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Small area mapping of domestic radon, smoking prevalence and lung cancer incidence – A case study in Northamptonshire, UK

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ABSTRACT

Smoking and radon both cause lung cancer, and together the risk is significantly higher. UK public health campaigns continue to reduce smoking prevalence, and other initiatives identify houses with raised radon (radon-222) levels and encourage remedial action. Smoking prevalence and radon levels in the UK have been mapped at Primary Care Trust level. This paper extends that work, using a commercial socio-demographic database to estimate smoking prevalence at the postcode sector level, and to predict the population characteristics at postcode sector level for 87 postcode sectors in Northamptonshire. Likely smoking prevalence in each postcode sector is then modelled from estimates of the smoking prevalence in the different socio-economic groups used by the database. Mapping estimated smoking prevalence, radon potential and average lung cancer incidence for each postcode sector suggested that there was little correlation between smoking prevalence and radon levels, as radon potential was generally lower in urban areas in Northamptonshire, where the estimates of smoking prevalence were highest. However, the analysis demonstrated some sectors where both radon potential and smoking prevalence were moderately raised. This study showed the potential of this methodology to map estimated smoking prevalence and radon levels to inform locally targeted public health campaigns to reduce lung cancer incidence.

1. Introduction

It is well established that smoking is the primary cause of a range of diseases, including lung cancer, which result in preventable morbidity and premature mortality. Smoking accounted for 81,400 deaths in England in 2009 (Department of Health (DoH), 2011). Around 35% of all deaths from respiratory diseases and 29% of all cancer deaths are attributable to smoking, with the greatest number of deaths due to lung cancer. Smoking is the most significant risk factor for lung cancer, responsible for 86% of lung cancer deaths. As a result of education and health campaigns to reduce tobacco use, smoking prevalence in England has dropped from 45% in 1974 to 28% in 1998, declining further to 21.2% in 2010 (DoH, 2011). This is a slowing trend, with the latest estimate being 20% in 2012 (Health and Social Care Information Centre (HSCIC), 2014). Smoking prevalence in UK national statistics includes occasional and daily smokers, aged 16 years or more in the numerator against mid-year population, and this definition applies throughout this paper.

The second most significant risk factor for lung cancer, after smoking, is Radon-222 (hereinafter referred to as 'radon'), which is the most common isotope of Radon, a naturally occurring radioactive gas. Significant levels of radon may exist in the built environment, and case–control studies have demonstrated an increase in lung cancer in people with raised radon levels in their homes (AGIR, 2009). Measurement and reduction of radon levels in homes is relatively simple, and campaigns to reduce radon risk have been conducted over the last 25 years, through Local Authority Environmental Health Departments and Radon Roll-out Programmes, a

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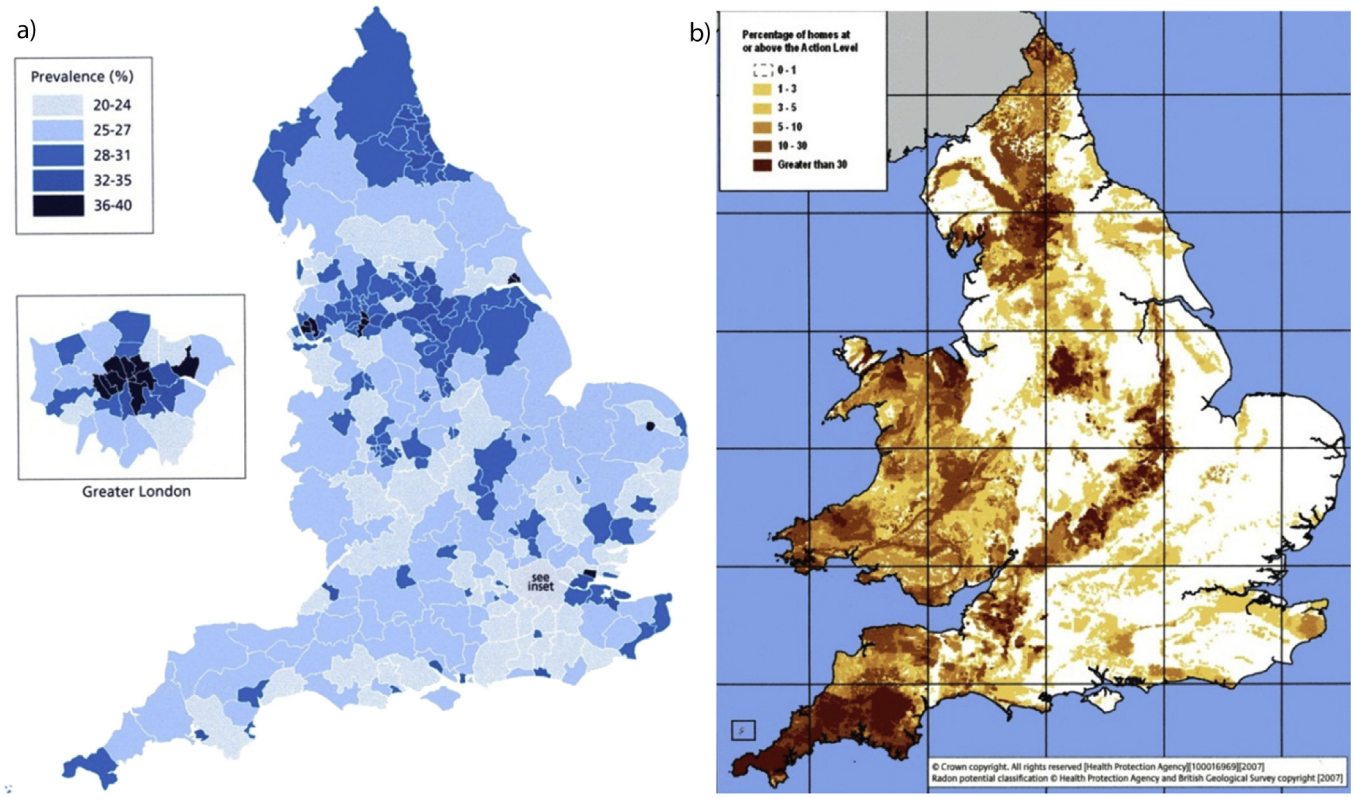

