The Impact of UK Government Targets for Smoking Cessation on the Effectiveness of the Radon Remediation Programme.

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ABSTRACT

Smoking and radon gas are both known causes of increased lung cancers, with smoking being the most significant risk. In the UK there are separate initiatives to reduce the risk from each. Programmes to find houses with raised radon levels, and then encourage householders to take remedial action have been running in radon affected areas for some years. However, to date only around 40 % of householders have tested their homes, and, of those who find radon levels over the Action Level, only around 15% have taken action to reduce radon levels.

National Health Service (NHS) Smoking Cessation Services combined with nationally and locally delivered social marketing campaigns have achieved great success in reducing smoking prevalence from 45% in 1974, to 28% in 1998, and to around 21% in 2011. In 2011, the UK Government published its commitment to drive down the prevalence of smoking and support comprehensive tobacco control in local areas with a key ambition to reduce adult smoking prevalence to 18.5% by the end of 2015.

It has been shown that the two risks together are sub-multiplicative, and that most radon-induced lung cancers occur in smokers. Therefore the two initiatives to reduce risk are not independent, and a reduction in the number of smokers will reduce the effectiveness of the radon remediation programme.

Our group has studied the characteristics of those who remediate their homes to reduce radon risk, and has shown that they are older, have fewer children, and include fewer smokers than the general population, and so radon remediation programmes are not reaching those most at risk.

This paper considers the impact of the Government's targets for Smoking Cessation on the effectiveness of the radon remediation programme, and makes recommendations for future public health initiatives in light of the interaction between the two risks.

KEYWORDS: Smoking, Radon, Remediation, Domestic Houses, Cost Effectiveness.

1. Introduction

Smoking is the primary cause of preventable morbidity and premature death, accounting for 81,400 deaths in England in 2009. In England, deaths from smoking are more numerous than the next six most common causes of preventable death combined (i.e. drug use, road accidents, other accidents and falls, preventable diabetes, suicide and alcohol abuse) (Dept. of Health, 2011). Smoking causes a range of illnesses, most of which only become apparent after many years of smoking. In 2009, around 35 per cent of all deaths in England from respiratory diseases and 29 per cent of all cancer deaths were attributable to smoking; with the greatest number of deaths due to lung cancer. Smoking also accounted for 14 per cent of deaths from circulatory diseases and 6 per cent of deaths from diseases of the digestive system. Smoking is the most significant risk factor for lung cancer, responsible for 86% of lung cancer deaths. Since this became known, education and health campaigns have been conducted to reduce smoking prevalence. In England, smoking prevalence has dropped from 45% in 1974 to 28% in 1998, declining further to 21.2% in 2010 (Dept. of Health, 2011).

Radon, a naturally-occurring radioactive gas, is the second most significant risk for lung-cancer after tobacco smoking. High levels of radon were first identified in uranium mines, but more recently, it has been established that significant levels are found in the built environment, and case-control studies have shown an associated increase in lung cancer in the public from radon in their homes (AGIR, 2009; BEIR VI, 1999; Darby *et al.,* 2005).

Radon levels can be tested simply, and, if raised radon levels are found, remediation work, usually involving the introduction of a sump and attached pump to extract radon to outside and costing around £850, will reduce radon levels nearly always well below the Action Level. Over the last 18 years, campaigns to measure and reduce radon in homes have been implemented through the local councils' environmental health departments. Despite publicity, only around 40% of householders in Radon Affected Areas (RAAs) have tested radon levels in their home, and of those who discover raised levels, only 15% remediate their homes (Wei Zhang *et al.,* 2011). Our group has studied the characteristics of those who remediate their homes, and has shown that they are older, have fewer children, and include fewer smokers than the general population (Denman *et al.,* 2004).

