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# Exploring the Impact of Public Services on Quality of Life Indicators

## CHE Research Paper 46

# Exploring the impact of public services on quality of life indicators

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## Abbreviations

| | |
|---|---|
| AC | - Audit Commission |
| ANOVA | - Analysis of Variance |
| CCA | - Community Cohesion Agenda |
| DCLG | - Department for Communities and Local Government |
| DEFRA | - Department for Environment, Food and Rural Affairs |
| DETR | - Department of the Environment Transport and the Regions |
| DTLR | - Department of Transport Local Government and Regions |
| FA | - Factor Analysis |
| IMD | - Index of Multiple Deprivation |
| JSA | - Job-Seekers Allowance |
| LA | - Local Authority |
| LAA | - Local Area Agreement |
| LGA | - Local Government Act |
| LSOA | - Lower Super Output Area |
| LSP | - Local Strategic Partnership |
| MVML | - Multivariate Multilevel Model |
| ML | - Multilevel Model |
| NRF | - Neighbourhood Renewal Funding |
| OA | - Output Area |
| ODPM | - Office of the Deputy Prime Minister |
| ONS | - Office for National Statistics |
| PCT | - Primary Care Trust |
| PSO | - Public Service Organisation |
| QoL | - Quality of Life |
| SHA | - Strategic Health Authority |
| SOA | - Super Output Area |
| SUR | - Seemingly Unrelated Regression |
| SWB | - Subjective Wellbeing |

# Executive summary

## Introduction

- The fundamental aim of public services is to improve the quality of life of citizens. The main objective of this study was to investigate the influence of public service organisations (PSOs) on aspects of quality of life (broadly measured) of citizens at a local level.

- Quality of life is a multi-dimensional concept incorporating facets such as health and social well-being, economic well-being, quality of education, level of security and safety, access to transport, and other aspects of life at a local level.

- Quality of life and well-being is linked closely to the notion of social capital which broadly concerns networks and shared values and understanding that exist within and between groups. Social capital highlights the importance of many aspects of the social associations that people encounter in their everyday life that may contribute to their well-being and quality of life. Public policy has a current emphasis on the role of social capital and the responsibility of organisations and agencies to work together to address the needs of local communities in terms of creating the conditions that enhance social capital.

- Moreover, there has been increasing policy emphasis on the responsibility of PSOs to promote the well-being of their area and this explicitly entails working with other agencies - even where boundaries are not coterminous - in order to develop sustainable community strategies that address the full range of quality of life issues.

- The increasing emphasis on notions of 'community' and 'neighbourhood' as levels at which well-being, community cohesion and social capital are fostered, implies that it is useful to look beyond the usual regional, local authority or health area level to smaller geographical areas.

## Aims

- We considered the degree to which PSOs can influence a range of aspects of the quality of life of citizens across a broad range of measures both within and outside their usual domains of influence.

- We examined the degree to which factors outside the control of PSOs (e.g. socio-demographic population characteristics) influence quality of life outcomes.

- In most public sector service areas, administrative organisations are arranged in a hierarchical manner. Large organisations such as Strategic Health Authorities and Government Regions are at the top, with lower level organisations such as Primary Care Trusts and Local Authorities nested within these boundaries and much smaller geographical areas below these. We investigated at which level there appears to be most scope to influence quality of life of citizens.

## Data

- We assembled a rich database using 20 of the 45 quality of life measures developed by the Audit Commission. Those we selected covered broad areas of quality of life such as safety, housing, health, education, and transport and were available at 'small area' level.

- Small areas include electoral wards which are the units used to elect local government councillors. They constitute the lowest administrative units in the UK. There are 8,797 electoral wards in England. Small areas also include lower super output areas (LSOAs) which have an average population of 1,500. There are 32,482 LSOAs in England.

- Sources of data included: the 2001 Census, Index of Multiple Deprivation (IMD), British Local Elections Database, Neighbourhood Statistics and the Public Health Observatory.

- We added data on indicators of deprivation (to measure 'needs' of the local population) and on the performance of PSOs.

## Methods

- We used a range of advanced statistical methods to analyse the relationships between PSOs and quality of life measures at different hierarchical levels. The techniques were selected to be robust when making comparisons between levels and when looking at associations between quality of life measures.

- Three models used were: (a) multilevel (or hierarchical) models (ML); (b) models of multiple outcomes or seemingly unrelated regression (SUR) models, and (c) an integration of both these approaches, namely the multivariate multilevel model (MVML model).

- The ML models took a variety of specifications, varying according to the level considered, the way in which needs were taken into account, and whether or not the performance of organisations was included. Our approach allowed us to consider simultaneously the interactions that may exist between quality of life measures and levels, rather than looking at each model in isolation.

## Results

- Our descriptive analyses (bivariate correlations, factor analysis and ANOVA) suggested overall some significant correlations between some of the quality of life variables. The SUR model results also indicated that the quality of life indicators are correlated, and therefore that we should look at these measures in a joint modelling approach such as MVML, as envisaged in the study objectives.

- For each model specification we calculate the proportion of variance (called the intra-class correlation coefficient) at each level to show at which level in the hierarchy the most variance can be explained. Our findings present a fairly consistent picture in terms of the level at which variation in quality of life indicators is most apparent.

- As an illustration, results from one of the 3 tier models with healthcare organisations show that the majority of the variation is at the small area level although a significant proportion of the variance is also attributable to the two higher level organisations. For the health variables - life expectancy, standardised mortality ratio and percentage of households with limiting long-standing illnesses - 98%, 94%, and 84% of the variation (respectively) is at small area level, whereas for teenage conceptions it is only 49%.

- Also, the results suggest that much of the variation at small area level for variables such as percentage of people living rough may be very localised and area specific; whereas for variables such as air quality, election turnout and method of transport to work, the majority of the variation is attributable to the higher levels.

## Discussion

- The identification of the degree of variation in quality of life indicators apparent at each level is important. It suggests that where those variations are large, there may be scope to influence outcomes at that level to a greater extent than where the variations are small. So where we find large variation in indicators such as the number of teenage conceptions at the higher level where healthcare organisations such as Strategic Health Authorities and Primary Care Trusts exist, we suggest that these organisations should be able to influence that outcome. On the contrary, because we find small variation at this level in indicators such as overall life expectancy, we suggest that these are less amenable to influence by higher level organisations.

- The large degree of variation found in many quality of life indicators at small area level is also important. Whilst there are no obvious PSOs with responsibility for quality of life at that level, it

suggests that organisations need to be aware of the potential impact of their policies at small area level. Moreover, recent policy highlights the importance of local communities and neighbourhoods and PSOs have been encouraged to become more responsive to local needs and to devolve to communities a greater role in decision-making, including the handling of resources at neighbourhood, group and community level. Our results suggest that this approach is likely to be fruitful.

## Conclusions

- Our research provides methodological and policy insights. From a methodological perspective, our work makes a distinctive contribution to the literature and as far as we are aware, this is the first study of its kind to provide evidence on the sources of variation in quality of life indicators at small area level and to use advanced methods to disentangle this variation.

- From a policy perspective, it provides both national and local policy makers with a deeper understanding of the role of public sector services in promoting the quality of life of citizens, contributes to a central area of public policy debate concerning neighbourhoods and quality of life and offers evidence on the influence that PSOs can exert on outcomes at different hierarchical levels and across public sector organisation boundaries.

- We identify scope for further work in order to exploit the rich database created and to further advance the methodological approaches.

# 1. Introduction

The fundamental aim of public services is to improve the quality of life of citizens. The main objective of this study is to investigate the influence of public service organisations (PSOs) on aspects of quality of life (broadly measured) of citizens at a local level. Quality of life is a multi-dimensional concept incorporating facets such as health and social well-being, economic well-being, quality of education, level of security and safety, access to transport, and other aspects of life at a local level.

Little is known about the degree to which PSOs can influence specific local quality of life measures. For instance, how much variation in health outcomes is associated with local authorities responsible for education, housing and community safety, compared with the health services? How much of this variation is attributable to socio-economic circumstances and to what extent are the actions of different authorities coterminous in improving health outcomes? Indeed, is there a correlation across different quality of life measures or does achievement on one measures come at the expense of attainment on another? And finally, at what level in the organisational hierarchy can most of the variation in quality of life measures be explained – for instance, in the case of health outcomes, is it at the Primary Care level, or at the higher Strategic Health Authority level? This project has set out to examine these questions which might offer regulators with useful information on relative performance of organisations operating within a hierarchical structure and in a system where attribution of performance may be multi-faceted.

We address these questions through a series of quantitative analyses of quality of life data in England at a small area level. We construct a large comprehensive dataset which covers 20 quality of life indicators at small area across a range of areas such as education, community cohesion, community safety, economic well-being, environment, health, housing and transport. We also include a number of PSO markers at higher levels, as well as various socio-economic characteristics of the small areas and performance measures of the PSOs.

The objectives of the study were to then develop statistical models to explain the link between PSOs and quality of life indicators in order to:

1. examine the degree of variation in quality of life indicators associated with different PSOs;
2. explore the extent to which factors beyond the control of PSOs influence their outcomes;
3. explore the correlation in quality of life indicators across PSOs; and
4. examine the level in the organisational hierarchy which exerts the most influence on local outcomes.

We describe briefly the rationale for each of our key research questions.

