Spatial Scale and the Geography of Tobacco Smoking in New Zealand: a multilevel perspective

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Abstract

Smoking in New Zealand is more common in deprived areas and in areas with a significant Maori population. Despite its status as a major health problem there has been little work investigating this apparent geography of smoking. Data from the 1996 Census is used to construct a multilevel 'proportions-as-responses' model of smoking prevalence. This enables an exploration of the geography of smoking at different spatial scales. Levels within the model distinguish contextual variation between local authorities, census area units and meshblocks. Particular account is taken of the influence of deprivation and ethnicity on smoking. Results confirm the importance of ethnicity and deprivation and indicate that cross-level interaction between meshblock and census area units measures is significant. They also challenge crude stereotypes about the apparent geography of smoking and suggest that, while levels of smoking may be high in parts of North Island, they are less high than might be expected given the socio-demographic composition of the areas concerned. Conversely, smoking is more prevalent than expected in parts of South Island. The paper notes the health policy implications of these emergent geographies.

Key Words

Smoking, Ethnicity, Multilevel Modelling, Health Geography

Introduction

Tobacco smoking is now widely seen to be a major cause of death on a world-wide scale (Peto et al., 1994). This smoking-related mortality is generally held to be both premature and preventable: people die younger and unnecessarily. These statements can be applied directly to the situation in New Zealand. The overall social cost of smoking in New Zealand has been estimated at 3.2% of total human capital and 1.7% of GDP (Easton, 1997). A Ministry of Health survey has suggested that approximately one in five deaths in New Zealand result from smoking (Ministry of Health, 1999). Centrally, for the purposes of this paper, smoking is the greatest single contributor to premature mortality amongst Maori, who continue to smoke at a rate that, is, on average, almost twice that of the Pakeha population (Ministry of Health, 1998). It has been estimated that smoking causes a loss of 3.5 years mean life expectancy among Maori compared to 1.6 years among Pakeha (Tobias and Cheung , 2001)

There can thus be little doubt of the socio-medical significance of smoking and its economic consequences. There has, however, been little research on the geography of smoking in New Zealand. Prompted by the apparent high levels of smoking among Maori, we consider the relationship between smoking rates and the distribution of the Maori population. We assess the extent to which smoking rates are associated with compositional factors reflecting not only the ethnic make-up of an area but also its socio-demographic characteristics. We use multilevel models to consider these associations, focussing particularly on the variation in smoking rates that remains once compositional factors are taken into account and on the spatial scale at which such variation is to be found. Our research strategy employs a novel extension of the multilevel analytical framework. This enables us to assess how the geography of smoking in New Zealand varies in a complex fashion with geographical scale across the whole country.

In taking such an avowedly empirical approach, emphasising statistical modelling, we recognise that we are stepping back from important cultural issues. Though clearly, at an empirical level, it is possible, given the higher levels of smoking among Maori, to characterise smoking as a Maori problem, it is important to avoid the 'victim-blaming' possibilities associated with such a simplistic view (Robson and Reid, 2001). Given our focus on Maori smoking, we must thus, at this early point, acknowledge that our research concerns a topic in which a broader socio-historical context is relevant (Broughton, 1996). The modelling presented in this paper deals with empirical processes that are rooted in colonial oppression (Pawson, 1992) and matters of ethnic assimilation, dispersion and identity (Durie, 1998), as well as general processes of economic restructuring affecting all New Zealanders but impacting severely on Maori (Le Heron and Pawson, 1996; Te Puni Kokiri 1998; Brown, 1999).

The paper is organised into four sections. We begin with a brief assessment of the current state of knowledge concerning the geography of smoking in New Zealand. Attention then turns to an outline of our analytical approach. The main body of the paper reports the results of our analysis and we conclude by exploring the implications of our findings.

Tobacco Smoking in New Zealand

The results of a 1996/97 Health Survey showed that just under one quarter of all New Zealanders were current smokers (Ministry of Health, 1999). The precise figures were 26.4% of men and 23.5% of women. Younger people were more likely to smoke and smoking prevalence declined with age. As with other developed countries, young women (under 30 years of age) were more likely to smoke than young men. Overall, the basic demography of smoking in New Zealand is unsurprising. The general prevalence of smoking is in line with that of similar countries. Nor is New Zealand remarkable in the clear relationship that exists within the country between levels of smoking and levels of deprivation. The 1996 Ministry of Health survey compared smoking rates between areas classified by quartiles according to the NZDep96 score (Health Services Research Centre, 1997). It was found that the proportion of people living in the most deprived areas of New Zealand were over twice as likely to be current smokers compared to those living in the least deprived areas.

