associated with differences in population-level characteristics. Research focused on populations with poor participation rates, including Indigenous Australians, CALD groups, males, those of younger eligible ages, and people from low socioeconomic background is required to ensure maximum participation leading up to the full implementation of the national program by 2020.

Implications for public health

This study provides important evidence to understand the regional disparities in participating in the national screening program. One implication is that the solution to increasing screening participation rates may need to be population-focused rather than location-based, for example, by using appropriate and culturally relevant intervention strategies that are tailored to a specific group.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary File 1: Captions and notes for supplementary figures.

Supplementary Figure 1: Crude and adjusted * associations (ORs and 95% CIs) of Remoteness Area with NBCSP participation in New South Wales, July 2011 – June 2013

Supplementary Figure 2: Crude and adjusted * associations (ORs and 95% CIs) of Remoteness Area with NBCSP participation in Queensland, July 2011 – June 2013

Supplementary Figure 3: Crude and adjusted * associations (ORs and 95% CIs) of Remoteness Area with NBCSP participation in South Australia, July 2011 – June 2013

Supplementary Figure 4: Crude and adjusted * associations (ORs and 95% CIs) of Remoteness Area with NBCSP participation in Western Australia, July 2011 – June 2013