First, the performance of many PSOs is in part dependent on inputs from outside agencies. For example in health care, other agencies may be responsible for the production of health outcomes. If the performance of only one of these organisations is under scrutiny, there may be a difficulty in identifying the element of outcome that is attributable specifically to its endeavours. The danger is either (i) its contribution towards care is ignored in the analysis (under-attribution) or (ii) the contribution of other external agencies towards outcome is ignored (over-attribution). We need to disentangle the contribution of each organisation to the quality of life measures.

Second, a basic tenet of effective performance management is that decision makers should be held responsible only for aspects of performance over which they have control. Variation in quality of life indicators may come from 'environmental' factors beyond managerial control. These are exogenous influences on the public sector organisation's production function, beyond its control, that reflect the external environment within which it must operate. In examining the performance of PSOs on quality of life indicators, we need to take account of the neighbourhood influences on performance or the characteristics of the population group they serve.

Third, there may exist important relationships between individual quality of life measures across service areas. There are numerous reasons why performance on one indicator might be correlated positively or negatively with performance on another. Variations in the observed performance of two organisations may depend on them operating in different environments, leading to variations in the

feasible levels of performance. The extent to which these are correlated is clearly of interest to regulators as it will indicate the knock-on effect that changes on one indicator may have on others.

Fourth, in most public sector service areas, a hierarchical organisational structure exists. A key policy question arises: to what level of the hierarchy are variations in health system outcomes attributable? Of vital importance for regulators and policy makers is the ability to ascertain at what level in the system, policy changes can have the greatest impact and where improvement efforts are best focused. For example, we could anticipate systematic differences in the way Primary Care Trusts (PCTs) and Strategic Health Authorities (SHAs) formulate and implement health care policies. Our primary aim in this research is to identify at which spatial level most of the observed variance can be found.

## 2. Review of quality of life, social capital and the policy context

Our literature review for this study was tailored according to the main themes of our project, and covers the areas of quality of life, social capital and the policy context of attempts to improve the well-being of citizens. Details of the literature search strategy are given in Appendix A.

First, the project explores a wide range of quality of life domains rather than restricting analysis only to health related quality of life. The overall quality of life experienced by citizens will depend on more than one aspect of their living and working environment. In addressing a wider range of quality of life indicators we are recognising that quality of life is multi-dimensional and encompasses many facets of life beyond health related quality of life. Our literature review therefore considers quality of life concepts and the way in which they link to well-being and happiness of citizens.

Second, we consider the concept of social capital which broadly concerns the networks of relationships and bonds formed at individual or community level that may be important influences on the quality of life and well-being of citizens. There has been increasing emphasis in public policy making on the role of social capital and the responsibility of organisations and agencies to work together to address the needs of local communities in terms of creating the conditions to enhance social capital.

Third, we bring these concepts together by considering the policy context over the last decade. The advent of the modernisation agenda placed an emphasis on the need for partnerships between organisations and for policy to be developed and implemented across the traditional sector boundaries. This is relevant for our project because our analysis acknowledges that public sector organisations may influence more than one dimension of quality of life. In particular, local authorities have been charged with promoting the well-being of their area and this explicitly entails working with other agencies in order to develop sustainable community strategies that address the full range of quality of life issues. Partnerships between organisations have been seen as a major tool for delivering change at local level and have been formalised in many sectors. Our study also seeks to address the *level* at which the quality of life of citizens may be influenced. Public services are organised at a variety of geographical and organisational levels such as local authority and PCT areas. The level at which influences on quality of life can be exerted may vary across organisations and with aspects of quality of life. The increasing emphasis on notions of 'community' and 'neighbourhood' as levels at which community cohesion and social capital are fostered, implies that it is useful to look beyond the usual regional, local authority or health area level to smaller geographical areas.

Our aim in covering the literature is to demonstrate the rationale for our approach in terms of the relevance of key concepts and the policy context to the quantitative analysis that we undertake in the core part of the project. The three topics on which we focus are each highly contentious areas on which a substantial body of philosophical, theoretical and empirical literature exists from a wide range of disciplinary perspectives. We do not therefore seek to provide an in-depth discussion which is far beyond the remit of our project, but instead take a broad brush approach.

### 2.1. Quality of life

Quality of life is not a simple construct. In this review we outline some broad concepts of relevance and we later go on to consider the important links between quality of life and social capital.

Concepts of quality of life may focus on the individual or the collective; and may be subjective or objective. Phillips (2006 pg. 242) provides two definitions of quality of life:

*"Quality of life is both an individual and collective attribute. At the individual level it includes objective and subjective elements. People's objective quality of life requires that their basic needs are met and that they have the material resources necessary to fulfil the social requirements of citizenship. Their subjective quality of life depends on them having the autonomy to make effective choices to (1) 'enjoy' – enhance their subjective well-being, including hedonism, satisfaction, purpose in life and personal growth; (2) 'flourish' in the eudaimonic, other-regarding, Aristotelian sense of fulfilling informed as well as actual desires; and (3) participate in the full range of social activities of citizenship. People's collectively focused quality of life requires global environmental sustainability, both physical and*

*social, and the following social resources within the communities and societies in which they live: civic integration, synergy and integrity; extensive weak network links and bridging ties at all levels of society; wide-ranging integrative norms and values including trust, reciprocity and other-regarding behaviour; and societal norms and values relating at least to fairness and equity and possibly to some degree of social justice and egalitarianism."*

Its shorter version is:

*"Quality of life requires that people's basic and social needs are met and that they have the autonomy to choose to enjoy life, to flourish and to participate as citizens in a society with high levels of civic integration, social connectivity, trust and other integrative norms including at least fairness and equity, all within a physically and socially sustainable global environment."*

There is a wealth of research from a wide range of disciplines but we focus here on issues most relevant to our project rather than attempting to cover the philosophical foundations of quality of life (QoL) concepts. Our main focus is on the notion of subjective well-being and the associated links with social capital and public policy.

### *2.1.1. Subjective well-being, happiness and quality of life*

Whilst neoclassical economists were inclined to equate the choices that people made in the market about the goods and services they pursued (revealed preferences) as an indicator of their utility (well-being), the fact that people make choices that do not always appear to accord with their own well-being, has led to an interest in looking beyond revealed preference and maximisation of utility for other ways of assessing well-being.

There are many possible approaches – for example, in line with one element of Phillip's definition outlined above, one approach is to focus on indicators that demonstrate the *opportunity* that exists for needs to be met. Thus, social, economic and health indicators such as literacy rates and life expectancy can be used to assess the quality of life across countries – for example, in the United Nations Development Index. However, these measure the opportunities that individuals have to improve their QoL, rather than the QoL they actually experience. Another approach is to use techniques to elicit directly preferences from individuals rather than relying on revealed preferences. This approach has been used extensively to consider health related QoL although there are many issues still hotly debated (Dolan, 2008; Hausman, 2008; Smith *et al*, 2008).

However, the approach that has spawned most research effort is one in which the focus is on assessments of subjective well-being (SWB). We use this term to mean generally how people think or feel about their life and their level of satisfaction or happiness. This is often assessed through surveys and single questions along the lines of "How satisfied are you with your life overall?" or "Taken all together, how would you say things are these days? Would you say you are happy?" - respondents are usually given a categorical response option. Sometimes several responses to questions about life satisfaction and happiness are used to create a scale.

Whilst there are still many unresolved methodological issues surrounding the measurement and use of SWB (some of which we explore later), the concept has influenced substantially the policy arena. In particular, it has shifted attention away from the assumption that the aim of public policy should only be to influence economic indicators such as income on the grounds that this will enhance automatically the well-being of citizens. Instead, research in many countries has demonstrated consistently that on average, reported measures of satisfaction or happiness have remained fairly stable over the last 40 years despite huge increases in per capita income (Kahneman *et al*, 2006). In other words, being richer does not necessarily make people happier. Although there are some complex explanations for this (some of which we return to later in this section), the point is that there is widespread recognition that enhancing subjective well-being is a legitimate goal of public policy and that this entails consideration of what actually makes people happy.

Indeed, some have advocated having a single goal for public policy of maximising happiness or quality of life of current and future generations (Layard, 2005). It has even been reported that the Kingdom of Bhutan has made 'Gross National Happiness' rather than GNP, their main policy goal (Kahneman & Krueger, 2006). Recent proposals outline a method for incorporating measures of

personal and social well-being into national accounts to create comparative national well-being accounts (New Economics Foundation, 2009.) As we describe in Section 2.3 of this review, the UK government places a great deal of emphasis on the responsibility of public sector organisations to improve the quality of life of citizens in a broad sense and expects organisations to create and maintain an environment that will enhance well-being at an individual and community level.

### *2.1.2. The determinants of SWB*

In this section we consider briefly the research evidence on the determinants of SWB and in doing so we draw heavily on two thorough and recent reviews by Dolan *et al* (2008) and Clark *et al* (2007; 2008). We do not cover all possible influences.

#### *2.1.2.1. Income*

It was mentioned earlier that at country level, higher incomes in many developed countries over the past four decades has not been accompanied by higher levels of reported SWB on average. However, the general consensus from cross-sectional studies is that there is a weak but positive relationship between income and SWB. Explanations of the apparent paradox have focused on a number of key issues. First, it may be relative not absolute income levels that are important to people and there is a great deal of evidence to suggest it is your 'rank' in the income distribution or in your peer group that is important. Second, changes in circumstances are important and recent increases in income can have a positive effect on SWB. Third, aspirations and expectations can have an impact in that there may be adaptation to higher income over time because aspirations are in part based on past higher levels of income (your income is judged relative to the past rather than to that of others).