These expected regularities are accompanied by major ethnic differences in smoking rates. In New Zealand nearly half of all Maori adults (45.5%) reported that they were current smokers in the 1996 survey compared with 23.2% of Pakeha, 27.7% of Pacific Peoples and 10.1% of ‘Other’ adults. These inter-group differences are longstanding and show little sign of decreasing (Durie, 1998; Te Puni Kokiri, 1998). Declines in smoking have been more typical of Pakeha than Maori. While smoking prevalence among Pakeha decreased by approximately 3% between 1990-2001, no such trend was evident among the Maori or Pacific Island populations (Ministry of Health, 2002).

It is, of course, likely that deprivation and ethnicity overlap in terms of their relationship to levels of smoking. Maori are undoubtedly over-represented in deprived areas. Crampton et al. (2000) show however that Maori levels of smoking exceed those of other groups for all levels of deprivation. Table 1 provides additional evidence of this and other associations. It reports bivariate correlations at a variety of spatial scales, showing that smoking in New Zealand correlates significantly with ethnicity, age, gender balance and deprivation. In a preliminary indication of the themes we will pursue later in this present paper, these clear associations are replicated at different spatial scales, though with some variation.

'Table 1 about here'

Given this correlational background, it is not surprising that an exiting body of work, largely in public health, has focused on the effects of social and ethnic variations on smoking prevalence (Broughton and Lawrence, 1993; Klemp et al, 1998; Wilson and Borman, 1998; Borman et al, 1999; Ministry of Health, 2001, 2002). The few studies that have specifically examined the geography of smoking have focussed largely on descriptive mapping analyses and regional tabulations, standardised by age and sex but neglecting the two most important compositional factors affecting smoking: deprivation and ethnicity. For example the Ministry of Health (Ministry of Health, 2001a, 2002) apply crude national gender-specific rates, standardised by age, to estimate current rates of smoking among District Health Boards. They indicate that, for males, between 1998-2000, the regions that differed most from the national average included Tairawhiti (Gisborne), Hawkes Bay and Taranaki in the North Island and Canterbury in the South Island. For females, rates were significantly higher in Northland, Waitemata, Tairawhiti, Lakes (Rotorua-Taupo), Wanganui, Capital Coast (Wellington) in the North Island and the West Coast in the South Island.

By contrast, Barnett (2000) explicitly considers deprivation in his analysis of smoking in Christchurch and provides a preliminary indication that there is considerable complexity behind the regularities that drive the basic geography of smoking. Thus, while smoking is related to deprivation at very local scales, a higher level association with ethnic segregation compounds that relationship. Deprived census meshblocks located in census area units (CAUs) with the greatest ethnic segregation had levels of smoking nearly three times higher than those found in meshblocks in the least segregated CAUs.

These findings are significant in that they suggest that scale matters in understanding the geography of smoking: the relationship between smoking and deprivation varies according to place. Higher levels of smoking in low status localities are even higher if the low status locality is in a low status part of town. It is likely that similar conclusions could be drawn concerning the relationship between smoking and ethnic status. For example, Crampton et al. (2000) note that the generally high levels of smoking among Maori can be modified where there is a strong community-level commitment to anti-smoking policy (Te Puni Kokiri, 1999). It is this probable complexity in the Maori-smoking relationship that we seek to explore in this paper.

Research Strategy

It is evident from this brief review that there are significant variations across New Zealand in the prevalence of smoking. Among the major factors that have been used to explain these variations are ethnic status and deprivation as well as age and sex. Our research strategy focuses on the inter-relationships between these explanatory factors and the geographical scales at which analysis is conducted. We seek to uncover the extent to which age, sex, ethnicity and deprivation impact upon levels of smoking at the micro, meso and macro scale. Importantly, we also seek to identify areas of higher or lower levels of smoking than would be predicted on the basis of their population composition. To address these tasks we use data on smoking collected by the 1996 Census.

