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# Using matched areas to explore international differences in population health

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ABSTRACT

In this paper, we develop and test a method for examining the influence of national level contextual influences on population health. Acknowledging calls for the use of experimental study designs to explore contextual influences on health, we develop a study design in which sets of local areas from Britain and Belgium became akin to two ‘treatment’ groups; one exposed to British society and culture and the other exposed to Belgian society and culture. The areas are matched on the basis of showing very strong similarities in economic, demographic and historical characteristics. Data describing these characteristics are obtained from national census data. A principal component analysis of these variables permits areas in Britain and Belgium with similar scores on the resulting components to be matched into pairs. A sequence of logistic regression models identifies between-country difference in the risk of reporting poor health. Our final model compares the risk of reporting poor health among Belgians and people from Britain living in similar local contexts, adjusting for any residual differences in individual level characteristics. We compare results from this new method with those from more conventional approaches. All approaches show that residence in Britain is associated with a substantial and significantly higher risk of reporting poor health for both men and women, after adjustment for both individual and local contextual influences. We then critically reflect on our method and on the context-composition framework for research into area variation in health. We conclude that whilst our approach succeeded in applying the idea of comparable groups with different exposures to an observational, international comparison, it also brought associated questions about external validity and the extent to which a sample of matched areas captures a ‘national’ context.



## Introduction

This paper is drawn from a wider study examining health inequalities in Belgium (TAHIB, 2006). One component of the project was to compare health inequalities within and between two countries; Belgium and Britain. The wider study was focused on the impact of residence in Belgium or in Britain on the health consequences of providing informal care. For this paper, which explores methodology, our focus is on self-reported poor health only. In the paper we develop a method for making international comparisons and for trying to weigh the extent to which variation in health and associated characteristics between residents of differing countries is a property of the societies in which they live.

The majority of existing international comparison studies fall into one of four methodological categories. First is the genuinely ecological analysis in which the variables of interest are summary measures for each nation state. Good examples of this approach are analyses focused on the relationships between GDP, income inequality and aspects of health. Pickett, Kelly, Brunner, Lobstein, and Wilkinson (2005) and Wilkinson and Pickett (2007), for example, present a number of analyses in which single summary measures for a variety of countries are related to each other. Suppose, for example, that a study was comparing the relationships between wealth and health across several different countries. In an ecological analysis, each country would be represented in the study by a number which captured its economic performance (GDP per capita for example) and a number which captured its health (average life expectancy for example).

The second design is also ecological, but compares the small area populations (such as those of neighbourhoods) in different

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countries rather than country populations as a whole. To continue our example of assessing the association between wealth and health, this study design would deploy measures of health for neighbourhoods in different countries, and measures of their wealth. Analysis might examine whether the neighbourhood level association between wealth and health varied between countries. This study design is often employed for studies within single countries, and is perhaps the least commonly deployed of the four for international comparisons. International comparison examples include McPherson, Wennberg, Hovind, and Clifford (1982), Salvador et al. (2008) and Curtis et al. (2006).

The third design involves analyses of individual level data. To continue our example again, this kind of study would have data about many individuals from each country, describing how wealthy and how healthy these individuals are. Relationships between wealth and health would be derived for each country by studying the individuals who live in that country; then the relationships for each country would be compared. In this case, we might find a closer relationship between wealth and health in some countries than in others. Comparing individuals from different countries permits an analysis of whether associations between exposure and outcome variables vary between populations living in different countries. Classic examples of these kinds of studies are those from Mackenbach and colleagues who have drawn together data about individuals from across Europe and examined between-country variation in associations between socio-economic status and health (Kunst & Mackenbach, 1994a, 1994b; Mackenbach et al., 2003; Mackenbach, Kunst, Cavelaars, Groenhof, & Geurts, 1997).

The fourth approach is to put data about individuals from different countries together in a single model and determine whether a statistical association between the health outcome and country of origin remains, after control for other confounding factors. This approach is less common, but arguably more methodologically sound (Stafford, Martikainen, Lahelma, & Marmot, 2004; van Lenthe et al., 2005). So, to continue our example, we would have data on wealth and health for individuals from all countries of interest in a single model. We would establish a relationship between wealth and health, and then determine whether country of origin added to an explanation of this relationship. We might also determine if there was a statistical interaction such that the relationship between wealth and health at an individual level varied by country of origin. Furthermore, where the data have a spatial structure (i.e. individuals are clustered within local areas and within countries), the model could be multilevel. This would enable us to explore the extent to which health outcomes in similar local contexts vary between national settings (Duncan, Jones, & Moon, 1998; Macintyre, Ellaway, & Cummins, 2002; Pickett & Pearl, 2001). Multilevel models are considered by some to be the most appropriate approach to examining the influence of genuinely ecological characteristics on the health of individuals (Subramanian, Jones, Kaddour, & Krieger, 2009b).

An influential, if now slightly dated (Cummins, Curtis, Diez-Roux, & Macintyre, 2007) theoretical framework for thinking about how health and why health varies from area to area, separates influences on health into 'compositional' and 'context' (Macintyre et al., 2002, 1993; Shaw, Dorling, & Mitchell, 2002). Composition refers to the fact that individuals all have characteristics such as age, sex, genetic endowment, wealth and behaviour, which may elevate or lower their risk of poor health. Context refers to influences on health which operate over and above individual characteristics. Factors such as air pollution, the health service and local cultures are good examples. Composition puts the understanding of why health varies from area to area at the level of individuals. Context puts the understanding of why health varies from area to area beyond the level of the individual and connects it to the social economic and physical environment in which they live. Contextual influences on health have been detected in both developed and developing countries, at a variety of spatial scales (Msisha, Kapiga, Earls, & Subramanian, 2008; Pickett & Pearl, 2001; Santos, Chor, Werneck, & Coutinho, 2007). The majority of this work is however intra-national, exploring for example how similar individuals compare across different local settings where service provision varies. Often, international comparison is asking whether contextual influences (presumed to operate at a national level) have an influence on health. In our case, although Belgium and Britain are two relatively similar western, wealthy nations, there are social, economic, political, welfare state and environmental differences between them (Bambra, 2007; Kautto, 2002). It was the influence on health of these contextual aspects of life in Britain or Belgium which our study was interested in exploring.