If the relative income effect dominates the absolute income effect this might explain why cross-section data show that richer individuals within a society are happier; whereas, over time, average SWB levels do not change as the whole society becomes richer. However, it may not explain (unless there is a comparison effect of incomes between countries) the finding in some research - especially in less developed countries of a positive relationship between income and average SWB (Dolan *et al*, 2008). Clark *et al* (2007) approach this issue by considering a utility function in which higher income brings both consumption and status benefits to an individual. Comparisons can either be to others or to oneself in the past. Such functions can therefore explain why some empirical research finds a positive relationship between income and happiness. However they also show that "since status is a zero-sum game, only the consumption benefit of income remains at the aggregate level. Since the consumption benefit approaches zero as income rises, happiness profiles over time in developed countries are flat."

Other explanations have been offered – for example, Kahneman *et al* (2006) suggest that the 'focusing illusion' is important. If people are asked a question about an aspect of well-being, the respondent's attention is drawn to that aspect and they may exaggerate its importance. The argument is that people tend not to continuously think about their circumstances until they are reminded to do so by being asked how satisfied they are, for example, and then they will compare their situation with that of others.

The discussion of the link between income and happiness is complex, unresolved and still the subject of much debate. For our purpose we need only to note that whatever the nature of the relationship, research suggests that many other factors aside from income are likely to influence SWB. We consider some of these further below, although a full treatment is available in Dolan *et al* (2008).

#### *2.1.2.2. Personal and social characteristics*

Women tend to report higher happiness levels than men, although the empirical results are not unanimous; older and younger people tend to be happier than those in middle-age although this may be misleading as the middle years are when key life events are more evident; results on ethnicity are difficult to interpret partly because of the tendency for surveys to group people under 'other' category.

Additional educational attainment has been associated with both higher and lower SWB and indeed some studies have shown no effect at all. The methodologies of studies are key as it is likely that education is correlated positively with other variables such as income and health - but if studies use

such variables as controls this may introduce a bias because the correlation may be due in part to a causal relationship for example between education and higher income. There is a more consistent, positive pattern emerging from studies that examine SWB and physical and psychological health status. Similarly, individual unemployment is associated negatively with SWB in the majority of studies. The issue of whether unhappy people self-select into unemployment has been examined carefully but it does not appear to be a major explanation.

#### *2.1.2.3. Work and community activities*

The relationship between hours worked and SWB is not straightforward and studies have produced both positive and negative results. Dolan *et al* (2008) consider that more attention needs to be paid to the type of work undertaken and whether the hours worked are a matter of choice or not. Caring-giving duties appear to have a negative impact on SWB and may be associated with loss of autonomy amongst care-givers.

Membership of organisations is in most cases positively associated with life satisfaction in many studies, especially at the individual level rather than at a country level. Volunteering has in some studies been linked with greater life satisfaction but after controlling for other variables likely to be associated with volunteering, the effects are much smaller. The evidence is therefore not easy to interpret. Regular engagement of some sort in religious activities seems to be positively associated with SWB.

#### *2.1.2.4. Attitudes, beliefs and relationships*

We focus here on only those most relevant to the rest of our review (particularly with the link to social capital).

Higher levels of reported social trust (trust in other people) is associated with higher life satisfaction and happiness and lower suicide rates. In the UK, measures of neighbourhood trust increases life satisfaction. Trust in public institutions (such as the police and legal system) is linked with higher satisfaction. Religious people tend to be happier than non-religious people regardless of their faith and there is some suggestion that religious belief can protect people against the effects on SWB of some negative shocks such as loss of income or work.

In general, people who are married or in stable partnerships appear to be happier than those who are alone although there are interactions with gender. Having children has an indeterminate effect on SWB with important variations depending on the status of the parents (e.g. single, divorced etc.), the age of children; and moderated by income levels.

Social contact with family and friends appears to be beneficial in terms of SWB although when some of the contact involves caring responsibilities, this may lead to lower satisfaction.

#### *2.1.2.5. Living environment*

The impact on SWB of national levels of unemployment and inflation are not well understood, although unemployment appears to have a negative effect or no effect; results for inflation are mixed but also mainly negative or neutral.

There is a difficulty in interpreting the (usually negative) association between pollution and other environmental problems and SWB because of the potential relationship between income levels and poor environment. Similar issues arise in the interpretation of the negative link between living in an unsafe area and SWB, although this does appear to be robust to controlling for income.

This has been a very partial review but it is sufficient to see that there has been a great deal of research on what influences happiness, SWB and QoL and although the results are consistent for some of the relationships (such as income, health, relationships, employment status) the evidence base is not as strong as some would suggest and there are still many gaps and ambiguities.

### *2.1.3. Measuring SWB*

As indicated earlier, much of the empirical research takes the response to a single or small number of questions about the respondent's satisfaction with life or happiness as an indicator of SWB. Sometimes these can be abstracted from existing surveys – the World Values Survey (data from individuals in 81 countries on values, attitudes, wellbeing) is widely used especially for cross-country comparisons as it contains the single questions "How satisfied are you with your life"? Other questions from the same survey (e.g. on trust levels) are also used widely. In the US, the General Social Survey is used widely and in the UK, the British Household Panel Survey asks "How satisfied are you with your life overall?" Surveys can be designed to extract information specifically about SWB, often creating a scale – for example, the Positive and Negative Affect Scale and the Satisfaction with Life Scale (cited in Dolan *et al*, 2008).

One main criticism of this approach is from those who see severe shortcomings in assessing people's feelings by asking them retrospectively about their perception of their experiences. Kahneman, as a leading proponent of employing alternative measures of how people actually feel, suggests that it is better to capture views closer to the time of, and in direct reference to, the actual experiences of respondents. This has links to the concept of utility dating back to Bentham whereby utility was seen as a constant flow of hedonic pleasure or pain and Kahneman has called this 'experienced utility' as opposed to 'remembered utility' (Kahneman & Krueger, 2006). In the quest to capture this more accurately, experiments have sought to measure moment to moment reactions to stimulus in laboratory settings (e.g. to hot and cold sensations) by asking respondents to use levers or dials to indicate their ratings of pain on a moment to moment basis. Crucially, there is evidence from a range of similar experiments, that comparisons of retrospective evaluations of the whole experience with evaluations of the real-time reports, show systematic biases. In particular, in retrospective assessments people tend to neglect the duration of the episode of pain in favour of the end of the experience or a peak or trough and therefore it is argued that the global assessments of SWB that are made via surveys are unlikely to be a good indicator of the true feelings about the experiences of respondents.

These findings have formed the basis for new approaches to measurement of experienced utility that capture reported feelings throughout the day. These include the Experience Sampling Method which uses hand held computers to prompt people to answer questions on their current subjective experience several times during the day and also records their activity at that time and the people with whom they were interacting. Applications have been limited because of difficulty of implementation in large populations. However, another similar approach – the Day Reconstruction Method, asks people to record episodes from the previous day in terms of activities etc and then to recall their feelings for each episode. This has been used empirically to give some interesting insights on 'time use', linking the time spent doing types of activity with the 'net affect' (a measure of mood based on positive and negative feelings). Not only is it possible to rank activities depending on the mean net effect they produce, but it is also possible to explore differences between responses to survey questions about enjoyment of activities and the emotional affect brought about at (or near to) the time they were experienced (Kahneman & Krueger, 2006). Activities bringing about highest net affect (positive emotion) are social and leisure activities such as socializing with others, eating, relaxing, exercising, religious worship; and the lowest net affect is associated with work related activities and personal maintenance activities such as housework. Negative feelings about an activity are often alleviated if the respondent had company whilst doing them (e.g. commuting to work).

### *2.1.4. Quality of life and communities – the link with social capital*

There is a large literature concerning the theoretical and philosophical aspects of the community and societal context of quality of life, as opposed to the individual level. Phillips (2006) details the issues related to poverty and social exclusion and also outlines several approaches to defining 'over-arching' concepts of quality of life at societal level. Simplifying greatly, most approaches to societal quality of life combine aspects of economic circumstances, resources and security; with aspects of social relations, social cohesion and sustainability; and also introduce notions of equality and empowerment. We do not cover these theoretical approaches in this review, but we focus instead on social capital as the factor most relevant to our project. Quality of life at the collective or community level focuses on features of communities or societies that affect the happiness and well-being of citizens within communities and it is here that social capital has an important role.

## 2.2. Social capital

### *2.2.1. What is social capital?*

There is a substantial literature that seeks to define social capital and many definitions exist. Of interest to this project is that the origin of some of the approaches taken to social capital stem from the recognition that economists were failing in their economic modelling approach, to recognise the existence of multi-dimensionality or multi-facets of the concept of "capital" which is widely employed. Bourdieu and Wacquant (1992) identify three fundamental types of capital: economic capital, cultural capital and social capital. The latter is defined as:

> '*Social capital is the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalised relationships or mutual acquaintance and recognition. Acknowledging that capital can take a variety of forms is indispensable to explain the structure and dynamics of differentiated societies*' (Bourdieu & Wacquant, 1992, pg. 119, cited in Halpern, 2005).