Data

In international terms, the New Zealand Census is significant for collecting data on smoking behaviour, usually once a decade. Despite the epidemiological salience of smoking, few other countries collect relevant data other than via sample surveys. The greatly enhanced coverage afforded by a census basis for data collection means that research into smoking behaviour can proceed with enhanced confidence in New Zealand[1]. Two forms of smoking question were used in the 1996 census (Statistics New Zealand, 1996). Do you smoke cigarettes regularly, that is, one or more per day? Have you ever been a regular smoker of one or more cigarettes per day? The research reported here focuses on the first question, that is on the prevalence of smoking within the New Zealand population.

Overall, the results of the 1996 Census indicated that some 23.4% of the respondent population defined themselves as regular smokers (Statistics New Zealand, 1998). Two caveats are of relevance in understanding this national prevalence. First, it is based on the number of respondents answering the smoking question. Post-census analysis suggests that around 8% of the New Zealand population failed to provide details of their smoking habits. Neither the reason for this non-response nor the likely smoking status of the non-respondents are known. Second, the smoking questions are based on self-reports. This is thought to under-estimate the true prevalence of smoking (Hedges, 1996; Tappin et al., 1997).

Data on smoking status were supplemented by other census data. In order to explore the key relationships established in the existing literature, we assembled data on the age, sex and ethnic structure of each census meshblock. Analysis allowed us to reduce this dataset to five key indicators: the proportions of the meshblock population aged under 25, over 60, of Maori ethnicity, and of Pacific ethnicity, and the male-female ratio. We acknowledge the ongoing debate about identity and census-based ethnic categorisation (Gould, 1992).

To these data we then linked the NZDep96 raw component score[2], as a continuous measure of deprivation at the meshblock level (Health Services Research Centre, 1997), and an indicator variable denoting the urban or rural status of Territorial Local Authorities (TLAs) on the basis of population density. Data for each meshblock was referenced to its appropriate CAU and TLA. Table 2 sets out the variables selected for further analysis and the associated hypotheses.

‘Table 2 about here’

The Multilevel Approach

The three hierarchically-nested spatial scales that structure the census geography of New Zealand and thus the data used in the present study point to a research strategy based on multilevel modelling (Goldstein, 1995). Multilevel modelling originated in educational research where it is used to quantify school performances relative to the characteristics of pupils. It has been widely applied in health geography in the UK where a particular emphasis has been on elucidating the role of ‘place’ or contextual factors at different spatial scales as explanations of health-related behaviour and health outcomes (Duncan et al., 1993, 1996, 1998, 1999). In New Zealand health applications have largely been restricted to studies of medical practice variation and the extent to which individual, practice and area characteristics have affected clinical decision-making (Davis et al., 2000, 2002).

The principles and statistical background of multilevel modelling have, over the past decade, become increasingly well documented in the social sciences, including human geography, and do not bear repetition here.[3] Essentially multilevel modelling is a technique that seeks to identify the random variation occurring in a response variable and apportion that variation to different ‘levels’ while controlling for relevant ‘fixed’ predictors. In the present paper our response variable is smoking, our levels are meshblocks, census area units (CAUs) and territorial local authorities (TLAs), and our controls are those summarised in Table 2.

A recurring criticism of geographical studies using multilevel models, concerns the artificiality of spatial units (Kearns and Moon, 2002; Mitchell, 2001). Put crudely, meshblocks, CAUs and TLAs are often presented as administrative units that hold little real sociological significance for the explanation of a phenomenon. Undeniably there is some strength to this argument. Nonetheless, administratively-driven hierarchical structurings are usually derived with some consideration for their sociological significance. Their construction generally reflects at least an element of formal as well as functional community geography. Despite their problems, they remain a powerful and, crucially, available means of capturing scalar variation. We acknowledge the drawbacks of the mesh – CAU – TLA hierarchy but employ it in the analyses that follow.

