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The geography of chronic obstructive pulmonary disease: A population-based study of Norway

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ABSTRACT

Research on chronic obstructive pulmonary disease (COPD) that includes geographic information is important in order to improve care and appropriate allocation of resources to patients suffering from COPD. The purpose of this study is to investigate the geography of COPD and factors associated with the spatial patterns of COPD prevalence. Particular emphasis is put on the role of the local socioeconomic environment. Utilising information from the Norwegian Prescription Database on all lung medication prescribed in 2009 we identified 62,882 persons with COPD in the Norwegian population. Patterns of spatial clustering in the prevalence of COPD are clearly evident, even when age and gender are controlled for. Gender and age are strongly related to COPD risk. Socio-economic characteristics of the community such as education and unemployment are also significantly correlated with COPD risk. People living in rural parts of the country are generally associated with less risk than people in urban settings, and in particular people living in communities with high levels of farm and fisheries employment.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. COPD was the fifth leading cause of death in high income countries in 2001, and was also estimated to be a leading cause of disability-adjusted life years (Lopez et al., 2001). Tobacco smoking has been linked to COPD since the 1950s, and has been widely known as the primary cause of COPD in industrial countries (Whittemore et al., 1995; Pauwels et al., 2001; Tzanakis et al., 2004; Kohansal et al., 2009). Consequently, much research has focused on the role of smoking in COPD, and several prevalence studies have been conducted only on smokers, and in particular on smokers with at least 20 pack-years of cigarette smoking exposure (Huchon et al., 1997; Tzanakis et al., 2004). However, later studies have suggested that risk factors other than smoking are strongly associated with COPD, such as indoor and outdoor pollution, workplace exposure to dust and fumes, history of repeated lower respiratory-tract infections during childhood, history of pulmonary tuberculosis, chronic asthma, intrauterine growth retardation, poor nourishment, and poor socioeconomic status (SES) (Salvi and Barnes, 2009). The latter factor is particularly relevant in the case of COPD, because of the greater proportion of smokers among people in lower socioeconomic groups. Although the link between SES and COPD through smoking habits is unquestionably very important, research has also revealed that socioeconomic factors have strong independent effects on the prevalence and severity of COPD (Bakke et al., 1995; Eisner et al., 2011; Danielsson et al., 2012). This relationship is important, since it represents risk factors that are at least partly modifiable. With the increasing socioeconomic differences it is becoming increasingly important to treat SES in COPD as an independent risk factor whose constituents need to be disentangled, and not just as a 'nuisance' parameter to adjust for (Prescott and Vestbo, 1999). Thus, while age and smoking are strong contributors to COPD, they do not fully explain variations in disease prevalence. Although smoking cessation is becoming an increasingly urgent objective for an ageing worldwide population, a better understanding of other factors that contribute to COPD is crucial to assist local public-health officials in developing the best possible prevention policies for their regions (Buist et al., 2007).

The purpose of this study is to investigate the role of geography in COPD. Utilising information on all lung medications prescribed in Norway in 2009 for COPD, and controlling for the age and gender of the patient, we examined the association between a number of

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residential factors and COPD. By exploring geographic differences one may identify factors that are associated with lower prevalence of COPD, and thereby also arrive at care practices and policies that may generate better future health outcomes. The results from earlier studies of the geography in COPD are not easily generalised. More specifically, many of the studies were limited by only including data from one or a few states, regions or counties (e.g., Sobradilla-Penä et al., 2000; Lipton et al., 2005; Ansari et al., 2007; Jackson et al., 2011). COPD prevalence in most countries vary regionally; therefore, focussing attention on individuals from only one place may limit our understanding of COPD. The advantage of conducting analysis in a single health care system is obvious: it may help remove some of the variation caused by various administrative and incentive structures across different health care systems. Also, while earlier studies have restricted the samples to patients actively seeking health care (i.e., patients in the setting either of a hospital, general practice or rehabilitation), our study examines COPD outside of the clinic or inpatient setting. Several residential factors have yet not been fully considered in the COPD literature, and this study will fill this gap by investigating relationships of socio-demographic, industrial and health system characteristics with COPD.

2. The risk factors of COPD

As with other lifestyle-related illnesses, there are many risk factors related to COPD. How and where people live their lives matters for the risk of illness. In most instances of COPD there are probably no single risk factor causing the disease, but rather multiple physiological, behavioural, environmental, and institutional risks. What complicates the disentanglement of their individual effects is the interdependence often found between them. Take, for instance, a well-documented behavioural risk such as smoking. As a group, smokers also have lower SES, which implies that they will likely have a different diet, they might be exposed to different environmental risks (prenatal exposure, pollution, occupational hazards, etc.) and perhaps even a different institutional context (the level and quality of health care) than non-smokers. Hence, the geography of COPD will in large part be determined by the spatial distribution of these interrelated risk factors.