Bourdieu and Wacquant (1992) saw social capital in terms of the network of resources or contacts people call upon for financial support, emotional support, help with the children, a favour at work, etc. This network functions as both a means to accessing and a substitute for economic capital. Not surprisingly it is unevenly distributed among the social classes. Like cultural capital, social capital networks are more easily accessed by the rich and powerful, who transmit these as well as financial capital across generations. Similarly Giddens (2000, pg. 78) defines social capital as the investment accrued in "*trust networks that individuals can draw on for support, just as financial capital can be drawn upon to be used for investment*". When stocks of social capital are low, it is argued, society starts to break down: crime, corruption, underachievement, unhappiness and all manner of social ills follow. Putnam (2000) describes social capital as "*connections among individuals in social networks and norms of reciprocity and trustworthiness that arise from them".*

Putnam (1993) and Fukuyama (1995) have focused on the cultural aspects of social capital – that certain cultures are more conducive to the establishment of strong social networks and consequently the accumulation of social capital. In particular, some cultures encourage the building of 'bridging' links with 'people unlike me', as well as networks based on commonality e.g. families, trade unions, etc. Bridging networks, it is claimed, offer far more opportunities for accessing and accumulating social capital but are difficult to maintain unless levels of social trust are high. Hence, the higher levels of social capital purported to exist in Nordic countries.

More generally, whilst there are many debates and differences in emphasis about various aspects of social capital (e.g. is it purely a community concept or is there also individual social capital?), most agree that the crux of the concept is that it relates to networks of relationships in which the bonds, formed between members of the network are a key part. The OECD definition that has been adopted by the UK government in many contexts defines social capital as "*networks together with shared norms, values and understandings that facilitate co-operation within or among groups*" (OECD, 2001 pg. 41).

The literature on social capital identifies three basic components of social capital:(i) (social) networks, (ii) clusters of norms, values and expectancies that are shared by members of a group and (iii) sanctions put in place by individuals/groups themselves to help maintain the norms and networks. These three components of (social) networks are usually embedded in any type of social association that we may encounter in every day life, such as local community or more simply neighbourhood.

(i) networks usually refer to any form of relationship between individuals or groups, such as simple recognition by sight, occasional greetings or even deep friendship (e.g. 'neighbourhood'). These are not always perceived as positive by individuals, and they may be characterised by forms of rivalry and dislike. Further, networks can be defined by the proportion of people that know each other, referred to as density and by the dominance of intra- versus inter-community links, referred to as closure.

(ii) social norms refer to rules, values and expectancies that are shared by members of, say, a community or neighbourhood. Many of these rules are unwritten and some may require people to behave or not to behave in certain ways.

(iii) Sanctions may be applied within the network for not complying with existing and accepted social norms. Sanctions can be formal, although they are more frequently informal, especially within a small community. Sanctions can be applied directly by telling people (either politely or harshly) that their behaviour is inconsiderate/inappropriate; although forms of indirect punishment can also be envisaged, such as gossip and loss of reputation. Obviously, sanctions can also be positive in the form of praise.

These three basic components can be found in any type of context, starting from the family (lowest level) up to super-communities such as nations. The relevant level or domain of analysis of the concept of social capital is not generally agreed upon within the social sciences.

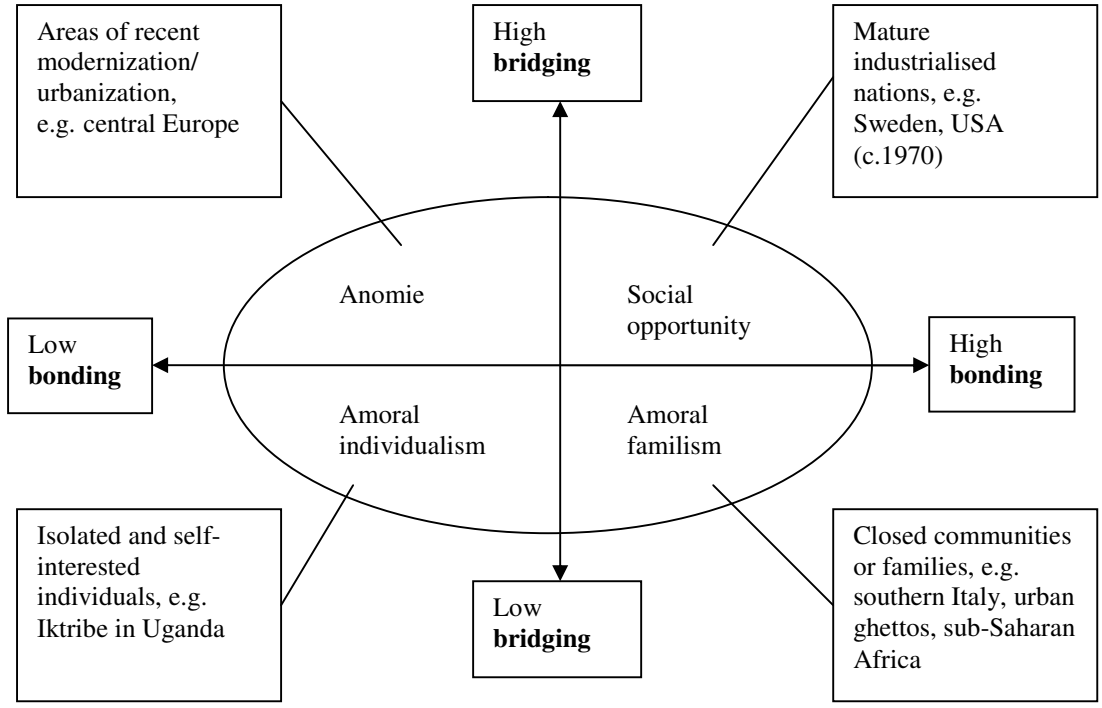
### *2.2.2. Social capital: bonding, bridging and linking*

Leaving the conceptual level of analysis of social capital aside, in this section we consider the types of social capital discussed in the literature. Putnam (2000) notes that some forms of social capital tend to sustain, support and preserve single individuals and homogenous groups, in an 'inward looking' way. This is usually referred to as bonding social capital, examples of which encompass ethnic fraternal organisations, book clubs, etc.

Bridging social capital is characterised by outreaching aspects, with links reaching across what Putnam describes as 'diverse social cleavages'. Examples of this form of social networks are civil rights movements and many youth service groups. One encounters easily both types of social capital in any civil society: "*bonding social capital provides a kind of sociological superglue whereas bridging social capital provides a sociological WD-40"* (Putnam, 2000, pg. 22-23). Bonding and bridging social capital may be highly correlated at the individual level. Hence, if an individual or even community is rich in one type of social capital, they may also be rich in the other. However, some of the potential negative effects of social capital arise from consideration of these distinctions. Bonding capital can create groups with such strong cultural identity and cohesion that they effectively become isolated from other parts of society with potential detrimental effects. For example, access to opportunities and socio-economic resources may be curtailed as a result of belonging to strictly defined groups such as those in the caste system. Additionally, such groups can take on their own norms and values to such an extent that they become corrupt, subject to cronyism and may utilise extreme sanctions against those who try to break away from the group. Unless there are also strong elements of bridging social capital that allow such groups to also be linked into other parts of society there is potential for isolation and conflict between very tight-knit groups. Racial unrest has often been attributed to clashes between different groups with strong bonding capital where links between the groups were not made, although this is a matter of some controversy.

The notion of linking was introduced by Woolcock (1998) who used the label 'integration' when referring to the relationships that happen within a community; and the label 'linkage' to describe liaisons that occur outside the community boundaries. Woolcock states that combining these two different kinds of social networks leads to the formation of different types of society. Halpern (2005) offers an adaptation of Woolcock's matrix[1], in which he shows the interactions between bonding and bridging social capital (see Figure 1).

[1] Halpern uses Gittell and Vidal's terminology, rather than Woolcock's.




Source: Halpern (2005)

**Figure 1: The interactions between bridging and bonding social capital**

Additional sub-categories of social capital have been discussed by introducing two further functions: 'transparency' and 'rationalization' (Fedderke *et al*, 1999). Transparency refers to the ability and ease of a community's social capital to facilitate the flow of information, whilst at the same time reducing transaction costs. A society with more bridging social capital would be considered to be more transparent. Rationalization refers to the extent to which "*social capital moves from rules and norms that assume substantive content, to rules and norms that are procedural in character*" (Gittell & Vidal, 1998).

Social capital is often considered as a 'public good', that is a good whose benefits accrue to groups of individuals without belonging to any individual in particular. As a public good, social capital can be exposed to phenomena such as free-riding, where one individual (or group) benefits from being part of a network, without necessarily having to contribute towards it or engaging in any form of activity to maintain it. More often, however, social capital can be viewed as a semi-public good or even a club good, as devices for excluding some individuals from their benefits are feasible and easily implemented. Edwards and Foley (1998) point out that some social classes or professionals tend to have larger and more varied social networks that working-class people and less affluent individuals; thus displaying more bridging social capital. The term 'linking' social capital has been coined to refer to this type of social capital.

### *2.2.3. Conceptual level of analysis of social capital*

The different sub-types of social capital are nicely summarised in Halpern's conceptual map of social capital with examples. The map allows us to see that different types of social capital with their own specific networks, norms and sanctions operate at different levels. For example, at the meso-level one form of network that can be envisaged is that of a neighbourhood, with norms represented by community customs and sanctions consisting of exclusion from the circle of neighbours.