Census data are generally reported for areas, in the New Zealand case the meshblock. There are two ways in which this can be reconciled with the multilevel framework. First, it is possible to model discrete data for small areas within a multilevel structure made up of hierarchically nested higher-order geographies. Thus Langford (1995) used a multilevel Poisson model to examine the role of population mixing in the aetiology of childhood leukaemia at the local authority scale for England and Wales. In this paper we could have modelled the raw counts of the numbers of smokers in each meshblock. We chose however to use an alternative, second approach: a 'cells as proportions' strategy. There are few published applications of this approach. It works by developing the notion of the 'cell' as a level in a model lying below the basic areal unit for census data reporting. Thus, for the present research, a meshblock count of, say, thirty smokers out of a population of one hundred people, translates to a smoking cell (30/100) and a non-smoking cell (70/100) nested within the meshblock. Where multiway crosstabulations of census data are available, additional individual attributes can be identified. Subramanian et al. (2001) provide an example using crosstabulations of literacy and social status for districts identified in the Indian census, reducing several million individuals to three proportions for each of 445 districts.

In this paper we work with a single-way tabulation. This is a novel approach in health geography. Our cells record the proportion of smokers; we have no other information about our cell populations (apart, implicitly, from non-smoking). As the focus of our research is on smoking we thus have a single cell-level response variable: the proportion of smokers. Moreover our cells are actually equivalent in number to our meshblocks; we have exactly the same number of units at level-1 (cell) and level-2 (meshblock). While it might be expected that this would generate confounding within the model, Rasbash et al. (1999: 113) argue that in fact this is not so. The complete multilevel structure for the analyses reported in this paper is therefore one of cells within meshblocks within CAUs within TLAs.

The response variable for our analyses was the (cell) proportion of individuals self-declaring as regular smokers; the denominator was the adult population. This response was modelled against the chosen predictor variables noted above. We elaborate further on our modelling strategy in the following section. For modelling purposes each predictor variable was centred around its national mean. As a consequence, results should be interpreted as indicating variation above or below the national mean for the variable concerned. It is also assumed that the response variable is subject to a (general) binomial distribution. Hence model results are expressed in logits. All reported models are derived from second order partial quasi likelihood estimation procedures that were checked for parameter instability using Monte Carlo Markov Chain simulations. No significant problems were found.

Findings

We take as our start point a simple 'null' model of the proportion of a cell population reporting regular smoking (Table 3 Model A). There are no predictor variables, only an intercept term and a set of random coefficients that capture the amount of variation present at each of the levels within the dataset. As cells are equivalent to meshblocks, we are, in effect, modelling the proportion of a meshblock population that smoke. The intercept term can thus be interpreted as the mean level of smoking across all New Zealand meshblocks taking no account of potential influencing factors. The model coefficients, like all those reported in Table 3, are measured in logits. These can readily be transformed to indicate a mean proportion of smokers, in this case 23.7%. This is in line with expectations from census reports (Borman et al., 1999) and the results of the Ministry of Health's adult smoking survey (Ministry of Health, 2002).

The random coefficients from the null model confirm Barnett's argument for the importance of context in understanding the geography of smoking in New Zealand (Barnett, 2000). We are able to distinguish the variation at each of the three substantive levels in our analysis in relation to the global mean proportion of smokers. Using the conventional chi-square test of significance for these coefficients, each easily reach statistical significance ($p < 0.05$). Greatest significance attaches to the

CAU level suggesting that there is substantial variation between CAUs in the proportion of smokers. Variation at the other levels is less but still important with variation being least between TLAs. The clear implication is that there is indeed a geography of smoking in New Zealand. A focus on that geography at the TLA level would however obscure much more marked variation within TLAs.

Much of this variation would be expected to stem from the characteristics of meshblocks, CAUs and TLAs. A standard approach would be to consider the impact of age-sex standardisation. We can approximate such an analysis by modelling smoking as a function of the age and sex variables identified in Table 1. The TLA-level residuals from this analysis indicate TLA deviations from the national mean proportion of smokers controlling for age and sex. They are thus analogous to age-sex standardised smoking rates. Figure 1 maps this measure and confirms a regional geography of smoking in which highest rates are concentrated in the North Island, particularly in Taupo, Rotorua, Ruapehu, Opotiki, Wairoa, Gisborne and the Far North districts. Though there are rates that are above the national average (100) in the South Island, notably to the south and west, there is a major concentration of low smoking in the Greater Christchurch region.

