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EPIDEMIOLOGY: What can we learn from geospatial analyses?

Daniela Fecht outlines how spatial epidemiology is helping unravel the link between environmental hazards and health risks

Where we live, be it rural, suburban or urban, has a strong impact on our health. The local environment in which we reside, work or socialise has both positive and negative influences that directly affect our bodies, but which also indirectly influence our health choices and behaviours. These influences are mostly due to the environment itself. Having easy access to parks or sports fields might encourage us physical exercise. On the other hand, air, soil or water pollution, traffic noise or light pollution that disrupts our sleep, increases our risk of disease.

Researchers estimate that nearly a quarter of all deaths worldwide can be linked to the environment.[1] In this context, environment includes chemical pollution (e.g. in air or water) and physical pollution (e.g. noise and radiation), man-made features such as housing or infrastructure, and life-style behaviours. It is the role of the public health workforce in each country to inform about and protect the public from these negative impacts and to advise on best practice. To do so, researches have to provide sound and comprehensive scientific evidence to support those recommendations and guidelines.

The local neighbourhood has a big impact on human health. One quarter of deaths worldwide can be link to the environment in which people live

Environment and health

Linking environmental exposures to specific diseases is difficult. Challenges arise, in particular, if the exposure is very low or acts over a long period of time. Such low levels of long-term exposures are difficult to establish. They cannot be ascertained easily with conventional pollution monitor, such as those used, for example, to measure air pollution levels in cities. It is even more difficult to prove a direct link between a pollutant and a disease.

The health risks associated with environmental pollution are often very small and accurate exposure estimates are, therefore, needed for very large populations to establish a direct link between a pollutant and a disease. Although individual health risks from environmental pollutants are small, given that they are pervasive and affect a large population - in the case of air pollution, the whole population – they are a huge public health concern.

The overall health burden, for example, on the health service or economic damage due to productivity loss because of an ill workforce, is potentially very large. The Environment, Health, Transport and Environmental Audit committees estimated in a joint report last month that air pollution alone cost the UK £20bn annually.[2]

Spatial epidemiology

One of the tools to help unravel a potential link between environmental hazards and

health risks is spatial epidemiology. The latter concerns itself with describing spatial patterns and geographical variations in population health and the environment.

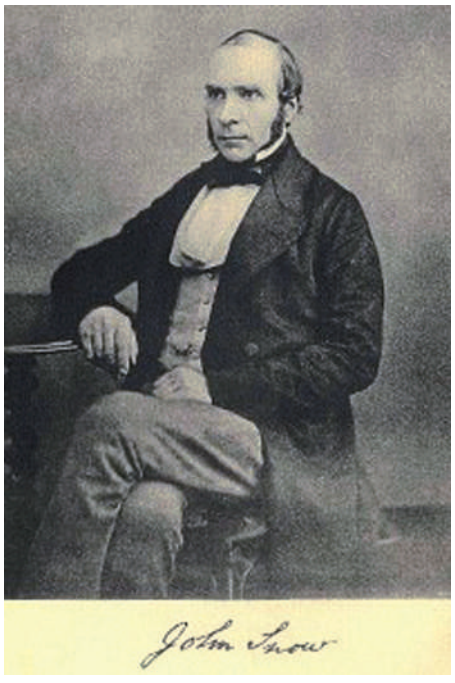
An early pioneer in using geographical patterns to establish a link between environmental factors and disease was John Snow, now considered to be the father of spatial epidemiology. Snow used an 1854 outbreak of cholera in Soho, Greater London, to test his hypothesise about the mode of transmission of cholera after plotting cases of this infectious disease on a map.

He consequently disproved the previously established 'miasma' (bad air) theory which assumed that cholera was airborne. As this example shows, spatial epidemiology is particularly useful to formulate hypothesis about disease aetiology.