Two general levels of analysis have emerged from the literature: the macro- and the micro-level, with potentially a third level emerging, namely a multi-level analysis. The macro-level of analysis refers to the sharing of cultural habits within a nation. These cultural conventions are said to make it possible for people to get along with one another, and to achieve their goals without major conflicts with other individuals or groups of individuals. If we were to analyse this conceptual level in terms of the three

basic components of social capital, it is apparent that rules or social norms exist at this level and that these have the beneficial effect of facilitating the actions of each single individual. Sanctions are also recognisable at the macro-level and these include both formal and informal punishments. The third component - network - is not as easily identifiable at the macro-level, as individuals of a nation cannot possibly know everyone else in the nation. However, as Halpern (2005) points out, citizens of any nation are bound to interact with fellow citizens and to "*normally share some form of loose identity* [and] *share a common understanding of how to behave in relation to one another"* (Halpern, 2005, pg.16).

Strong support for the inclusion of macro-level phenomena in the social capital definition come from researchers working on regional (and national) differences in the level of trust between strangers, and the relationship between these differences and various empirical outcomes. The World Bank suggests:

> "*Social capital refers to the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions. Increasing evidence shows that social cohesion is critical for societies to prosper economically and for development to be sustainable. Social capital is not the sum of the institutions [that] underpin a society – it is the glue that holds them together"* (World Bank, 1999, cited in Halpern, 2005).

The macro-level is, however, opposed, in some cases also strongly (Portes, 1998; Edwards & Foley, 1998), by those who believe that one cannot abstract from the individual level, as macro-level effects need still need to be micro founded. In particular, both Portes and Edwards and Foley go as far as denying any *raison d'etre* to the macro-level. Halpern reconciles these two extreme positions by establishing the importance of both and the creation of what is labelled a multi-level approach. Moreover, Halpern (2005) argues that in many societies it is possible to envisage the substitution of social capital at one level for that at another.

### *2.2.4. Why does social capital matter?*

The link between social capital and the public policy process – and one reason why it is of interest to this research project – is that there is a vast literature that attempts to explore the contribution of social capital to various aspects of individual, community and national life, with the perspective differing depending on the disciplinary approach. The research is wide-ranging, attempting to link social capital to variations in economic conditions and the relative growth rates of countries; to variations in health, well-being and quality of life at country, area, community or individual level; and to indicators of social 'problems' such as rates of suicide, divorce, crime, teenage pregnancy, civil unrest. Thus social capital is seen in positive terms as contributing to many aspects of life; and also the lack of, or declining social capital is seen as one explanation for problems of social unrest.

Whilst the theoretical basis and the methodological quality of much of the empirical research may well be problematic (we consider measurement problems later in this section) and there is lively debate, there is a wealth of research on the topic across a wide range of disciplines. Putnam's famous research on the effectiveness of local government in Italy (Putnam *et al*, 1993) in which he linked the performance of organisations to the existence of associational life and levels of trust within regions, gave social capital a central place in social science research.

From an economic perspective, this spawned great interest in the link between social capital and growth – mainly in terms of income levels. In a recent review, Sabatini (2006) considers several studies that find a positive relationship between aspects of social capital and growth at the regional and country level, many using measures of trust (although he is critical of their approach mainly because they aggregate up from measures of trust captured at an individual level to the area level). Other studies have found conflicting results on the link between growth and social capital and indeed, some have argued that economic growth may lead to a deterioration of social capital by driving people into work and consumption rather than into social participation (Routledge & von Amsberg, 2003). The results suggesting a positive relationship appear stronger in developing countries where social capital may have as large a role as any other sort of capital. There are also studies linking economic indicators to measures of social capital at the regional and area level, also reporting positive results in many cases.

There is also a wealth of literature that considers the link between social capital and aspects of physical and mental health status. Research based in many different countries has, on the whole, revealed a positive association between social capital (measured in various ways) and aspects of health related behaviour or access to health care resources that ultimately influence health status (Costa-Font & Mladovsky, 2008). Although again, there are limits to the empirical analysis and there is a lack of clarity about the precise mechanisms involved whereby social capital can influence health production.

Aldridge *et al* (2002) summarise the research in other social policy areas such as crime and educational attainment, concluding that in both cases, there is evidence to suggest that higher levels of social capital are associated with better outcomes. In the case of crime rates, social control theory often links strong social networks and bonds to mainstream society as effective ways of sanctioning those who transgress against expected norms, thereby preventing people from offending and they note this has been demonstrated at regional and neighbourhood level.

There has also been a large body of research aimed at assessing trends in social capital over time, mainly at the country level. Simplifying greatly, there seems to be a view of declining levels in the USA (from a high baseline) and Australia; stable or ambiguous levels in the UK and France; and increasing levels in Japan and Germany (from a high base) and in Sweden and the Netherlands (from a high base) (The Strategy Unit, 2002). Whilst some types of social capital appear to be increasing in the UK (e.g. associational membership has increased) there are declines in other areas such as traditional women's groups, political parties and religious organisations; and reductions in reported levels of inter-personal trust and trust in public institutions, especially amongst younger people (The Strategy Unit, 2002).

Regardless of the various methodological gaps in some of the empirical literature, it is no surprise therefore that public policy is influenced heavily by the notion that social capital has a key role to play in supporting and creating a better quality of life and environment for individuals, communities and countries. For example, the World Bank recognises social capital as a key policy tool in reducing poverty and encouraging sustainable development; the OECD has co-ordinated international approaches to the definition and measurement of social capital; and the UK government has given social capital prominence in many aspects of public policy. We discuss the UK policy context further in section 2.3 of this review.

The key question for policy makers is about determining the ways in which the public sector can intervene to prevent the further decline of trust networks or to increase access to social capital; and to decide how much intervention is needed. The wrong kind of, or too much intervention might be counterproductive and destabilise private institutions like the family. But without some kind of state interference there is a risk that individuals will retreat into their private networks, which are based on race, class, sex, etc. These may not only be a less effective means of acquiring social capital, but may also have negative effects such as dividing rather than uniting communities where there is strong bonding social capital within groups without associated bridging capital. The issue is therefore one of optimisation, rather than maximisation.

### *2.2.5. Measuring social capital*

We are not attempting in our project to measure social capital. We therefore just briefly consider some of the issues that arise.

It has been noted that the conceptualisation of social capital has raced ahead of the development of tools to measure it empirically (Stone, 2001). The standard approach has been to use proxy indicators e.g. frequency of participation in voluntary organisations or other civic activities and it is usual for a set of indicators, rather than just one to be employed. Sometimes the measures can be gleaned from secondary data sources but there is also a wealth of research that has utilised instruments and surveys to measure social capital utilising proxy indicators – for example, the Social Capital Community Benchmark Survey developed by Putnam and further developed in the Petris Social Capital Index that uses data from the USA to look at employment in community voluntary organisations (Scheffler & Brown, 2008). The World Bank and the UK Office of National Statistics have both been involved in the development and use of surveys to capture social capital (World Bank, 2009; Harper & Kelly, 2003). The World Bank has developed two instruments for measurement of

social capital, one that focuses on household, community and organisational level and another designed for developing countries, which provides a set of questions to be used in household surveys. The latter covers six areas: groups and networks; trust and solidarity; collective action and cooperation; information and communication; social cohesion and inclusion; empowerment and political action. The UK government working group recommended five domains for inclusion in government surveys: social participation, civic participation, social networks and support; reciprocity and trust; views of the local area, with several indicators suggested for each domain for use in national and local surveys.

The main issue with the use of indicators is that they often confuse what social capital *is* with what the *outcomes* of social capital may be. If you expect social capital to impact on such things as crime rates or altruistic activities, then using these also as measures of social capital is tautological. This tendency has been noted as a widespread phenomena in the empirical literature (Sabatini, 2006) and has been acknowledged by those involved in survey development but still often put aside in the quest to capture all relevant dimensions of social capital (Harper & Kelly, 2003). Moreover, whilst some indicators are linked closely to the key components of social capital (e.g. trust, networks etc); many other indicators used in social capital research have far looser and less obvious links to social capital. Stone (2001) lists a whole array of what she terms 'distal' indicators that fit the latter category and have been used in social science research, including: life expectancy, health status, suicide rates, crime rates, employment rates, teenage pregnancies, income, marital relationship status, growth, GDP and balance of trade.

Attempting to limit questions directly to the key components of social capital is perhaps theoretically more sound, but can still result in use of a mixture of indicators and outcomes. Along these lines, some studies attempt to measure levels of trust and / or trustworthiness as one component of social capital, asking questions such as "do you agree that most people can be trusted?" ;"do you trust strangers more or less than you used to?"; and "would your friends say you can be trusted?". The 'World Values Survey' which investigates social and political change by repeated public surveys contains some core questions on trust that are used extensively in social science research to develop indicators of trust. The survey approach suffers from the problem that it relates only to the perception of individuals and not to their actual behaviour, although some research has attempted to capture behaviours related to trust (e.g. number of legal proceedings for work disputes, number of disputes over cheques etc.) (Degli Antoni reported by Sabatini, 2006).

Even when measurement focuses on the key concepts of social capital such as networks and trust there are a host of issues arising in how to ensure that relevant aspects of these dimensions are captured. For instance, networks can relate to formal and informal networks; to family or wider networks; to those based on individual behaviour; to those around associations and groups; to social; and to work related groups. Moreover, 'measuring such networks involves not just gathering information on whether or not they exist but to demonstrating the intensity and quality of the networks. Take the UK for example: the level of association has been fairly constant since WW2 but surveys indicate that social trust has declined. This suggests that the *quality* of associations has deteriorated even though the quantity remains roughly the same: also that some types of association build trust/capital better than others; there may even be types that have a negative impact on trust/capital. Hall (1999) argues that 'collectivist' types of association are superior in this respect to 'individualist' types, the difference being that collectivist associations do create a higher proportion of public goods. Compare, for example, charity work with the E-Bay phenomenon: the latter requires a degree of trust to function but the benefits are mostly private.