Recently, a collaborative analysis of 13 European studies has confirmed that there is an increased risk of lung cancer in the range 100 to 200 Bq m^{-3}, which is consistent with linear interpolation (Darby *et al.,* 2006). As a result, the Health Protection Agency have reviewed the risks of radon (AGIR, 2009), and made recommendations to reduce the risk from radon, including introducing a lower target level of 100 $Bq.m^{-3}$, and suggesting that all new houses should be built with basic radon protection (HPA, 2010).

The risks from radon and smoking are considered to be sub-multiplicative (BEIR VI, 1999), yet smokers, who are most at risk from radon, are not being targeted by current radon remediation campaigns. This led our group to consider the local smoking cessation initiatives, and whether these might be valuable in reducing radon-induced lung cancers. Our initial work showed that the smoking cessation programme in Northamptonshire has added value compared to smoking cessation programmes in areas with lower radon levels. In addition, there is greater health benefit for a smoker living in a high-radon house from quitting smoking than from remediating the house and continuing smoking (Groves-Kirkby *et al.,* 2008).

As the risks from radon and smoking interact, any initiative to reduce the number of smokers will also reduce the number of radon-induced lung cancers, and change the estimates of cost effectiveness of radon remediation campaigns. The UK Government is continuing to work hard to reducing the number of smokers, with key ambitions to support comprehensive tobacco control in 2011 – *Healthy Lives, Healthy People : A Tobacco Control Plan for England* (Dept of Health, 2011). This paper considers the impact of the Government's targets for Smoking Cessation on the effectiveness of the radon remediation programme, and makes recommendations for future public health initiatives in light of the interaction between the two risks.

2. UK Government Smoking Initiatives

The UK Government has actively striven to reduce smoking rates with a series of initiatives, such as health warnings on cigarette packages, and funding support for local Smoking Cessation Programmes. Smoking prevalence has continued to drop over a number of years, as shown in Figure 1, and new targets and ambitions aim to continue this trend. The previous strategy, *A Smokefree Future* (Dept of Health, 2010) included a target of 10% for adult smokers by 2020, as well as targets for children and pregnant women), while *Healthy Lives, Healthy People: A Tobacco Control Plan for England*, (Dept of Health, 2011), has an ambition to reduce smoking prevalence to 18.5% for adults by 2015, and includes the national initiatives in Table 1.

Implement Tobacco Display Regulations (2010) to end tobacco displays in shops.
Look at whether the plain packaging of tobacco products could be an effective way to reduce the number of young people who take up smoking and to support adult smokers who want to quit, and consult on options by the end of the year.
Continue to defend tobacco legislation against legal challenges by the tobacco industry, including the Tobacco Vending Machines Regulations (2010) which stop tobacco sales from vending machines from 1 October 2011.
Continue to follow a policy of using tax to maintain the high price of tobacco products at levels that impact on smoking prevalence.
Promote effective local enforcement of tobacco legislation, particularly on the age of sale of tobacco.
Encourage more smokers to quit by using the most effective forms of support, through local stop smoking services.
Publish a three-year marketing strategy for tobacco control.