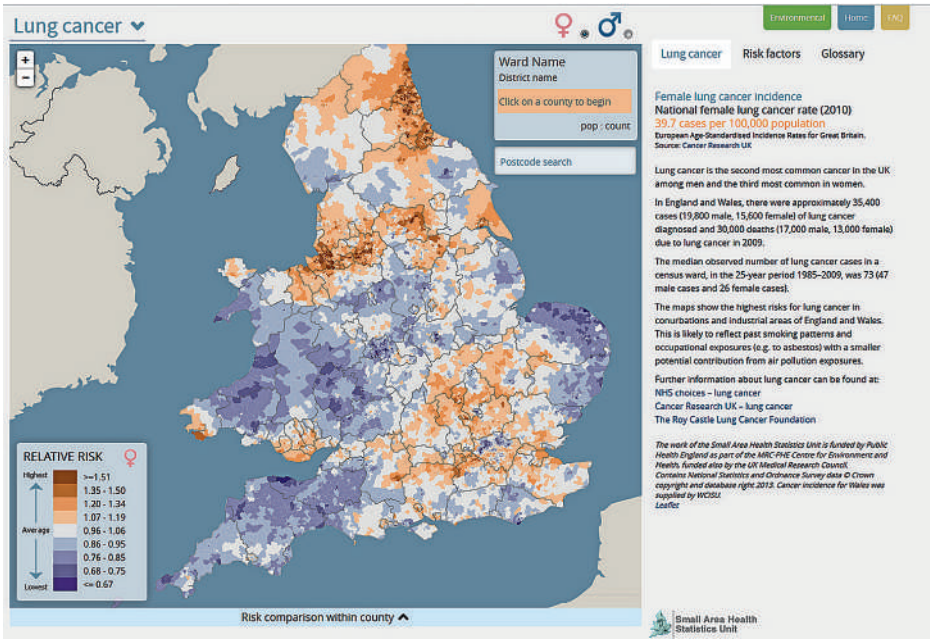
By taking into account the spatial variation of environmental hazards together with that of disease, new environmental risk factors can be identified. Such geographical studies have the advantage that they can cover large populations, many countries or continents, with larger frequency of disease and a wider contrast of environmental exposures. The annual average temperature range globally is, for example, much larger than that within the UK. There are two types of studies frequently used in spatial epidemiological: disease mapping and ecological studies.

Disease mapping

Disease maps show the geographical variation of disease and health conditions. They cannot, in themselves, explain geographical patterns, but can be used to identify hypotheses of disease occurrence and to provide useful information to guide policy-makers. Disease maps also provide a baseline picture to compare past or future disease maps and are, therefore, an essential tool for spatial and temporal disease surveillance.



John Snow, the father of spatial epidemiology



Online version of The Environment and Health Atlas produced by the UK Small Area Health Statistics Unit. The map shows lung cancer incidence risk for Women in England and Wales. The atlas is accessible via the website: http://www.envhealthatlas.co.uk/ Users are able to input a postcode and toggle between maps of environmental agents and health conditions

The methods used for disease mapping have greatly improved in recent years thanks to advances in geographical and statistical techniques, as well as the availability of spatial health and environmental data. In 2014, the UK Small Area Health Statistics Unit (SAHSU), Imperial College London, published The Environment and Health Atlas for England and Wales. This provides maps on the geographical variation for long-term risks relating to 14 health conditions and levels of five environmental agents. The data is at a small-area scale (census wards) and contains a summary on what is known about possible health effects associated with the environmental agents mapped in the atlas.

The atlas uses routinely collected health data, including mortality and cancer statistics, from the Office for National Statistics and the Welsh Cancer Intelligence and Surveillance Unit. Although, disease maps such as those shown in the atlas, are very useful in portraying the geographical distribution of disease, they cannot be used on their own as evidence of disease clusters or to make causal links between environmental and health.

Ecological studies

Ecological studies, sometime called geographical correlation studies, describe the relationship between the level of environment exposure to a specific agent or physical feature and the frequency of a disease.

Such studies typically use small spatial areas of a few thousand inhabitants, such as neighbourhoods or wards, as the basic unit of analysis, rather than individual people. To do so, both disease occurrences and environmental exposure need to be linked to the small area. This is done via the place of residence. Routinely collected health data register the place of residence at the time of diagnosis or occurrence of a health-related event, e.g., an admission to hospital. SAHSU uses geographic information systems (GIS) to connect people to places and link these to environmental exposures. With the help of sophisticated spatial models, SAHSU then assigns levels of population exposure to the small area.

Historically, the distance from a residence to an exposure source such as an industrial plant or landfill site was used to establish exposure. The availability of sophisticated exposure models and high-quality spatial data on environmental pollution including satellite images on light at night, vegetation patterns, or aerosol optical depth, allow for harmonised high-quality exposure assessment across large geographical areas. Remotely sensed data are now extensively used for spatial epidemiological purposes to determine global risks to human health via climate change or environmental pollution in particular in low and middle-income countries where such studies were previously not possible.

[1] https://academic.oup.com/jpubhealth/article/39/3/464/3003007
[2] http://www.bbc.co.uk/news/uk-politics-43405684

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