The apportionment of influence between composition/context has been challenged in both statistical and theoretical terms (Cummins et al., 2007; Macintyre et al., 2002; Mitchell, 2001; Oakes, 2004b). In literature less dominated by epidemiological approaches, (social geography for example) a more nuanced and flexible framework to understanding people and place has emerged (Cummins et al., 2007). In other literature however, the debate continues. Oakes for example, (Oakes, 2004a, 2004b, 2006, 2009) has been a vocal critic of the multilevel approach to examining neighbourhood influences on health pursued by some researchers (Subramanian, Jones, Kaddour, & Krieger, 2009a, 2009b).

Oakes' solution is to call for the use of experimental designs, and randomised community trials in particular. So, for example, if we want to know whether the walkability of a neighbourhood influences health, Oakes suggests experimentally changing the walkability of a group of neighbourhoods and comparing changes to health there with control neighbourhoods in which walkability does not change. That presents a problem for international comparison studies. Clearly, we could not randomly allocate individuals to 'be Belgian' or 'be British' and observe their subsequent health status.

The 'natural experiment' is an alternative to the use of fully randomised trials which retains elements of experimental design (Petticrew et al., 2005). In this case, changes to employment structure, housing provision, service redesign or neighbourhood redevelopment can be exploited by comparing what happens to areas and populations that experience this change, with those which are similar but do not experience the change. Natural experiments permit investigation of the influence of contextual determinants of health, which cannot easily be altered or allocated at random, and which are not perhaps malleable by an academic team through the usual route of project funding (Petticrew et al., 2005).

Experimental studies are partly defined by comparison of any impacts of change between recipient and control groups. In our study, focused on the impact of a national level context, we did not have any change to exploit. Yet, we were inspired by these ideas and wondered whether we could carry out an observational study which borrowed some elements of its structure from experimental design.

Our design took from and developed an approach and techniques from the second, third and fourth type of study outlined above. We proposed to match a subset of geographical areas from Britain with those in Belgium which were demographically, socially and economically very similar. Our intention was to identify areas, and thus populations, which could plausibly belong in either country. This was, in some limited ways, akin to creating two alternative 'treatment' groups; one exposed to British society and culture and the other exposed to Belgian society and culture. By comparing health in subjects from these matched areas (controlling for any remaining individual level differences between subjects resident in the matched areas) we move closer to making a comparison between similar groups of people, in similar types of area where the key difference was that one group was exposed to Belgian society and the other to British society. It is important to be clear that this approach did not compare two whole countries; it compared parts of two countries which have many features in common.

A further advantage of our approach was that it would allow us to recognise the potential influence of local context on health, as well as national level context. To assess the utility of our innovation we compared results with those from a more conventional approach which included people from all areas in Britain and Belgium, and which controlled for individual level differences.

## Methods

### *Design*

Our approach was in 7 stages

i) select 'local' areal units for use in analysis
ii) select variables which describe social, economic and historical characteristics of areas within Britain and Belgium
iii) undertake a principal component analysis of these variables to summarise area characteristics
iv) look for areas in Britain and Belgium with similar scores on the resulting components and match them into pairs
v) select data describing health and covariates for the British and Belgian populations, at an individual level
vi) run a variety of models exploring between country-differences in health for the whole British and Belgian populations, and for only those residents in the matched areas
vii) compare model results

### *Selecting areal units*

International comparisons which include sub-national areal units can be hampered by the comparability of the areal units. The areal units used in this study were Local Authority Districts in Britain, and Arrondissements in Belgium. Local authority districts represent the administrative level at which a large component of social care services (a key focus of the wider project comparing Britain and Belgium) is organised in Britain. Belgian Arrondissements were the level most comparable in size to local authorities. However, Brussels is a single arrondissement, whereas London is composed of several different local authorities. Pilot work showed that none of the Inner London local authorities (Camden, Hackney, Hammersmith and Fulham, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark, Tower Hamlets, Wandsworth, City of Westminster, Haringey and Newham) were a good match for a Belgian arrondissement individually. We therefore merged these local authorities into a single unit 'Inner London', expecting that it might be comparable with Brussels. Six local authority districts were excluded because they contained too few people to make potential comparisons with Arrondissements. This gave a final total of 433 areas, 390 in Britain and 43 in Belgium from which to identify matching pairs.

### *Selecting data to describe area characteristics*

Both countries undertook national censuses in 2001 and, for the purposes of identifying matching pairs of areas, data describing the 433 areas were drawn from aggregate tabulations of census variables. It is important to note that these data were based on complete census enumeration, not aggregated micro samples. We wanted to select variables describing features of the areas which existing literature suggested could be associated with risk of poor health. However, we also had to select variables from the two censuses which were identical or comparable. Seven variables were selected. Two variables represented labour market conditions in the areas; the percentage of those aged 25–54 in work and the percentage working full time. Working full time was included because Britain has an unusually high degree of female part-time labour which could have masked differences in the labour market if the indicator was simply employment rates. Level of education is also related to health per se. This was represented by the percentage of people aged 25–64 with a higher education (i.e. post secondary school) qualification. The broad demographic characteristics of the area and typical life stage of the resident population were captured by a ratio of the number of individuals aged less than 25 to those aged 65 and above. Settlement characteristics, such as level of urbanity and economic importance, were captured by population size and population density. Finally, both countries have concentrations of health, social and economic problems in areas formerly dominated by heavy industries such as mining and manufacturing. In Britain, there is evidence that the population still living with the effects of working in such industries and then the effects of subsequent unemployment, are also those in which levels of poor health are high (Mitchell, Gleave, Bartley, Wiggins, & Joshi, 2000). To identify areas with an industrial past in both countries, the percentage of working population employed in energy, mining or water industries in 1981 was extracted from 1981 census data using geographical boundaries which were consistent with those from 2001. This variable added an aspect of historical context to the matching characteristics. In the Britain, the 1981 census provided this information for a 10% sample of the enumerated population of each area.

### *Undertake principal component analysis to summarise area characteristics*

As expected, the seven variables capturing area characteristics were highly correlated. A principal component analysis reduced the variables into a smaller number of uncorrelated factors, with weighting allowing for the larger number of areal units in the British data than in the Belgian data. Three factors had eigen values larger than 1.0 and the loadings of each variable to these factors are shown in Table 1.