‘Figure One about here’

In Table 3, Model B we extend our analysis further by considering the importance of our full set of predictor effects: age, sex, ethnicity, deprivation and urban status[4]. As stated above, these effects are measured at the meshblock level except for urban status, which is a TLA-level variable. As a consequence of centring, the intercept in this model represents the average level of smoking for a meshblock with the national average proportions of older residents, younger people, Maori and Pacific populations, and the national average deprivation status and male-female ratio. The coefficients for the predictor effects show the extent to which a particular variable is associated with increases or decreases in the probability of smoking around the intercept. As would be anticipated from the literature, the probability of smoking reduces in meshblocks where elderly people are concentrated. Reductions are also evident in urban areas, suggesting that, in New Zealand, higher levels of smoking are a rural phenomenon. In terms of conventional statistical significance, far and away the most important effects are those stemming from the proportion of Maori resident in a meshblock and the deprivation score. In contrast, alone among the fixed effects, the proportion of young people in a meshblock does not appear to have a significant effect on the probability of smoking.

The random part of Model B shows the difference between places having controlled for factors likely to influence the level of smoking. There remain significant levels of variation at all three levels in the model with greatest variation continuing to be at the CAU level. Taking the findings of the fixed and random parts of the model together, it therefore appears that, thus far, the geography of smoking in New Zealand is one that is substantially related to the distributions of deprivation and the Maori population. It is also one in which variation remains, particularly at the CAU level, even after compositional factors known to be associated with smoking are taken into account. It is reasonable to hypothesise that this CAU-level variation might reflect further variables as yet unaccounted for in the model. As our interest focuses on the relationship between smoking and the distribution of the Maori population we now explore this possibility using a CAU-level measure of the proportion of Maori in the population.

Table 3, Model C reports this next analysis. In addition to taking account of the proportion of Maori in the population of each CAU, we also consider the effect of cross-level interaction between the proportions of Maori at CAU and at meshblock level. Our results indicate that the proportion of smokers in a meshblock rises with respect not only to the proportion of Maori in a meshblock but also the proportion of Maori in a CAU. The impact of the meshblock Maori population is substantially greater. Of greatest interest however is the cross-level interaction effect. This indicates the presence of a 'dampening' effect whereby an expected high level of smoking is significantly lower than might be anticipated in meshblocks with a high proportion of Maori located in CAUs with a high proportion of Maori. In short, cross-level interaction captures contextuality. It demonstrates the importance of ethnic segregation in understanding the geography of smoking. Smoking levels are highest when there is a large discrepancy between the meshblock and the CAU levels of Maori.

Table 4 uses hypothetical examples to exemplify this issue. Working with combinations of maximum and minimum meshblock and CAU Maori population proportions as 'straw statistics', we calculate the estimated smoking rate for meshblocks before and after consideration of the cross-level interaction term with all other effects held at their national average. All results are converted from logits to percentages for ease of interpretation. The intercept term from Model C suggests that some 24% of the population of a meshblock with national average characteristics would be smokers. In a meshblock with a minimal Maori population, located in a CAU with a minimal Maori population, that figure falls to 18% and remains the same once account is taken of cross-level interaction. In meshblocks with few Maori located in a highly Maori CAUs, smoking levels rise. A slightly greater rise is found in cases where a highly Maori meshblock is located in a CAU with relatively few Maori. The most striking finding however concerns the expectation that some 65% of a meshblock population will smoke if that meshblock is highly Maori and located in a highly Maori CAU. In fact, cross-level interaction suggests that relative homogeneity of ethnicity between meshblock and CAU leads to a smoking level of 26%, just two percent above the national average. We can conclude that it is the geography of the Maori population relative to the Pakeha population that is more significant for smoking, rather than absolute levels of Maori within a population.

‘Table 4 about here’

In Table 3, Model D we introduce complexity to the random part of the model in an attempt to understand more of this situation. The model so far has allowed for variation around the intercept. We have been able to say, for example, that smoking is higher in areas where there are more Maori residents. What we have not yet been able to evaluate is whether the gradient of the relationship between a particular predictor and smoking has remained constant for all places. Thus, while we know that smoking is higher in areas with many Maori, we do not know if the strength (gradient) of the relationship between the proportion of smokers and the proportion of Maori residents varies between areas. Following from the findings of Model C, we now allow for place-specific variation in the gradient of the relationship between smoking and proportion Maori. Further to Model C we anticipate that much of this variation will be at the CAU level.