It is also worth noting that there may be negative aspects to social capital at the *individual* level, that any attempt at measurement might address (we discussed earlier some of the *community* level effects of 'too much' bonding capital). Cultivating social capital is a good thing but not a panacea (Portes, 1998) and can lead to less personal freedom, therefore, lower quality of life. Unhappy marriages and free-riders are just two examples of the potential inefficiencies. The literature is generally quite optimistic about the benefits to an individual of accruing social capital but it does involve compromise and personal sacrifice – should Muslim women avoid wearing the veil to optimise their 'bridging' capital in the secular West? Johnston and Percy-Smith (2003) therefore suggest we measure both 'positive and 'negative' social capital, the latter referring to those associations that infringe upon individual preferences and perhaps even citizenship rights.

Whatever sort of indicators are used, the survey as a tool suffers from having to ask individuals about aspects of social capital that arise not just at the individual level, but also at the community level, although other types of approaches have also been used to study areas or communities, such as the use of historic or documentary analysis or focus group discussions.

Thus, measuring social capital is a large industry but the methodology is fraught with problems which are still being addressed in empirical research.

## 2.3. The policy context

In recent years there has been an increasing policy emphasis on modernisation and democratic renewal. There is a substantial literature emanating from a variety of disciplines that unpicks the meaning and origins of many of the concepts related to the associated political agenda – the 'Third Way' - and explores government policies across many different sectors in order to examine whether they are feasible, sustainable and indeed even compatible with each other. It is beyond the remit and requirements of this project to consider the full scope of this literature. Instead, we focus on some of the key themes that underpin the dual aims of the modernisation agenda: (i) improvements in public services and (ii) the enhancement of democratic participation. Of particular interest from the perspective of our research is the link with improved well-being of citizens and the enhancement of social capital. A central role has been given to partnerships as a means of addressing both these aims.

A plethora of descriptions and critiques of the modernisation agenda exist in the literature. We outline briefly below the key components of policy in order to provide an understanding of the policy background.

### *2.3.1. Policy development*

The starting point of most relevance to this project is the 2000 Local Government Act (LGA). This Act created a new discretionary power for local authorities in England and Wales to take action to promote and improve the economic, social and environmental well-being of their area. There was a perception that previous attempts to be innovative in addressing issues of social exclusion, health inequalities, neighbourhood renewal and environmental quality, may have been hampered by a lack of clarity about the remit and powers of local councils.

The new wide-ranging power of well-being was meant to be a 'power of first resort' so that local authorities can undertake any action that helps with this general endeavour of improving well-being in their area unless it explicitly is prevented under other legislation, or unless the secretary of State exercises the reserve power to prevent authorities from taking specific actions. The Act allows local authorities to incur expenditure; provide staff, goods or services; enter into partnership arrangements; and carry out the functions of other bodies in order to benefit persons resident or present in their local area. Another section of the Act allows local authorities to take action for the benefit of people located outside their local area if it adds to well-being within their area. The latter facilitates collaboration across areas and in particular, joint working with the health sector as the boundaries are not coterminous with local authorities. The powers to promote well-being of an area have been clarified and extended recently (DCLG, 2009).

Examples of the way in which the power of well-being has been used include: a council pairing up with the private sector to develop tourism marketing, economic regeneration and the development of the local harbour; a pilot project to investigate use of mobile libraries to plug the gap in post office provision in rural areas; acquiring and demolishing houses on an estate in decline and re-housing occupants (LGA, 2003; Kitchin, 2004).

### *2.3.2. Community, neighbourhood and quality of life*

The LGA legally requires local authorities to develop Community Strategies in order to deliver the improvements in economic, social and environmental well-being outlined above. A community strategy should aim to enhance the quality of life of local communities and contribute to sustainable development. The strategies are meant to reflect local circumstances and needs but should at a minimum meet four objectives (ODPM, 2000; DETR, 2000): allow local communities to articulate their

needs and priorities; co-ordinate actions of the council and all the public, private, voluntary and community organisations that operate locally; focus and shape activity of these organisations to meet the identified needs; contribute to achievement of sustainable development. They should also have four components: a long-term vision for the area focusing on outcomes; an action plan with short term activities and priorities; a shared commitment to implement the plans; arrangements for monitoring the implementation of the plan and reporting on progress to the community.

Guidance has been given on the processes to be followed in creating the community strategies, mainly focusing on the need to facilitate ownership by the local community which suggests a bottom-up, rather than a top-down, approach. The importance of partnership working to ensure all relevant parties participate is also highlighted and although there is recognition that the local authority may, in many areas, have a lead role to play, there is a requirement for them to engage with others. It is recommended that the development of the community strategy is through a local strategic partnership (LSP) which we consider further below (ODPM, 2004b).

The governments' ongoing assessment of Community Strategies reveals that almost all local authorities have formally adopted a Community Strategy and that almost 40% had undergone a process of partial or complete revision of the strategy in 2004 (ODPM, 2005c). However, many contained little analysis of evidence to support proposals; they tended to be devoid of data and relied on aspirations, rather than practical actions (ODPM, 2005c).

The focus of Community Strategies has shifted more recently towards the development of *Sustainable* Community Strategies as part of the UK's Sustainable Development Strategy. Sustainable Communities are meant to display a number of components that will establish long-term sustained success and a 'positive sense of place' and 'places where people want to live and work, now and in the future' (ODPM, 2005c). The focus is not just on the present situation but on meeting the needs of future generations and respecting the needs of other communities both in the wider region but also nationally and internationally to also make their communities sustainable. Sustainable Community Strategies should involve a number of stages, including: a baseline analysis of current performance (using available area data, survey information); a medium-term plan for the next 5-10 years that builds on the evidence and data and evaluates priorities; a Local Area Agreement (described in more detail later); Action Plans that state targets and responsibilities, processes for monitoring and reviewing the plan and reporting arrangements.

Current policy re-emphasises the importance of local communities and neighbourhoods and has put in place a wide range of mechanisms with the aim of giving more power, authority and rights to local communities (ODPM, 2005a; DCLG, 2008). Whilst there are no obvious PSOs with particular responsibility for quality of life below these levels, the whole thrust of government policy over the past few years has been to encourage PSOs to become more responsive to local needs and circumstances and to devolve to communities a greater role in decision-making. A range of financial and non-financial resources with which to implement local policies and schemes is accessible to local community and neighbourhood groups (DCLG, 2006).

The 10 year National Strategy for Neighbourhood Renewal (Social Exclusion Unit, 2001) aimed to bridge the gap between the most deprived neighbourhoods and the national average, with a focus on key neighbourhood renewal themes (crime, education, health, housing, liveability and worklessness). The 88 most deprived neighbourhoods were 'fast-tracked' by receipt of Neighbourhood Renewal Funding (NRF) and were required as a condition of the funding, to develop Neighbourhood Renewal Strategies which contained targets. Annual accreditation was replaced by performance measurement processes under which NRF partnerships self-assess their progress on delivery of goals. Subsequently, many other types of neighbourhood initiatives have emerged.

The role of neighbourhoods has been highlighted more recently and a range of policy measures including the provision of funding for supporting neighbourhood developments has been developed (DCLG, 2008). The policy notes that "an important part of responding to the twin interconnected challenges – securing sustainable improvements in our public services and re-engaging our citizens with the institutions of government – is to promote and develop activities at a neighbourhood level, harnessing people's interest in those local issues that affect their daily lives … (and) …. build social capital, reducing isolation whilst building community capacity and cohesion". Proposals for neighbourhood ownership and management of capital have also been made (ODPM, 2006).

### *2.3.3. Community strategies*

Local Area Agreements (LAAs) are linked to Sustainable Community Strategies. The latter sets the vision and priorities for the area, whilst the LAA defines the detailed outcomes, indicators and targets which relate to the strategy. The LAA then forms part of the Sustainable Community Strategy's action plan. The responsibility for delivering the LAA rests with the Local Strategic Partnerships.

The LGA introduced Local Strategic Partnerships (LSPs) as a vehicle for developing and delivering community strategies for improving the local quality of life (ODPM, 2004b). Their main objective is to set the vision of an area and co-ordinate the delivery of local services. They are seen as the 'partnership of partnerships', encompassing all other partnerships in a locality (ODPM, 2005b). They take the strategic lead in the locality by bringing together the views of local partners and they are responsible for developing the Sustainable Community Strategy. Of most relevance to this research is the explicit notion that LSPs were expected to enhance the quality of life of citizens by achieving improved outcomes that were seen as beyond the remit of any single partner.

Two main roles have been adopted by LSPs – advisory and commissioning. Advisory LSPs typically have large memberships and work to build a consensus, co-ordinate and make recommendations. Commissioning LSPs make decisions, commission actions and are actively involved in the delivery of Community Strategy and Neighbourhood Renewal targets. The latter are less common outside the NRF areas.

There have been several evaluations of LSPs although many focus on the nature of the processes put into place, rather than on the achievements and impacts. OPDM research asked local authorities for their own views on the progress made with LSPs and reported advances in establishment of collective and co-ordinated strategies, but less so in establishing genuinely collaborative ways of working (e.g. by pooling budgets or mapping spends) (ODPM, 2005b). The government accepts it takes time to establish good partnerships and to work with the complexity of the relationships involved.