Table 1 – Commitments in Healthy Lives, Healthy People, 2011

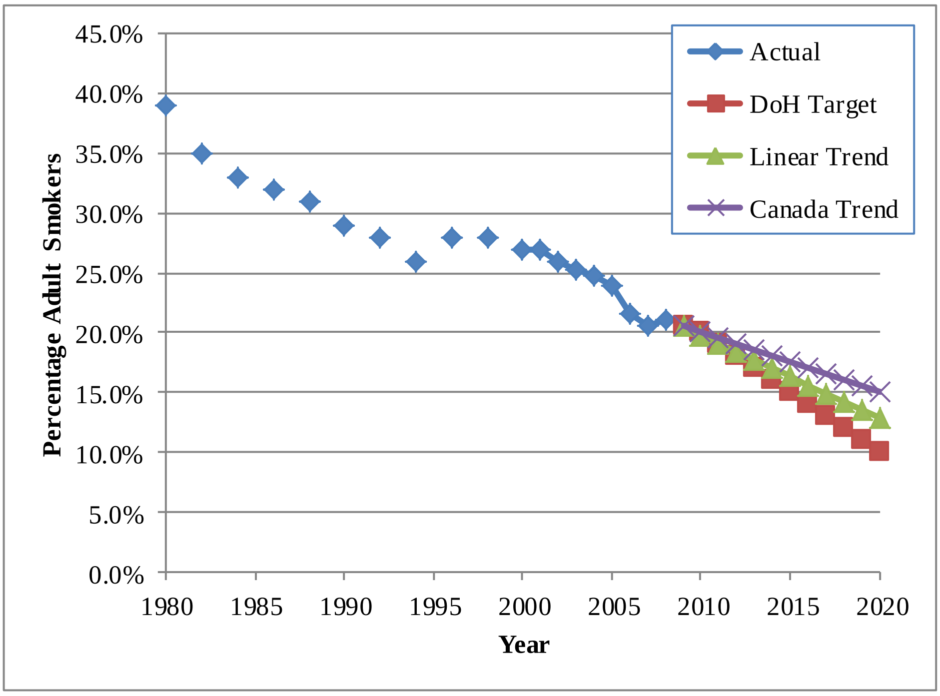

Figure 1 - Smoking Prevalance in England

Notes -Both Canada and Victoria, Australia have smoking rates below 20%, with a linear reduction at around 0.5% per annum. This is plotted as "Canada Trend" to provide context to the scale of the challenge by the DoH. "Linear Trend" is the extrapolation of current reduction. "DoH target" is that in *A Smokefree Future* (DoH, 2010), of 10 % or less by 2020, assuming linear progression to the target.

These national initiatives are supported by smoking cessation programmes which, in England, are currently commissioned by the local Primary Care Trust (PCT), part of the National Health Service (NHS), with the assistance of General Practitioners (GPs). These programmes encourage smokers to quit, provide aids to quit, and support them in the initial period after quitting.

Using the current risk estimates for lung cancer from smoking, and from radon (AGIR, 2009), it is possible to estimate the expected number of lung cancers associated with radon for a range of smoking prevalences, as shown in Table 2. In this case, the numbers are those for the newly defined UK Radon Affected Areas as defined in Denman *et al.*, (2012). Table 2 shows that the number of lung cancers averted by a radon remediation programme are halved by a reduction of smoking prevalence from 25% to 10%.

Smoking Prevalence	25%	22%	20%	19%	18%	17%	16%	15%	14%	13%	12%	11%	10%
Lung Cancers averted	1.21	1.09	1.01	0.97	0.93	0.89	0.85	0.81	0.77	0.72	0.68	0.64	0.60

Table 2 - Variation of Radon-induced Lung Cancers Averted Annually with Smoking Prevalence

3. Cost-Effectiveness

Denman and his co-workers have done extensive studies of the cost-effectiveness of radon remediation programmes (Denman *et al.,* 2008), and concluded that completed radon remediation programmes of existing houses in radon affected areas are cost-effective when compared to other health intervention and NICE guidelines, which suggest that interventions costing over £20,000 to £30,000 per Quality-Adjusted Life Year (QALY) are poor value. This analysis has now been extended to model the reduction in radon-induced lung cancers expected from the drop in smoking prevalence, using the methodology of Coskeran *et al.,* (2009), who assumed that a lung cancer sufferer lost an average of 13.51 years of life, and after diagnosis had a reduced quality of life. The analysis was conducted both for remediation of existing houses in UK Radon Affected Areas, and for new homes protected with radon precautions at the time of building both in Radon Affected Areas, and throughout England and Wales, and was updated to December 2011 prices and the current UK average occupancy of 2.32 (Office of National Statistics). The results are shown in Figure 2, together with coloured lines identifying £20,000 and £30,000 per QALY. The cost-effectiveness of a radon remediation programme for existing houses at the current public response rate of 15% of those finding high radon levels is also shown, but it should be noted that this analysis assumes the population-average risk. However, the evaluation of those who have remediated in Northamptonshire by Denman *et al.* (2004) would suggest that the cost per QALY is likely to be four times higher, as fewer smokers remediate homes. The finding that fewer smokers remediate is compatible with findings of other researchers that smokers under-estimate their risk of developing lung cancer (Weinstein *et al.,* 2005; Liu *et al.,* 1995).