Factor 1 was most highly correlated with labour market characteristics, factor 2 with age structure and population density and factor 3 with education and population size and (inversely) with industrial history.

### *Look for areas in Britain and Belgium with similar scores on the resulting components and match them into pairs*

This step aimed to match areas in Britain and Belgium which had very similar local contextual characteristics. Whilst differences in local characteristics intra-pair should be minimal, differences inter-pair were useful for including a range of local social and economic contexts in the two countries.

We computed the Euclidian distance between each British local authority district and each Belgian arrondissement from their respective coordinates on the three factorial axes. The distance was weighted by the part of variance explained by each factor, i.e., 0.41, 0.30 and 0.29 respectively. Using a purposive sampling frame, we selected a subset of 16 Belgian arrondissements which reflected a range of area types in Belgium (older and younger demographic profiles, healthier and less healthy labour markets) and identified the three 'nearest' British local authorities; that is to say, the 3 which appeared most similar in regard to their relative factor scores. The research team then collaborated on making a 'human'

**Table 1**
Results from principal component analysis of area descriptor data.

| | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| Part of total variance explained | 0.30 | 0.22 | 0.21 |
| Weight (part of the variance explained by the 3 factors) | 0.41 | 0.30 | 0.29 |
| Loadings | | | |
| Percentage of population aged 25–54 who are working full time among the population 25–54 | 0.943 | 0.001 | 0.218 |
| Percentage of population aged 25–54 who are working | 0.943 | −0.174 | 0.042 |
| Percentage with higher level qualifications | 0.369 | 0.133 | 0.700 |
| Ratio of population aged <25 to those aged 65+ | 0.070 | 0.848 | −0.149 |
| Population density | −0.255 | 0.710 | 0.315 |
| Population | −0.239 | 0.419 | 0.669 |
| Percentage of working population in 1981 employed in Energy, Mining or Water industries | −0.189 | 0.285 | −0.631 |

$n = 433$ areas, 390 from Britain and 43 from Belgium. Varimax rotation.

choice from the 3 ‘statistically identified’ candidate matches. This was felt to enhance the matching by, for example, pairing areas that were thought to have a similar ‘feel’ or had some other similarity in geographical context which had not been included in the matching variables; a location on the coast for example. In fact, in all but 5 cases, the closest match in statistical terms was selected. In the 5 cases, the second closest match was chosen. Table 2 shows the areas that were matched together, how similar they were on various characteristics, and the Euclidean distance between them. Fig. 1 summarises the Euclidean distances for all matched pairs, and shows how these relate to the mean distance between matched pairs and to the ‘global mean’, which is the mean distance between all 43 Belgian arrondissements and their nearest British match. Note that, despite our expectations, Brussels was not matched to London. Birmingham was a much better match in terms of the characteristics examined. We now had 16 pairs of areas. The residents of each pair of areas lived in different countries but in areas with similar social, economic and demographic contexts. The pairs reflected a range of area types, but types of area found in both countries.

Our study design did not require the sub-samples of matched areas to be representative of all areas in the two countries. Indeed, the process of choosing areas from two countries that were similar to each other was likely to render the samples somewhat distinct from their host nations. To understand the relationship between the matched sub-samples and their wider nations, it was useful to compare the aggregate characteristics of the whole nations and matched areas on several criteria. Table 2 shows broad similarity, with the exception of educational attainment (where the population resident in British matched areas were more likely to have higher attainment).

*Select data describing health and covariates for Britain and for the Belgian population at an individual level*

We used individual data from the 2001 censuses in Britain and in Belgium. The British data came from a 5% sample of the 2001 UK census. The Samples of Anonymised Records (SARs) scheme provides researchers with access to anonymised individual level census responses (Cathie Marsh Centre for Census and Survey Research, 2004). The Belgian data included all the individuals residing in the country in 2001. In both countries, the analysis was restricted to members of private households aged 25 to 59 (1,361,222 individuals in Britain, and 4,368,637 individuals in Belgium). The age restriction reflected the wider project for which

**Table 2**
Matched areas and their characteristics.

| Belgium | | | | | | Britain | | | | | | Distance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Working | High educ | Age ratio | Mining | Pop density | Name | Working | High educ | Age ratio | Mining | Pop density | |
| Brussels | 71.1 | 34.7 | 1.8 | 0.8 | 5928.7 | Birmingham | 68.2 | 19.4 | 2.5 | 1.3 | 3648.9 | 1.04 |
| Bastogne | 78.3 | 25.1 | 2.3 | 0.3 | 39.3 | Colchester | 79.6 | 21.7 | 2.2 | 1.4 | 449.3 | 0.13 |
| Virton | 78.5 | 29.7 | 2.0 | 0.5 | 62.7 | Worthing | 81.8 | 19.9 | 1.2 | 2.8 | 2790.4 | 0.19 |
| Maaseik | 78.2 | 23.0 | 2.5 | 6.6 | 248.8 | Durham | 79.3 | 20.6 | 2.1 | 7.3 | 469.8 | 0.15 |
| Leuven | 84.5 | 37.5 | 1.6 | 1.0 | 392.2 | St Albans | 83.6 | 41.6 | 2.0 | 1.6 | 800.4 | 0.51 |
| Hal-Vilvorde | 86.1 | 35.2 | 1.7 | 1.5 | 590.5 | Richmond upon Thames | 83.4 | 34.7 | 1.9 | 1.7 | 2932.5 | 0.56 |
| Anvers | 79.0 | 29.1 | 1.6 | 2.2 | 928.2 | Edinburgh | 78.5 | 44.7 | 2.0 | 2.2 | 1705.3 | 0.67 |
| Dixmude | 83.1 | 19.5 | 1.7 | 0.5 | 131.3 | Bridgnorth | 83.4 | 22.8 | 1.7 | 2.0 | 82.9 | 0.11 |
| Courtrai | 84.3 | 27.6 | 1.7 | 1.0 | 682.6 | Warwick | 83.4 | 33.7 | 1.8 | 1.0 | 445.2 | 0.04 |
| Charleroi | 64.6 | 19.4 | 1.8 | 2.4 | 751.5 | Liverpool | 70.7 | 14.1 | 1.8 | 1.3 | 3290.9 | 0.84 |
| Thuin | 69.5 | 24.0 | 1.8 | 2.1 | 155.5 | Swansea | 72.2 | 21.8 | 1.7 | 3.8 | 530.2 | 0.18 |
| Nivelles | 79.8 | 42.0 | 2.2 | 1.2 | 321.0 | Elmbridge | 80.7 | 38.2 | 1.8 | 2.3 | 1265.6 | 0.36 |
| Gand | 83.0 | 33.7 | 1.7 | 1.9 | 523.3 | East Renfrewshire | 81.4 | 41.6 | 2.0 | 1.8 | 513.0 | 0.40 |
| Alost | 84.2 | 26.4 | 1.5 | 0.8 | 554.7 | Winchester | 83.4 | 35.8 | 1.8 | 1.3 | 162.2 | 0.11 |
| Namur | 75.8 | 29.4 | 2.0 | 1.8 | 242.9 | South Lanarkshire | 75.4 | 26.7 | 2.0 | 2.3 | 171.4 | 0.14 |
| Liège | 69.4 | 26.2 | 1.6 | 1.5 | 734.3 | Dundee | 69.7 | 27.8 | 1.8 | 1.7 | 2453.6 | 0.70 |
| Sample mean[a] | 78.1 | 28.9 | 1.8 | 1.2 | 767.9 | Sample mean | 78.4 | 29.1 | 1.9 | 1.9 | 1128.4 | 0.38 |
| Country characteristics | | | | | | Country characteristics | | | | | | |
| Mean[b] | 78.5 | 26.8 | 1.8 | 1.6 | 469.2 | Mean | 78.9 | 21.8 | 1.9 | 3.3 | 1005.2 | 1.23 |
| Std | 5.4 | 4.7 | 0.2 | 1.8 | 880.9 | Std | 4.7 | 7.2 | 0.4 | 4.0 | 1247.4 | 0.38 |