In the following review of the current research we first treat explanations at the level of individuals, before moving on to environmental risk factors. Since many of these risks are related we will not discuss them entirely in isolation, but instead exemplify how they might relate to each other. However, to discuss every possible interaction between these risks is beyond the scope of the present paper. Clearly, the various factors linked to COPD may work both through structural and behavioural pathways, and there may be multiple factors at different levels (e.g. individual, community, municipality, etc.).

2.1. Individual factors

Tobacco smoking is established as a major risk factor of COPD in industrial countries (Whittemore et al., 1995; Pauwels et al., 2001; Tzanakis et al., 2004; Kohansal et al., 2009; Buist et al., 2007). It has been estimated that 73% of COPD mortality is related to smoking in high-income countries, with 40% related to smoking in nations of low and middle income (Lopez et al., 2006). However, emerging evidence now suggests that other risk factors are important as well (Salvi and Barnes, 2009; Zeng et al., 2012), and given the inability to control for smoking history in this study, these are the factors in focus here.

First of all, COPD prevalence, morbidity, and mortality increase with age (Buist et al., 2007). This is due to the lung function, which reaches its peak level in young adults, and starts to decline in the third and fourth decades of life (Fletcher et al., 1976). The role of gender in COPD is, on the other hand, controversial. Once thought of primarily as a disease of men, related to patterns of smoking and occupational exposures, COPD is now becoming equal in men and women in high-income countries in which smoking habits are similar between the sexes (Buist et al., 2007). Increasing tobacco consumption among women during the past several decades might explain some of this increase, but the relationship may be more complex, including factors such as differential susceptibility to tobacco, anatomic and hormonal differences, behavioural differences, and differences in response to available therapeutic modalities (Aryal et al., 2013).

Individuals with low SES tend to have a higher risk of developing COPD and its complications than their counterparts with high SES (Buist et al., 2007). However, given that SES is a surrogate measure for many factors that subsequently increase the risk of COPD, reviews limited specifically to the relationship between SES and COPD are thin on the ground. The risk factors linked to SES associated with COPD are usually thought to be prenatal exposure, poor nutritional status, poor housing conditions, exposure to community air pollution, smoking, and occupational exposure. Obviously, there may be multiple SES factors working at different levels (e.g., both individually and environmentally), and their pathways may be difficult to disentangle. As noted, smoking is the most important cause of lung disease, and there is a socioeconomic gradient in smoking behaviour, which is increasing (Prescott and Vestbo, 1999). Higher success rate in quitting is also associated with higher social class (e.g., Freund et al., 1992; Osler and Prescott, 1998). Furthermore, low birth weight has been linked to reduced lung function, respiratory infections, and asthma in children and adults (e.g., Chan et al., 1989; Seidman et al., 1991). The evidence is also strong on the association of low income and low education with COPD that cannot be explained by confounding by smoking (e.g., Chan-Yeung et al., 2007; Johannesen et al., 2005b; Kim et al., 2005; Lange et al., 2003; Prescott et al., 2003; Shin et al., 2003; Trupin et al., 2003; Zhong et al., 2007), although the extent to which this is due to occupation, air pollution, or other factors, remains unclear.

2.2. Environmental factors

As indicated, the SES factors may work at the environmental level as well as at the individual level. Community characteristics represent more than simply the sum of its parts, and hence SES may fail to protect even the health of well-off people if they live in socioeconomically disadvantaged environments. The additive effects of multiple demographic and socioeconomic factors have been demonstrated in several area studies. Lipton et al. (2005) analysed 1707 zip code tabulation areas in California for COPD hospitalisation rates and related hospitalisation charges, and found positive relationships for population age, percentage Hispanics, number of tobacco outlets and level of smoking, while negative relationships were found for higher education levels and increasing income in the communities. The same pattern was documented in a later study of changes in the geography of COPD hospitalisation charges in California in the period 1993–1999 (Lipton and Banerjee, 2007). Studying variations in COPD hospital admission rates in Victoria, Australia, Ansari et al. (2007), their analysis showed significant associations between COPD admission rates and the relative socioeconomic disadvantage and smoking rates of geographic areas. Nevertheless, due to the empirical approach and aggregated nature of these studies it remains unclear what the relative impact of individual effects and environmental effects are.

A link between prenatal exposure and respiratory disease has been suggested by several studies (e.g., Shaheen et al., 1995; Stein