Denman *et al.* (2010) have compared the local smoking cessation programme in Northamptonshire, UK, a radon Affected Area, with the radon remediation programme in the same area, and concluded that the smoking cessation programme reached a different target group, who do not currently consider radon as a significant risk. In addition, although the quantitative analysis of cost-effectiveness was incomplete, it was apparent that in a radon affected area, the cost per life-year saved from a smoking cessation campaign may well be significantly less than that arising from a radon remediation campaign.

It should be noted that this analysis considered only the direct costs of both campaigns and ignored the costs of the national initiatives and awareness campaigns for both radon and smoking. If these costs were included then the cost-effectiveness of each campaign would be reduced. In addition, the analysis for the smoking cessation campaign ignores all the other health risks associated with smoking, such as other cancers, and cardiovascular disease, and the resultant health benefits if these too were reduced.

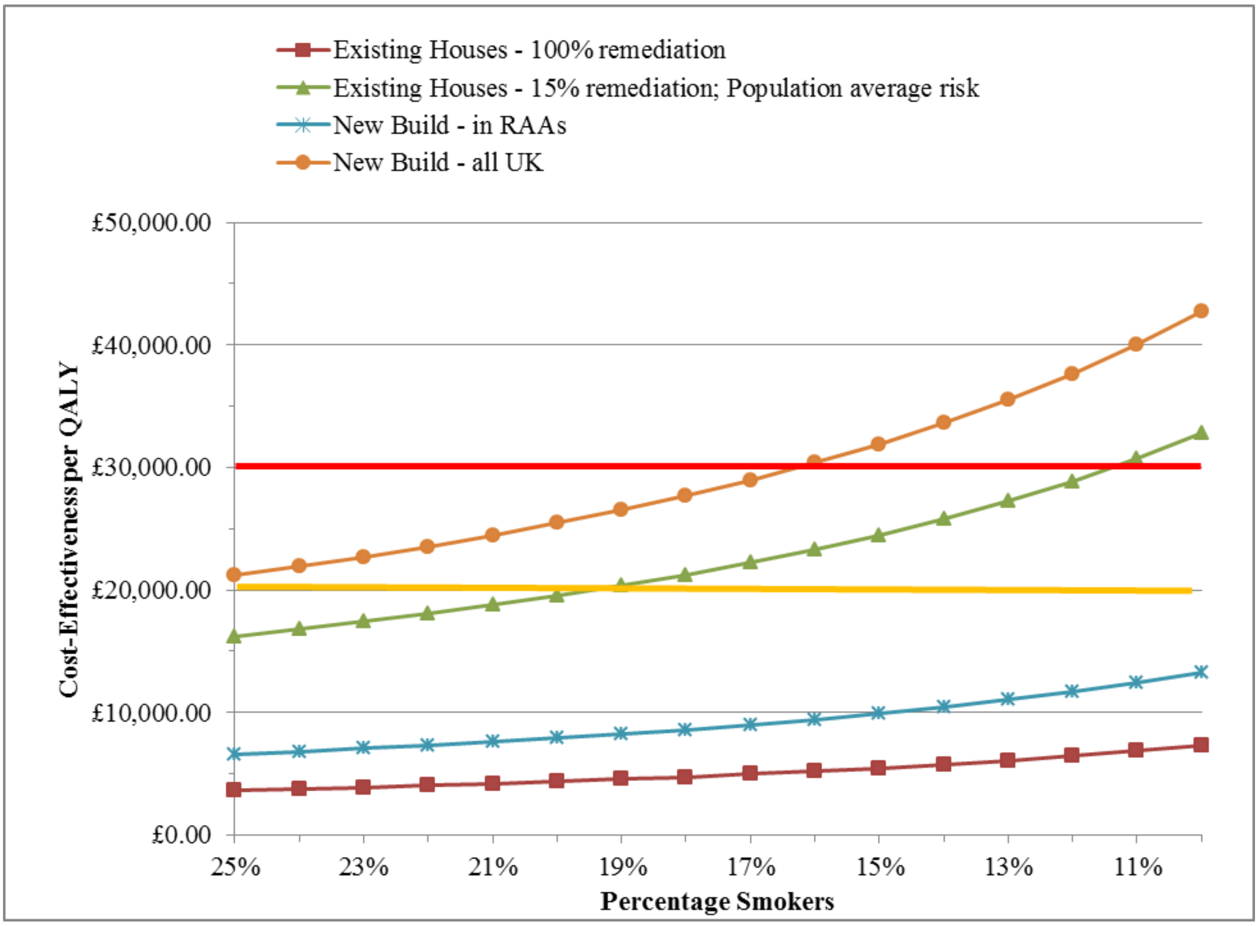

Figure 2 – Variation of Cost-Effectiveness of Radon Remediation Programmes with Smoking Prevalence

4. Discussion

Lung cancer is a disease where 5-year survival remains low, and where, on average, a lung cancer sufferer loses 13.5 years of life. For this reason, public health initiatives are aimed at prevention, and, as smoking is the most significant risk factor, governmental and local initiatives to reduce smoking prevalence are seen as very important.

As the second most significant risk for lung cancer, radon, in view of the potential for high levels in some homes, has also been the subject of public awareness campaigns to reduce risk. Completed radon remediation programmes in radon Affected Areas have been shown to be cost-effective, with costs per QALY comparable to other health interventions considered justified in the UK. However, the value of such programmes is reduced by the limited public response to the discovery of high radon levels in their homes, and, in particular, the reduced number of smokers who respond.

The fact that the combined risks from radon and smoking are sub-multiplicative accentuates this issue, but also means that smoking cessation programmes in radon Affected Areas will also reduce the number of radon-induced lung cancers.