Columns give the % of working population aged 25–59 in 2001 (Working), the percentage of individuals with post secondary education aged 25–64 in 2001 (High educ), the ratio of people aged under 25 to over 64 in 2001 (Age ratio), the percentage of working population employed in energy, mining or water industries in 1981 (Mining), the number of inhabitants per squared kilometre in 2001 (Pop density).

[a] Sample mean corresponds to the mean value for the sub-sample of matched areas.

[b] Mean corresponds to the country mean value for working, high educ, age ratio, mining and pop density, and to the mean distance between each Belgian arrondissement and all British local authorities for the distance variable.

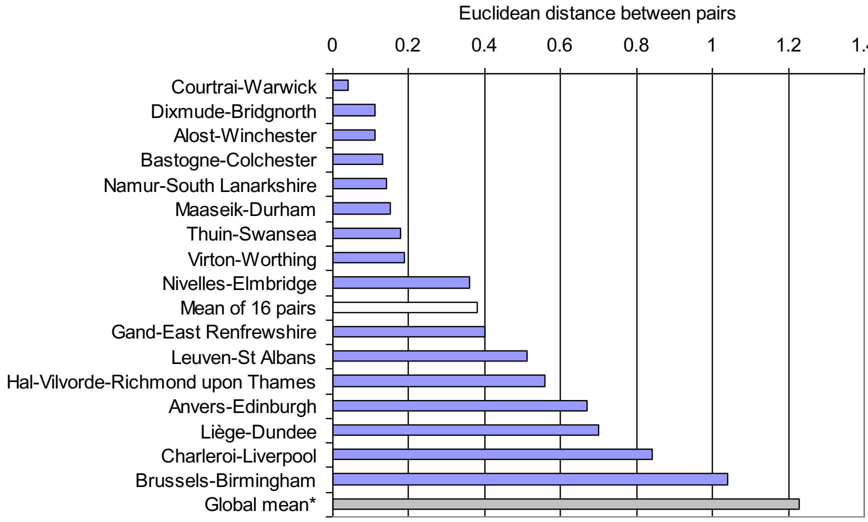


**Fig. 1.** Euclidean distance between matched pairs, mean distance between all matched pairs, and mean distance between all 43 Belgian Arrondissements and their closest British match. *mean distance between all 43 Belgian Arrondissements and their nearest British match.

this methodology was developed. It was focused on the provision of informal care, the majority of which is carried out by working age people.

Both censuses included a measure of self-rated health, but there was a difference between countries in the exact wording of the question used. The UK census included a three item question ('good', 'fairly good' and 'not good') and the Belgian census a five item question ('very good', 'good', 'average', 'bad' and 'very bad'). For purpose of comparison, respondents who reported 'not good' health in Britain and 'bad' or 'very bad' health in Belgium were regarded as having poor health (Farfan-Portet, Popham, Mitchell, Swine, & Lorant, 2010).

Information was also gathered on covariates. These were economic activity, housing tenure, education, family structure, age group and sex. A series of questions was asked in both censuses to describe a person's economic activity status. People were categorised as being employed, unemployed (but actively seeking employment) or economically inactive (not actively seeking employment). Other measures of socio-economic position known to be related to health status were also used: housing tenure and education (Mackenbach, van den Bos, Joung, van de Mheen, & Stronks, 1994). A person's housing tenure (Galobardes, Shaw, Lawlor, Lynch, & Smith, 2006) was categorised as owner occupied, privately rented or socially rented. For education, we used a modified version of the ISCED classification for both countries following the framework used in the most recent European comparative studies of social inequalities in health (Mackenbach et al., 2003). Family structure is also known to be related to health and well-being (Everson-Rose & Lewis, 2005). It was categorised as living alone, married or cohabitant without children, married or cohabitant with children and lone parent as reported in the censuses. Finally, age was categorised 25 to 29, 30 to 39, 40 to 49 and 50 to 59 for both countries. These were the smallest age ranges available in the British SARs 5% sample. All data were available separately for men and women.

Table 3 shows that the characteristics of individuals resident in the matched area sub-sample was broadly similar to their wider nation, again with the noted exception of greater educational attainment among those in Britain's matched areas.

*Modelling sequence*

A sequence of logistic regression models was run separately for men and women. This was because previous research shows both the prevalence of self-rated poor health, and its association with covariates, tends to differ between men and women (Crimmin et al., 2011). All models were adjusted for age. The modelling sequence is described in Table 4.