There is an expectation that LSPs will develop over time and in particular to consider the nature of governance and accountability arrangements. They will also be expected to make more use of data (e.g. neighbourhood statistics from the ONS) in their plans.

### *2.3.4. The modernisation agenda*

Simplifying greatly, there are two main strands of particular interest in our research context. These are **service improvement** and **democratic participation.** Both concepts are demonstrated in government policy as outlined in documents such as 'Modern Local Government, in Touch with the People' (DTLR, 1998) and 'Local Leadership, Local Choice' (ODPM, 1999); and as encapsulated in the introduction of Neighbourhood Renewal Strategies and in the Local Government Act 2000 which introduced Local Strategic Partnerships and Community Strategies. Moreover, other related policies reinforce the pursuit of modernisation such as Crime and Disorder Partnerships, Health Action Zones, Education Action Zones, Sure Start, and New Deal.

A key feature of this element of the modernisation agenda is the recognition that the environment in which public services are delivered has changed – a greater number of actors are involved and there are roles for the public, private, voluntary and community sectors in response to an increasingly diverse world. Each of these sectors can make a contribution to governance through a multiplicity of mechanisms such as elected representatives, market mechanisms, networks, partnerships. In principle, this might allow for fragmentation and a 'democratic deficit' with an absence of authority, accountability and legitimacy at local level. The government has put forward the notion of community governance as one mechanism by which democratisation can progress (Sullivan, 2001). There are many theories and definitions of community governance, but essentially they focus on the revitalisation of local government through a variety of means aimed at adjusting institutions of local government to make them more democratic and 'modern'. Pratchett (1999) classifies three different strands of this policy: (1) practical solutions for perceived problems of local democracy such as low electoral turnout and arcane decision making processes such as committees. Solutions include electoral reform, enhancing public participation through consultation and participation initiatives, improving political management and extending local autonomy and community leadership. (2)

Systemic failings in local government that reflect wider and deep-rooted failings in the democratic culture which relate to the attitudes, beliefs and behaviour of citizens in relation to democracy. Solutions include attempts to emphasise the responsibilities of citizens as well as their rights and refers to the social capital approach which stresses community relationships as a key factor in economic and social life. Initiatives include such things as awards for teachers and nurses that make public service appear more attractive and devolution as in the Scottish parliament and Welsh assembly. (3) Creation of a completely new mode of democracy that is more open and participative. This is a more ambitious agenda that requires a new democratic order. We return later to some of the main themes and tensions identified in relation to these policy goals.

The goal of service improvement is tied closely with the modernisation agenda and the enhanced role for the private, voluntary and community sectors in contributing to improvements in the quality of public services. One of the government's flagship policies in this respect is 'Best Value' which requires a review of how best to provide services locally and how to collaborate with other types of partners in order to provide a better service.

A central role for partnership in the provision of services has been created and Local Authorities are required to work with other public sector agencies, businesses and the voluntary sector to deliver services. Local Strategic Partnerships (LSPs) are the main vehicle for this way of working as outlined above. Partnerships and collaboration are seen as key to community strategies as a means of delivering cross-cutting outcomes such as social inclusion and health improvement.

Thus partnerships appear to have a vital role in the policy arena, both in terms of providing the model for modernisation of the delivery of public services and also though enhancing public participation and the democratic renewal agenda. They are seen as being central to the community leadership role of LAs, co-ordinating the contribution of local stakeholders through the LSP and associated community strategies. Both mechanisms have the ultimate goal of achieving enhanced quality of life for local citizens.

### *2.3.5. Partnerships*

As the notion of partnership is key to many strands of government policy across the public sector, we consider it in some depth.

#### *2.3.5.1. What are they?*

Partnership is a slippery concept despite the high profile it has been given as a central feature of the 'Third Way'. Commentators have noted that it is often used in policy announcements as a 'rhetorical invocation of a vague ideal' (Powell & Glendinning, 2002) and although partnership has a history that began well before the 1997 Labour Government, it has spiralled as partnerships have been promoted as the new paradigm for policy making and service delivery. There are at least 5,500 different partnerships at local level spending approximately £4.3 billion a year and involving around 75,000 people as partnership board members (Sullivan & Skelcher, 2002). However, the literature defining what is actually meant by partnership has been described as "methodological anarchy and definitional chaos" (Ling, 2000, quoted in Dowling *et al*, 2004).

It is not necessary for us to rehearse the many theoretical concepts of partnership that can be drawn from different disciplinary approaches, but rather we focus on the main elements of partnership as utilised in government policy. Sullivan and Skelcher (2002) identify three main types of partnership operating in localities: (1) strategic partnerships which have a remit to establish a vision across wide areas such as the LSPs; (2) sectoral partnerships which are responsible for the design and delivery of a programme or service in a specific policy area; and (3) neighbourhood partnerships that focus on identifications and addressing the needs of communities within a neighbourhood. They may cover a broad range of issues such as urban regeneration, community safety, environment, health, employment, children and youth, and have been a defining characteristic of social policies for many years.

They can involve many types of partners. In the welfare sector where partnership working has had a long history, the traditional approach was between public sector agencies and the voluntary sector; then between public and private sectors with the rise of PFI. More recent emphasis has been on

partnerships between local government and the business sector. Attention has also been paid to the type of partnerships that need to be developed in order to enhance public participation, either by providing a means by which the public views can be sought or a means of involving the public. The latter would involve local citizens as key partners.

Powell and Glendinning (2002) set out some minimal criteria for partnerships including the involvement of independent bodies, goals of common good, planning or implementation of joint programmes, mechanisms for sharing relevant risks and rewards, but they also note that there are no neat distinctions.

#### *2.3.5.2. The rationale for partnerships*

Many commentators have argued that the notion of partnership has now become a value in itself in the government arena, rather than a pragmatic response to the challenges of local governance or the improvement of public services (Lowndes & Sullivan, 2004). This is linked to the observation that partnerships no longer appear to be an option, but a requirement for the public sector (Dowling *et al*, 2004). The degree to which forced rather than willing partnerships are feasible is something to which we return later, but here we note that as Dowling *et al* point out, the ideological environment is uncritically pro-collaboration and ubiquitous – it is difficult to now find a single policy document that does not have collaboration and partnership as a central strategy for delivery of welfare or for enhancing local democracy.

The Audit Commission (1998) suggest a range of rationales for partnerships: to deliver co-ordinated services, track interconnected issues, reduce impact of fragmentation and subsequent perverse incentives, and facilitate bidding for/accessing of new resources. They also note that an external rationale is simply that it is often a statutory requirement in many instances. Lowndes and Sullivan (2004) cover similar ground in their description of the three main drivers for the increased use of partnerships: (1) Efficiency: multi-agency partnerships may make better use of resources through shared overheads, reduce duplication; they may bring in new resources through accessing grants available only to collaborative partnerships (e.g. urban renewal funds); (2) Integration: in an increasingly fragmented environment, services can be 'joined up'; (3) Accountability: if community groups and businesses are involved in public policy they can better hold providers to account and express their views.

#### *2.3.5.3. Are they successful?*

The popularity of the partnership concept might imply that there is robust evidence that they are a success. The reality is that evidence on their effectiveness is very sparse despite the many years of experience of partnership working in a variety of forms. One of the main problems is the lack of clarity about what they are expected to achieve. If there is a vague notion that partnerships are a 'good thing' then it is difficult to evaluate their impact. This has produced a tendency in the literature to define the 'success' of a partnership only in terms of whether the partnership was formed and an over-riding focus on the processes of partnerships, rather than outcomes.

Whilst there is wide recognition that what really matters is the impact of partnerships rather than the process, most of the frameworks and tools that have been used in practice to assess effectiveness focus on process. Whatever the goals of partnerships, outcomes tend to be difficult to evaluate for a number of reasons, including: (i) the probability that any impacts will not be achieved in the short-term, hence a long-term perspective is required; (ii) the absence of a counter-factual with which to compare outcomes of partnerships; and (iii) difficulty in attributing changes in outcome to partnerships rather than other factors. Evaluation focusing on the costs of partnerships is even more scarce.

#### *2.3.5.4. Partnerships and improved services*

Given the long history of partnership working in the welfare sector, attempts have been made to define what the goals of partnerships are in this context. Dowling *et al* (2004) review the relevant literature for research that attempts to link partnerships with some definition of 'success'. They observe that most use qualitative methods, largely focus on process matters and rarely consider issues of causality or the costs of partnerships. However, they distil the following findings:

(i) Process success

Successful partnerships are believed to:

- Depend on the level of engagement, enthusiasm and commitment of partners
- Require agreement on the purpose of partnerships and have a shared vision
- Have a degree of interdependence between partners
- Involve trust, respect and reciprocity
- Establish satisfactory accountability arrangements
- Have adequate leadership and management
- Operate within a favourable environment such as a good financial climate.

(ii) Outcome success

Two dimensions of 'success' are apparent in the body of literature concerned with partnerships in the welfare sector – first, changes in levels of services provided or changes in organisation and delivery methods; second, changes for users in terms of improvements or absence of deterioration in health related quality of life or wider quality of life dimensions and greater inclusivity of users.

Successful partnerships are indicated by:

- Improvements in service accessibility e.g. earlier, quicker interventions, convenience of location
- More equal distribution of services according to some criteria of need
- Improvements in efficiency or quality of service e.g. reduction on duplication or overlap, reduction in costs, improved standards of care achieved
- Improved staff and informal carers experience e.g. satisfaction, working conditions, quality of life
- Improved health status or greater well-being e.g. increased capacity to live independently, improvements in measured quality of life.