Fig. 1. (a) Estimated smoking prevalence, 2004 (source: Twigg et al., 2004) – (b) Radon map, 2007(source : HPA, Miles et al, 2007).

Table 1
Summary of analysis by postcode sector in Northamptonshire (source Mosaic data).

	Minimum	Maximum	Average	England & Wales, 2011 census
Average household size	1.66	2.78	2.36	2.4
Number of households	53	7511	3499	
Percentage of apartments	0%	40%	5%	21%
Smoking prevalence (estimated)	11.20%	36.60%	19.50%	

Department for Environment, Food and Rural Affairs (DEFRA) initiative to identify and make safe homes in radon hot-spots. Despite extensive publicity, only around 40% of householders in Radon-Affected Areas (RAAs) in England and Wales have tested radon levels in their homes, and of those who discover radon concentrations exceeding the Action Level of 200 Bq m^{-3}, only 15% remediate their homes (Zhang et al., 2011), so that only around 6% of houses over the Action Level in RAAs have been rectified to date. The University of Northampton Radon and Natural Radioactivity Research Group (RNRRG) reported that those who remediate their homes tend to be older, have fewer children, and include fewer smokers than the general population (Denman et al., 2004).

The risks from radon and smoking are considered to be multiplicative, and the risk to an ex-smoker slowly reduces to that of a non-smoker over five to ten years after quitting smoking (AGIR, 2009; Gray et al., 2009). As a result, local smoking cessation initiatives can prevent a higher number of lung-cancers in RAAs than radon remediation. The RNRRG's initial work (Groves-Kirkby et al., 2008) demonstrated that this was the case for the smoking cessation programme in Northamptonshire, UK, which would avert more lung-cancers, and therefore be more cost-effective, than similar smoking cessation programmes in areas with lower radon levels. In addition, current radon remediation campaigns are considerably less cost effective than would be expected when assuming an average population risk from radon, because these campaigns achieve a lower response from those most at risk from radon, namely, current smokers (Denman et al., 2014).

There is considerable geographical variation of smoking prevalence with higher prevalence generally in urban and more deprived areas in the UK (Twigg et al., 2004), and indoor radon levels also have a geographical variation, primarily due to underlying geology (Miles et al., 2007), as shown in Fig. 1. There is therefore the potential for locally-targeted campaigns for radon, smoking or both. Denman et al. (2014) carried out an assessment of the potential for such local campaigns at the level of Primary Care Trusts (PCTs),[2] showing little correlation between smoking prevalence and radon potential at PCT level, which had similar areas to local authorities. They concluded, however, that improved radon mapping allows

[2] Primary Care Trusts (PCT) were the organisations responsible for commissioning healthcare for the NHS in the period 2001–2013; local authorities have been responsible for commissioning smoking cessation services since 2014.