Model 1 established the 'overall' observed difference in the risk of reporting poor health, without attempt to adjust for anything other than age structure. Model 2 established the between-country difference in the risk of reporting poor health, once differences in the individual characteristics of the populations were taken into account. Model 3 repeated model 2 but included only people living in the matched areas. It thus controlled for any between-country differences in terms of the types of local area. Model 4 repeated model 3, but also took account of inter-pair differences in contextual characteristics via a fixed effects component. By using matched pairs of areas, and by adjusting for the fact that some types of area might exert greater or lesser influence on the health of their residents, we believed that model 4 removed the influence of individual characteristics and local contextual characteristics on the between-country differences in risk of reporting poor health.

The research was undertaken 2008–2010. We did not require ethical approval for the analysis of these anonymised or aggregate secondary data sets.

## Results

Table 5 presents the four model results for men, and Table 6 presents them for women. The key item of interest in model 1 in both Tables 5 and 6 is the 'Country effect' which describes difference in the risk of reporting poor health between which was associated with country of residence. It is important to be clear that the term 'country effect' is used here to describe a statistical association between country of residence and risk, not to claim a causal relationship.

The ratio of 1.918 in model 1, Table 5 means that, after taking account of the differing age structure of the population in the two nations, the odds of reporting poor health among men living in Britain were just under twice those of men living in Belgium. A similar difference was also seen for women, with those living in Britain just over twice as likely to report poor health as women living in Belgium. In model 2, for men, the results showed that being older, increasing levels of domestic isolation, being out of work (and especially economically inactive, that is to say not seeking work), renting your home and having lower levels of

**Table 3**
Comparison of whole and sub-sample population characteristics.

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Belgium | | Britain | | Belgium | | Britain | |
| | All areas | Matched areas | All areas | Matched areas | All areas | Matched areas | All areas | Matched areas |
| N | 2,212,059 | 1,294,101 | 669,824 | 42,122 | 2,156,577 | 1,278,917 | 691,398 | 43,614 |
| Health status (%) | | | | | | | | |
| Bad health | 4.4 | 4.5 | 8.1 | 9.1 | 4.5 | 4.7 | 8.9 | 9.7 |
| Not bad health | 95.6 | 95.5 | 91.9 | 90.9 | 95.5 | 95.3 | 91.1 | 90.3 |
| Age (%) | | | | | | | | |
| 25–29 | 13.0 | 13.3 | 13.4 | 13.8 | 13.3 | 13.4 | 13.6 | 14.4 |
| 30–39 | 31.3 | 31.3 | 32.0 | 32.7 | 31.3 | 31.2 | 32.4 | 32.7 |
| 40–49 | 30.7 | 30.6 | 28.1 | 28.3 | 30.7 | 30.6 | 27.9 | 28.3 |
| 50–59 | 25.0 | 24.9 | 26.5 | 25.1 | 24.7 | 24.8 | 26.1 | 24.6 |
| Family type (%) | | | | | | | | |
| Married with children | 58.7 | 57.0 | 50.5 | 49.0 | 56.4 | 54.4 | 47.1 | 45.4 |
| Married without children | 20.2 | 19.9 | 25.0 | 22.6 | 21.4 | 20.9 | 25.9 | 23.2 |
| Lone parent | 5.2 | 5.2 | 5.0 | 5.6 | 11.3 | 12.1 | 13.6 | 15.8 |
| Alone | 15.9 | 17.9 | 19.5 | 22.8 | 10.9 | 12.6 | 13.4 | 15.6 |
| Tenure (%) | | | | | | | | |
| Owner | 75.0 | 72.1 | 75.2 | 73.5 | 74.7 | 72.1 | 73.6 | 71.7 |
| Private rent | 20.5 | 23.1 | 11.0 | 10.9 | 19.4 | 21.7 | 10.1 | 10.2 |
| Social rent | 4.5 | 4.7 | 13.8 | 15.6 | 5.9 | 6.2 | 16.4 | 18.1 |
| Activity (%) | | | | | | | | |
| Employed | 84.1 | 83.6 | 83.3 | 80.1 | 65.0 | 65.1 | 69.5 | 67.5 |
| Unemployed | 5.8 | 6.6 | 4.6 | 5.7 | 8.9 | 9.3 | 2.8 | 3.0 |
| Inactive | 10.1 | 9.9 | 12.1 | 14.2 | 26.1 | 25.5 | 27.7 | 29.5 |
| Education (%) | | | | | | | | |
| Post secondary | 31.2 | 33.9 | 24.6 | 31.1 | 33.7 | 35.9 | 23.7 | 29.0 |
| Upper secondary | 30.2 | 29.1 | 7.5 | 9.3 | 29.0 | 28.4 | 7.4 | 8.9 |
| Lower secondary | 24.4 | 23.1 | 36.1 | 30.1 | 22.8 | 21.7 | 39.2 | 32.9 |
| Less than lower secondary | 14.2 | 13.9 | 31.8 | 29.6 | 14.5 | 14.0 | 29.7 | 29.2 |

education all increased the risk of reporting poor health. The country effect fell to 1.715 for men (a significant fall in excess risk of 0.203) and to 2.010 for women (a significant fall in excess risk of 0.095).

Model 3 only included people resident in the matched areas. This means the odds ratios in models 2 and 3 are not strictly comparable because the models contain different populations. However, it is worth noting that the odds ratio for the country men and women in the matched areas were slightly lower than for the entire population, at 1.676 and 1.885 respectively. Finally, in model 4 where differences in contextual characteristics between the pairs of areas were also taken into account, the country effect shrank rather more for men, to 1.522 (a significant fall in excess risk of about 0.154) and to 1.756 for women (a fall in excess risk of about 0.129). These results suggest that the British matched area sample contained more people resident in areas where the contextual characteristics were likely to have a greater adverse effect on health. Even after adjustment for this, however a substantial excess risk of reporting poor health remained associated with 'living in Britain' for both men and women resident in the matched areas.

## Discussion

In this study, we explored the extent to which health outcomes in similar local contexts vary between national settings. We explored and developed a method which selected areas within the two countries that were matched for having very similar local contextual characteristics and then compared risk of reporting poor health among their resident populations. We presented results from a conventional modelling approach in which the population from all areas in the two countries was represented in the model, and contrasted these with results from our matching approach. Both the conventional approach and the matched areas approach suggested that living in Britain was associated with significantly greater risk of reporting poor health than living in Belgium.