Model D provides the results of this analysis following a process of iterative model development based on significance testing. In terms of the fixed part, the results are essentially the same as those for Model C. In the random part however, we now have three coefficients to deal with at the CAU and meshblock levels as well as the single term at the TLA level. From the three intercept coefficients it again appears that greatest variation lies at the CAU level. The random slope coefficients for Maori tell us that there is significant variation between CAUs and between meshblocks in terms of the slope of the relationship between proportion smoking and proportion Maori. Thus, while an increase in the proportion of Maori is associated with a higher proportion of smokers, the impact of a unit increase on the proportion of Maori varies between CAUs and meshblocks. The suggestion is that the relationship between smoking and the proportion of Maori varies in its intensity across CAUs and meshblocks. Indeed, the changes in the CAU-level intercept term imply that much of the large CAU-level variation in smoking can be understood in terms of a place-differentiated response to the proportion of Maori in a CAU. Levels of Maori matter more in some locations than in others. In the light of our findings on cross-level interaction, it would be reasonable to presume that such locations are those where there is a substantial contrast with the meshblock-level proportion of Maori.

The final random coefficients in Model D address the issue of covariance. The CAU covariance coefficient shows that there is less variation in the proportion of smokers in a CAU when a CAU has a high proportion of Maori. In other words, a unit increase in the proportion of Maori has less impact on the smoking in CAUs that are more strongly Maori in their population make-up. A similar finding is evident at the meshblock level. The implication is that it is in ethnically more mixed CAUs that the relationships between proportion Maori and levels of smoking are strongest. This confirms the presumption made in the previous paragraph.

Following Jones and Moon (1992) and drawing on the original schools performance literature (Goldstein and Spiegelhalter, 1996) we now use results of Model D to construct level-specific residuals. These can be used as contextualised performance indicators in that they contrast a place's 'performance', here its smoking prevalence, with what that prevalence is predicted to be by the multilevel model. An important use of these residuals is thus to identify places where smoking prevalence is unusual once account is taken of factors known to influence smoking prevalence. Such places may be caricatured as those where smoking is low (or high) even after allowing for the characteristics of the place. In Figure 2 we show the TLA-level residuals from Model D. A contrast can be drawn with Figure 1. The comparison is stark. Given the composition of their populations, levels of smoking are surprisingly high in Clutha, Central Otago, Queenstown-Lakes, Waitaki and Timaru districts. After taking account of their socio-demographic composition, unusually low levels of smoking are found in the Far North and Whakatane.

'Figure 2 about here'

The implications of these contrasts are considerable. First, there are undoubtedly some TLAs where levels of smoking are low both before and after taking population characteristics into account. Auckland City, North Shore City and Wellington are cases in point. Second, there are TLAs where population characteristics suggest low levels of smoking but those populations are smoking more than expected. This is the situation in the parts of South Island, notably in Queenstown-Lakes and Timaru districts. Third, Clutha and Central Otago return high levels of smoking both before and after taking population characteristics into account. Finally, the stereotypical association of Maori with smoking masks a suggestion that, across areas of greatest Maori population concentration, and most notably in Opotiki, levels of smoking may be high but they are not as high as population characteristics would imply.

Discussion and Conclusion

The purpose of the modelling presented in this paper was to identify and explore the relationship between smoking and the distribution of the Maori population rather than attempt the construction of a comprehensive model of smoking in New Zealand. It is nevertheless appropriate to note that the comprehensive nature of the data source and the fact that the key parameters of the models were in line with a priori expectations concerning the direction and magnitude of relationships gives considerable confidence in our findings. By taking a multilevel approach we have also been able to add significantly to existing knowledge. By incorporating 'level' within the analysis, we have identified the scale at which most variation in smoking behaviour occurs. Thus, it is clear that, although the TLA scale allows a clear graphical portrait of variations in smoking prevalence, the TLA level is relatively less important in comparison to the CAU when it comes to understanding the geography of smoking.

Variation at the meshblock level is also less than that present at the CAU level. Thus smoking in New Zealand is best understood in relation to meso-scale influences that impact beyond the immediate community but more locally than the TLA.