Although the confirmation that radon has some risk below the current UK Action Level of 200 Bq.m^{-3} is an incentive to extend radon remediation programmes, the analysis in this paper suggests that radon remediation programmes become less cost-effective as smoking prevalence falls, to the extent that initiatives such as the provision of radon protection of all new homes in the UK becomes unjustifiable against NICE criteria for the value of interventions. Radon remediation of existing homes in low and medium radon Affected Areas is also an issue, unless methods can be found to increase public participation.

Mendez *et al.* (2011) have conducted a similar analysis on US data, and similarly conclude that, although still a genuine source of public health concern, radon-induced lung cancer in USA is likely to decline substantially, driven by reductions in smoking rates. Under their base case scenario, they estimate that annual radon-induced lung cancer deaths in USA could drop to 46% of the 2006 level by 2100, but that only 12% of this drop would be from radon remediation, and the other 42% would be due to decline in smoking. They conclude that smoking decline will reduce radon deaths more than remediation of high-radon houses, a fact that policymakers should consider as they contemplate the future of cancer control, and that their analysis merely emphasises the value of tobacco control as a public health strategy with broad ramifications for health.

5. Conclusions

The extensive initiatives to reduce the health effects of smoking and the resulting fall in the prevalence of smokers have the benefit of reducing radon-induced lung cancers significantly. Whilst radon remediation programmes in both existing and new houses will reduce additional lung cancers, the number of such radon-induced lung cancers will fall as smoking prevalence drops, which reduces the cost-effectiveness of such programmes.

The modest public response to radon remediation programmes in existing houses, coupled with the finding that fewer smokers respond, also reduces cost-effectiveness, and challenges authorities to consider ways to increase participation.

There is a need for an integrated strategy to tackle smoking and radon, to acknowledge the major role that smoking cessation programmes play in reducing radon-induced lung cancers, and initiate radon remediation programmes with care to ensure that limited resources are targeted where there is greatest benefit.

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