Whilst this substantive result is interesting, it is not the specific focus of this paper. The key question for us is whether our new approach made any real difference to the results obtained and whether our approach is consistent with theories of how place influences health.

Our approach is rooted in, and has extended, the fundamental idea that local context should be taken into account in research on determinants of health, and in policies to improve it (Cummins et al., 2007; Curtis & Jones, 1998). What does our method add? First, it arguably succeeds in borrowing elements from 'experimental' study design, particularly that of having two comparable groups with different exposures, to an observational international comparison. A matching approach has also been deployed in natural or quasi-experimental studies (see for example, Tudor-Smith, Nutbeam, Moore, & Catford, 1998 and Secker-Walker,

**Table 4**
Modelling sequence (all models adjust for age).

| Model | Includes all British and Belgian population? | Includes just the population resident in matched areas? | Adjusts for differences in individual characteristics associated with health? | Adjusts for differences in type of area that each pair represents? | N m = men f = women |
|---|---|---|---|---|---|
| 1 | ✓ | | | | *m*2,881,883 *f*2,847,975 |
| 2 | ✓ | | ✓ | | *m*2,881,883, *f*2,847,975 |
| 3 | | ✓ | ✓ | | *m*1,336,223, *f*1,322,531 |
| 4 | | ✓ | ✓ | ✓ | *m*1,336,223, *f*1,322,531 |

**Table 5**
Odds of reporting poor health, by gender, derived from logistic regression models containing populations from both Britain and Belgium (men).

| Men | Model 1 All areas, age only | | | Model 2 All areas, all individual covariates | | | Model 3 Matched areas, all individual covariates | | | Model 4 Matched areas, area dummies | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] |
| *Britain (ref : Belgium)* | 1.918 | <0.001 | 1.897–1.939 | 1.715 | <0.001 | 1.693–1.738 | 1.676 | <0.001 | 1.611–1.745 | 1.522 | <0.001 | 1.462–1.585 |
| *Age (ref: 25–29)* | | | | | | | | | | | | |
| 30–39 | 1.538 | <0.001 | 1.500–1.578 | 1.682 | <0.001 | 1.638–1.728 | 1.772 | <0.001 | 1.699–1.848 | 1.790 | <0.001 | 1.716–1.868 |
| 40–49 | 2.854 | <0.001 | 2.785–2.925 | 2.785 | <0.001 | 2.714–2.859 | 2.894 | <0.001 | 2.779–3.014 | 2.939 | <0.001 | 2.822–3.062 |
| 50–59 | 5.004 | <0.001 | 4.885–5.125 | 2.242 | <0.001 | 2.184–2.301 | 2.083 | <0.001 | 1.998–2.171 | 2.137 | <0.001 | 2.050–2.228 |
| *Education (ref: post secondary)* | | | | | | | | | | | | |
| Upper secondary | | | | 1.463 | <0.001 | 1.433–1.493 | 1.528 | <0.001 | 1.485–1.573 | 1.535 | <0.001 | 1.491–1.580 |
| Lower secondary | | | | 1.719 | <0.001 | 1.688–1.751 | 1.925 | <0.001 | 1.873–1.979 | 1.872 | <0.001 | 1.821–1.925 |
| Less than lower secondary | | | | 2.166 | <0.001 | 2.127–2.206 | 2.334 | <0.001 | 2.270–2.401 | 2.258 | <0.001 | 2.195–2.323 |
| *Tenure (ref: owner)* | | | | | | | | | | | | |
| Private rent | | | | 1.298 | <0.001 | 1.278–1.319 | 1.248 | <0.001 | 1.221–1.276 | 1.225 | <0.001 | 1.198–1.254 |
| Social rent | | | | 1.597 | <0.001 | 1.570 to 1.624 | 1.541 | <0.001 | 1.497 to 1.586 | 1.507 | <0.001 | 1.464 to 1.552 |
| *Activity (ref: employed)* | | | | | | | | | | | | |
| Unemployed | | | | 3.783 | <0.001 | 3.707–3.861 | 4.024 | <0.001 | 3.909–4.142 | 3.667 | <0.001 | 3.561–3.775 |
| Inactive | | | | 14.638 | <0.001 | 14.442–14.838 | 14.740 | <0.001 | 14.421–15.066 | 14.386 | <0.001 | 14.074–14.705 |
| *Family type (ref: married with children)* | | | | | | | | | | | | |
| Married without children | | | | 1.041 | <0.001 | 1.025–1.057 | 1.027 | 0.031 | 1.002–1.052 | 1.051 | <0.001 | 1.026–1.076 |
| Lone parent | | | | 1.204 | <0.001 | 1.176–1.232 | 1.344 | <0.001 | 1.298–1.393 | 1.323 | <0.001 | 1.277–1.370 |
| Alone | | | | 1.449 | <0.001 | 1.427–1.471 | 1.481 | <0.001 | 1.447–1.516 | 1.479 | <0.001 | 1.445–1.514 |
| *Area pair (ref: Brussels-Birmingham)* | | | | | | | | | | | | |
| Bastogne - Colchester | | | | | | | | | | 1.221 | <0.001 | 1.112–1.341 |
| Virton - Worthing | | | | | | | | | | 1.282 | <0.001 | 1.169–1.406 |
| Maaseik - Durham | | | | | | | | | | 0.739 | <0.001 | 0.702–0.779 |
| Leuven - St Albans | | | | | | | | | | 0.864 | <0.001 | 0.829–0.901 |
| Hal-Vilvorde - Richmond upon T. | | | | | | | | | | 0.752 | <0.001 | 0.722–0.784 |
| Anvers - Edinburgh | | | | | | | | | | 0.704 | <0.001 | 0.681–0.728 |
| Dixmude - Bridgnorth | | | | | | | | | | 0.831 | 0.001 | 0.748–0.922 |
| Courtrai - Warwick | | | | | | | | | | 0.676 | <0.001 | 0.641–0.712 |
| Charleroi - Liverpool | | | | | | | | | | 1.292 | <0.001 | 1.249–1.336 |
| Thuin - Swansea | | | | | | | | | | 1.366 | <0.001 | 1.301–1.435 |
| Nivelles - Elmbridge | | | | | | | | | | 0.978 | 0.322 | 0.935–1.022 |
| Gand - East Renfrewshire | | | | | | | | | | 0.638 | <0.001 | 0.611–0.665 |
| Alost - Winchester | | | | | | | | | | 0.741 | <0.001 | 0.704–0.780 |
| Namur - South Lanarkshire | | | | | | | | | | 1.202 | <0.001 | 1.152–1.254 |
| Liège - Dundee | | | | | | | | | | 1.094 | <0.001 | 1.058–1.130 |
| *Number of observations* | 2,881,883 | | | 2,881,223 | | | 1,336,223 | | | 1,336,223 | | |