We have also shown that there is a degree of complexity to the geography of smoking in New Zealand. This has often been hidden in surface illustrations of variation and shallow associative analyses. In particular, stereotypes concerning the association of smoking with ethnicity can be challenged. Undoubtedly ethnicity is associated with smoking in New Zealand, as it is in other countries. When operationalised as proportion Maori and considered as a compositional factor within a multilevel modelling framework, it is clear however that there are particular places where smoking is relatively low in relation to ethnic composition. It is also clear that levels of smoking are strongly influenced by the relative segregation of Maori within CAUs.

Why does ethnic composition have a differential impact on smoking prevalence in some areas? Why do ethnically heterogeneous CAUs have higher rates of smoking? The reasons underlying such patterns are not immediately clear and further work on the relationship of smoking to segregation and relative inequality is clearly needed. Undoubtedly the social stresses associated with rates of relative inequality amongst Maori living outside central North Island play a part. This suggestion would certainly be in line with the theme developed by Graham (1998) in her analyses of links between inequality, social stresses and smoking prevalence in the United Kingdom. Future research should also consider the role of social-geographic variation in attitudes to smoking (Frohlich et al., 2002; Ross and Taylor, 1998), the stresses involved with economic restructuring (Mitchell et al., 2000) and the impact of local social capital as a constraint on tobacco sales and consumption (Blewden and Spinola, 1999).

It is our contention that a more qualitative, ethnographic research design would be an effective strategy for further research focussed on the examination of these possible routes to understanding the processes underpinning the complex geographies of smoking that we have exposed in this paper. Such research would clearly need to consider the broader structural contexts that we noted in our introduction. It would also need to consider smoking as a situated social practice. To this end, works by Poland (1998, 2000) and Stead et al. (2001) offer exemplars of inquiries that successfully interrogate the operationalisation of contextuality in particular places.

The results presented here also indicate that policy measures should pay more attention to the local diversity of the processes that shape smoking prevalence. There is a case for enhancing access to culturally appropriate health and social care and targeted smoking cessation programmes at the CAU level. We suggest there is also a need to value more highly the efforts of Maori communities as they work towards smoking reduction. The Tipu Ora well child care services in the Rotorua region exemplifies these possibilities: a successful area-based programme resulted in 76% of Maori mothers cutting down or stopping smoking during pregnancy largely due to the effects of new locally based and more culturally sensitive forms of service delivery aimed at changing lifestyles (Ministry of Health, 1998). Further evidence is provided in Aukati Kai Paipa (2000). These smoking-focussed initiatives from communities and the health sector need to be accompanied by wider developmental activity targeting the socio-economic disadvantage underpinning inequality and continuing national campaigns and legislative measures.

The clear conclusion that can be drawn from this paper is that levels of smoking are often remarkably low in communities with population characteristics strongly associated with smoking. A monitoring approach based on sensitivity to such place characteristics could provide a sensitive complement to the large national smoking prevalence surveys conducted annually by A.C. Nielsen for the Ministry of Health. It would be particularly useful to identify the constellation of local factors that differentiate ‘successful’ from ‘less successful’ communities with respect to decreasing smoking rates. Place sensitivity would also enable account to be taken of the way particular causes of smoking play themselves out differentially in different places. In this way attempts could be made to identify both the opportunities and the constraints affecting the implementation of area-based health promotion strategies. The research presented here contributes to this objective.

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Graham Moon's research focuses on the geography of smoking, health applications of multilevel analysis, primary care reform and discourses linking place and health.

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Notes

[1] The 2001 Census did not include questions on smoking. The 1996 data thus represents the most recent comprehensive source of data.

[2] The raw component score represents the basic output from the analysis that reduces a set of statistical indicators to a single measure of multiple deprivation. In the case of NZDep, the component scores are usually reported as ten ordinal classes. In this paper we use the less familiar continuous component score as it has computational advantages.

[3] Interested readers should consult the standard works: Goldstein (1995) or Snijders and Bosker (1999). Jones (1991) provides an introduction for geographers. The supporting documentation and website for the software used for the analysis reported here is generally exemplary in its helpfulness (see http://multilevel.ioe.ac.uk).

[4] In model B and all subsequent models we undertook extensive testing for non-linear relationships. None were found that contributed significantly to the models.