Holland, Lloyd, Pelkey, & Flynn, 2005). Others have used different techniques for matching however, with propensity score matching being one example (Oakes & Johnson,, 2006; Rosenbaum & Rubin,, 1985). Melhuish, Belsky, Leyland, & Barnes, 2008 provide a recent illustration, though in an intra-national study. Our use of a principal components approach to identify area types and sample selection within the two countries is novel. Furthermore, previous epidemiological studies have perhaps not been so explicit about their motivation and the wider methodological and theoretical debates as a context for their work.

The use of matched areas ensured that our international comparison did not include those facing radically different local contextual influences on their health. There are many parts of Britain which are extremely different to Belgium. There is nowhere in Belgium comparable to the Highlands of Scotland, or North Wales in Britain for example. It was plausible that in a conventional analysis, subjects from such areas would be outliers on confounding variables, exerting strong leverage on regression models and influencing the magnitude of the between-country effect. Our approach removed that possibility. However, the small difference between results from the all area analyses and the matched area analyses suggested that the higher risk of reporting poor health in Britain was largely not because it contains types of area and hence local contextual influences which are very different to those in Belgium. Whilst this absence of influence was 'discovered' through our approach, it means that the new method did not produce substantively different results to more conventional approaches.

Is the matched area approach acceptable in theoretical terms? One might argue that the range of area types and contextual influences faced by the members of a nation are, in themselves, an inherent part of that nation's identity. In our final two models, which only included areas that plausibly belonged in either country, we compared two 'similar' sub-samples rather than two nations. One interpretation of our results is that we were able to detect the influence of national level contextual characteristics on health within these sampled areas. However, an alternative perspective might argue that a sub-sample of areas and people cannot, by definition, represent an entire nation. It might be that the influence of national-level context is most profound in the areas we have excluded from our matched area analyses, and this is why the country-effect was apparently smaller in the matched analyses than in the all-area analyses. In our attempt to compare 'like with like', we may have lost external validity. This issue is strongly connected to our original intention to adopt some elements of a 'trial' or experimental design, as advocated by Oakes and others. Both randomised trials and natural experiments can have problems with external validity (Petticrew et al., 2005; Rothwell, 2006). Rothwell highlights numerous axes along which external validity

**Table 6**
Odds of reporting poor health, by gender, derived from logistic regression models containing populations from both Britain and Belgium (women).

| Women | Model 1 All areas, age only | | | Model 2 All areas, all individual covariates | | | Model 3 Matched areas, all individual covariates | | | Model 4 Matched areas, area dummies | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] | Odds Ratio | *P*>\|z\| | [95% Conf. Interval] |
| *Britain (ref: Belgium)* | 2.105 | <0.001 | 2.083–2.128 | 2.010 | <0.001 | 1.985–2.034 | 1.885 | <0.001 | 1.817–1.955 | 1.756 | <0.001 | 1.692–1.823 |
| *Age (ref:25–29)* | | | | | | | | | | | | |
| 30–39 | 1.662 | <0.001 | 1.620–1.704 | 1.702 | <0.001 | 1.658–1.747 | 1.766 | <0.001 | 1.691–1.844 | 1.798 | <0.001 | 1.722–1.877 |
| 40–49 | 3.188 | <0.001 | 3.112–3.266 | 2.931 | <0.001 | 2.858–3.007 | 2.831 | <0.001 | 2.716–2.952 | 2.906 | <0.001 | 2.787–3.030 |
| 50–59 | 5.036 | <0.001 | 4.917 to 5.157 | 2.535 | <0.001 | 2.470 to 2.602 | 2.223 | <0.001 | 2.130 to 2.320 | 2.300 | <0.001 | 2.204 to 2.401 |
| *Education (ref:post secondary)* | | | | | | | | | | | | |
| Upper secondary | | | | 1.287 | <0.001 | 1.262–1.313 | 1.437 | <0.001 | 1.397–1.478 | 1.475 | <0.001 | 1.434–1.518 |
| Lower secondary | | | | 1.498 | <0.001 | 1.472–1.525 | 1.817 | <0.001 | 1.768–1.867 | 1.786 | <0.001 | 1.737–1.836 |
| Less than lower secondary | | | | 1.940 | <0.001 | 1.906–1.975 | 2.370 | <0.001 | 2.306–2.437 | 2.330 | <0.001 | 2.266–2.396 |
| *Tenure (ref:owner)* | | | | | | | | | | | | |
| Private rent | | | | 1.402 | <0.001 | 1.381–1.423 | 1.400 | <0.001 | 1.370–1.430 | 1.355 | <0.001 | 1.325–1.385 |
| Social rent | | | | 1.727 | <0.001 | 1.701–1.754 | 1.771 | <0.001 | 1.727–1.817 | 1.678 | <0.001 | 1.635–1.721 |
| *Activity (ref:employed)* | | | | | | | | | | | | |
| Unemployed | | | | 2.987 | <0.001 | 2.922–3.054 | 3.118 | <0.001 | 3.023–3.217 | 2.843 | <0.001 | 2.755–2.934 |
| Inactive | | | | 6.774 | <0.001 | 6.685 to 6.865 | 7.408 | <0.001 | 7.245 to 7.574 | 7.291 | <0.001 | 7.131 to 7.456 |
| *Family type (ref:married with children)* | | | | | | | | | | | | |
| Married without children | | | | 1.441 | <0.001 | 1.420–1.462 | 1.419 | <0.001 | 1.386–1.452 | 1.454 | <0.001 | 1.421–1.488 |
| Lone parent | | | | 1.585 | <0.001 | 1.559–1.612 | 1.809 | <0.001 | 1.764–1.856 | 1.735 | <0.001 | 1.691–1.780 |
| Alone | | | | 2.476 | <0.001 | 2.436–2.516 | 2.565 | <0.001 | 2.502–2.630 | 2.502 | <0.001 | 2.440–2.565 |
| *Area Pair (ref: Brussels-Birmingham)* | | | | | | | | | | | | |
| Bastogne - Colchester | | | | | | | | | | 0.776 | <0.001 | 0.702–0.858 |
| Virton - Worthing | | | | | | | | | | 0.833 | <0.001 | 0.757–0.917 |
| Maaseik - Durham | | | | | | | | | | 0.610 | <0.001 | 0.578–0.644 |
| Leuven - St Albans | | | | | | | | | | 0.827 | <0.001 | 0.795–0.861 |
| Hal-Vilvorde - Richmond upon T. | | | | | | | | | | 0.714 | <0.001 | 0.687–0.742 |
| Anvers - Edinburgh | | | | | | | | | | 0.580 | <0.001 | 0.562–0.599 |
| Dixmude - Bridgnorth | | | | | | | | | | 0.612 | <0.001 | 0.546–0.685 |
| Courtrai - Warwick | | | | | | | | | | 0.664 | <0.001 | 0.632–0.698 |
| Charleroi - Liverpool | | | | | | | | | | 1.226 | <0.001 | 1.188–1.265 |
| Thuin - Swansea | | | | | | | | | | 1.119 | <0.001 | 1.066–1.175 |
| Nivelles - Elmbridge | | | | | | | | | | 0.909 | <0.001 | 0.873–0.948 |
| Gand - East Renfrewshire | | | | | | | | | | 0.579 | <0.001 | 0.555–0.603 |
| Alost - Winchester | | | | | | | | | | 0.685 | <0.001 | 0.651–0.720 |
| Namur - South Lanarkshire | | | | | | | | | | 1.022 | 0.299 | 0.981–1.064 |
| Liège - Dundee | | | | | | | | | | 1.118 | <0.001 | 1.084–1.152 |
| *Number of observations* | 2,847,975 | | | 2,847,975 | | | 1,322,531 | | | 1,322,531 | | |

can be hampered, including differences between the way an intervention occurs during the trial and how it might be rolled out as routine practice, and the tendency for trials to occur in settings or on populations which differ from the wider world. In the necessarily controlled conditions required for a trial design, something of the 'real world' is inevitably lost; this has implications for the interpretation and meaning of such studies.

At a deeper level, our approach also raises further theoretical questions about what constitutes contextual characteristics. We should question the extent to which a country can be considered as an entity 'independent' of its people. If the true relationship between the characteristics of places and societies, and their constituent people is dialectic, it seems unlikely that attempts to apportion influence on health between 'individual' and 'national' level characteristics will ever produce definitive and reliable results. Such attempts are encouraged by thinking about context and composition (and this is one source of the criticism aimed at treating context-composition as a dichotomy). However, we would argue that this does not render the context-composition framework useless. It can be a useful tool because it offers a means to structure thinking about relationships between the characteristics and behaviours of individuals, and the places in which they live and work. It is perhaps easier to begin designing a study into how area and health are related with this simple, if ultimately false, dichotomy than with a relational concept of health and place. Perhaps, just as thinking has developed from comparatively simple 'context and composition' to more nuanced 'relational concepts' of how health is influenced by place, so study design and interpretation might benefit from starting simply and then acknowledging complexity.

Our approach had some specific empirical strengths and weaknesses. In positive terms, we used large data sets, drawn from censuses with robust measures of individual and area level characteristics. The comparative approach, in which we contrasted results from our matching method with those from a more conventional approach helped to illuminate and explain our results. The models themselves were comparatively straightforward. Our approach to making an international comparison is repeatable by others wherever the data are available.

In terms of weaknesses, we have assumed that the remaining difference in risk of reporting poor health between those from Britain and from Belgium represents the impact of a national level contextual influence. However, there are at least three other possible contributors to this residual difference in risk. The first is a failure to match the areas precisely (i.e. the matched pairs are not truly identical in terms of their contextual characteristics). Although we matched the pairs together on the basis that they were similar, Table 2 does reveal that the local characteristics were not totally identical. It is possible that some of the between-country effect which we are taking to illustrate a national level contextual influence is due to differences between the areas in local contextual characteristics. The second is that we have failed to take account of other important individual or contextual differences in the modelling or matching process. Our results are likely dependent on the choice of area characteristics with which to match areas, and of individual level characteristics with which to control for compositional differences between the populations. Whilst our choices were all rooted in the literature and have proven associations with risk of reporting poor health, they were also constrained by what was available in comparable data covering the two countries and did not represent a complete range of influences on health. We were not able, for example, to include information on smoking status. Some of the remaining between country difference will likely be explained by these confounders. The third is that we were unable to take account of differences in reporting behaviour of our populations. Whilst we have been careful to refer to a country-effect on the risk of reporting poor health, there is an implicit assumption that the variable is capturing 'health' in the same way in the two different countries. Alternatively, there may be socio-cultural differences in the ways people from each country respond to questions about health. Higher propensity to report poor health for a given level of physical or mental symptoms might be a genuine feature of those living in Britain, or it may be that this population is objectively 'sicker' than that in Belgium. In Britain, the sub-sample was better educated than the national population, therefore if anything, the estimate of excess risk in Britain may be conservative. Our study restricted the age-range of its population to those aged 25–59. In excluding the younger and older age population we were unlikely to represent the full range of household composition in Belgium and Britain. This may have introduced bias to our substantive results, though we think it unlikely to affect our methodological investigations. Finally, our study did not examine variations in country-effect by characteristics other than gender. It is likely that the impacts might also vary by age, socio-economic position and other personal characteristics. We restricted the scope of our study, in order to focus on its methodological exploration.

Our study then, aimed at an increment in the methods with which we carry out international comparisons in epidemiology. We have demonstrated that it is possible to take samples through matching similar areas in two nations and to use these to account for influences in health at an individual and local-area level. This approach perhaps reveals something about the influences on health which may operate at a societal level. In trying to bring elements of experimental study design to an observational, international comparison, we raised interesting questions about what constitutes national level context.

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