The evaluation of partnership as a means of delivering better outcomes offers methodological challenges that limit the empirical evidence available (Ansai *et al*, 2001). The review by Dowling *et al* concluded that although there have been attempts to identify concepts of outcome success, there is a lack of robust and consistent evidence that good outcomes are achieved by partnerships in the context of welfare services. It is also the case that these outcomes are not exclusive to partnerships and are likely to emerge to some degree from all methods of co-ordination rather than just from partnerships. Other research across the welfare sector has similarly failed to demonstrate convincing empirical evidence on the benefits of partnership and indeed, some studies have suggested that there may be potentially high costs from some examples of partnerships in education and urban regeneration (Rummery, 2002).

In some areas there may be strong links between process and outcomes, but very often the literature focuses only on the dimensions of success that are related to the formation of the partnership, with no attention to the link between this and outcomes. It is possible that good processes of partnerships are a *necessary* pre-requisite for good outcomes, therefore there is some merit in defining the success characteristics of partnerships in terms of process. But it is unlikely that good processes are a *sufficient* condition for good outcomes, so most research falls short of establishing this link.

### *2.3.5.5. Partnerships and public participation/governance*

Our second focus is on the use of partnerships to deliver goals associated with democratic renewal. Whilst there are links with the goal of improving public services, the specific issues we consider here relate to the use of partnerships as a more inclusive mechanism for government. As outlined earlier, the 2000 Local Government Act (LGA) gave local councils a key role in promoting economic, social and environmental well-being of communities through LSPs. In part this was aimed at changing the delivery of services, but also sought to promote public participation in local government through the use of partnerships. LSPs represent a cross-sector, multi-agency grouping of strategic players in the locality and are required to demonstrate that the public are being engaged and that policy is informed by the public. The LGA requires consultations with consumers, involvement in policies such as urban regeneration and neighbourhood renewal, in order to tackle social exclusion and build social capital.

Surveys have indicated a big increase in the volume and range of non-electoral participation initiatives used in local government and ODPM estimated that 14 million people took part in some type of participation exercise in 2001 (ODPM, 2002 quoted in Lowdnes & Sullivan, 2004). Many of the reforms across the public sector have included ways of enhancing public participation, many using partnership working as a mechanism at local and neighbourhood levels.

However, the tensions in developing partnerships for local government have been widely documented. In particular, the role of elected local governments often remains unclear in the development of partnerships, sometimes having a central role and other times, a more peripheral role. As Sullivan (2001) notes, the development of Community Strategies suggest central leadership role for LG but there are no changes in institutions that allow this. Thus some of the partners have a duty to develop policies and participate in the partnership, whilst others do not, which creates tensions for partnership working. There is also an unclear relationship with central government as the shift to local partnerships might imply a re-balancing of power in the central / local relationship but this may not happen in practice (Sullivan *et al*, 2004). In practice, LSPs are required to meet adequately the targets set for them centrally in order to access funding and thus their capacity to act with others locally is constrained by the profile of central government.

Lowdnes and Sullivan (2004) categorise the potential and pitfalls of using partnerships to promote participation. They argue that local partnerships can resemble a new form of 'corporatism' – a system that binds together the representatives of different interest groups into a collective decision making process. Whilst they can offer the best aspects of corporatism, they may also suffer from the weaknesses of that approach. First, there is an assumption that disparate individuals can be represented and can be held to account by representatives of their 'peak' organisation. But there are issues of who the community is that is being represented and how members are held to account and how arbitration between different preferences is undertaken. There is limited evidence of robust infrastructure to link representatives and communities. Second, there is a risk of the marginalisation of less powerful partners by official representatives. They observe that in many partnerships, semi-professional community workers or even voluntary sector staff are expected to deliver a 'community' perspective. This tends to exclude the most socially disadvantaged and research suggests that community leaders often replicate social exclusion. Third, there is the problem of redressing the unequal power of partners where some will have superior technical or business expertise whilst others have none and run the risk of being the victims of tokenism. Last, many partnerships may operate by trading concessions in order to reach a consensus and avoid conflict. For these reasons, the legitimacy of local partnerships may be called into question and may become less about direct participation of citizens and more about the substitution of "community representatives" in a form of 'delegate democracy'.

The evidence base on the impact of partnerships on enhancing participation is even more sparse than that relating to service delivery. The same methodological challenges exist with the added dimension of trying to measure participation in a meaningful way. Thus, much of the literature attempts to describe the processes of partnership rather than examine the impact. There are some examples that focus on impact – for example, a study of the role of community sector organisations in local governance investigated a specific example of community waste projects which incorporated a range of different levels of 'participation' and partnership (Luckin & Sharp, 2004). The results suggested that the projects gave significant opportunities for participation on decision making processes but fell short in terms of their ability to represent the wishes of local communities because of the mismatch between the community and the individuals who participate in policy forums as representatives of community waste projects, with the latter tending to be employees of these organisations. In Scotland, an empirical examination of case studies of the partnerships formed to deliver on the government's community planning agenda concluded that they exhibited all the long-standing challenges of participatory democracy around representation, inclusion and empowerment, but with the added difficulties brought by partnership governance (Cowell, 2004).

#### *2.3.5.6. The partnerships agenda*

It is clear that the partnership concept is central to the government's dual objectives of service modernisation and democratic renewal and has a key role to play in all parts of the public sector. It has been noted that the word 'partnership' was used 6,197 times in Parliament during 1999, compared to 38 times, 10 years earlier (quoted in Dowling *at al*, 2004). However, there are some

doubts about whether the form of partnerships advocated by the government will deliver on these objectives. As summarised above, there is little existing research evidence to suggest that partnerships have a positive impact on outcomes for citizens along either dimension, although the methodological challenges involved in evaluating partnerships has limited the available evidence base.

However, setting aside the lack of empirical evidence, commentators note that some of the inherent characteristics of the partnership agenda also suggest limitations in their effectiveness. In particular, key characteristics of 'good' partnerships include interdependence and trust. Interdependence matters in terms of the degree to which partners need each other in order to reach their internal goals. Rummery (2002) notes that the evidence suggests that there are significant differences in interdependence in public-private partnerships and other types. The private sector often does not need the public sector in order to achieve its aims to the same extent as the public sector needs to work with outside partners. For example, Education Action Zones offered very little to the private sector whereas the public sector had much to gain because partnership was required by the government. In contrast, the Private Finance Initiative in the public sector shows that where the private sector had much to gain (security of long term contracts), their participation was guaranteed. Whoever has least to gain in partnerships has the greatest power. Where partnerships are forced on the public sector through central requirements and targets, they are less valuable to the partners. External pressures are in danger of outweighing internal dynamics of collaboration. Where partners need each other in order to meet goals, success is more likely (e.g. HAZs recognise the role of social causes of ill health and crime prevention partnerships reflect recognition that the police cannot exert influence over many social and economic factors that influence crime). Trust is an important defining characteristic of partnerships and parties that are engaged in trusting others to deliver on joint objectives are likely to be more successful than those where trust is lacking – evidence on failed partnerships show that lack of trust is often a feature (Rummery, 2002).

Thus, it is possible that the top-down insistence on partnership working will simply serve to reinforce the unequal balance of power that often exists between partners. Vertical control through central targets for partnerships and a range of punitive measures and controls affecting access to funds may indicate the retention of a largely vertically orientated form of governance, despite the rhetoric of local autonomy.

### *2.3.6. Community cohesion and social capital*

The notion of community cohesion is also a central theme in government policy and is linked with social exclusion and the creation of social capital. Most commentators agree that the community cohesion agenda (CCA) can be traced back to the 2001 riots in the North of England and was the main component of the political response to the violent events. A government review and number of government reports followed these incidents identifying a range of causes such as weak community leadership, insufficient youth provision, and high levels of poverty. Concern was expressed at the fracturing of local communities and the perceived existence of 'parallel lives' where different communities were seen to live, work and socialise separately (Robinson, 2005).

The focus on the disturbances largely as a segregation issue prompted wide-spread criticism of the role that some versions of 'multi-culturalism' might have played in these developments. It was argued that physical segregation between communities can result in isolation of education, employment, social life and service use. If deprivation is perceived as being located within certain communities, tensions and further division may be created. Social capital is sometimes used interchangeably with community cohesion in official documentation, although it has been noted that an important distinction in this context is the notion of 'bonding' capital which involves relationships between similar individuals and 'bridging' capital where relationships are often between more heterogeneous individuals (Green & Pinto, 2005). The latter is more relevant to promoting cohesion as the individuals involved are likely to be diverse. This was discussed earlier in section 2.2.

As community cohesion is often pluralistic and potentially exclusive, some have noted that this may conflict with ideas of *social* cohesion which is universalistic and potentially inclusive (Green & Pinto, 2005). However, the government claims that the notion of community cohesion suggests cultural diversity and integration are compatible. However, there are concerns that people feel happier when

they are with people 'like themselves' and that policy attention needs to be paid to ways of building bridging capital, particularly between ethnic groups (Cave *et al*, 2007).

It has also been argued that policies of community cohesion may clash with other aspects of government policies such as the 'choice' agenda. Jordan (2005) argues that the model of the public sector developed under the third way administration came to resemble Tiebout's competing jurisdictions approach where households vote with their feet to choose between competing bundles of goods provided in public sector infrastructures, with choices facilitated by the availability of league tables and standards. He argues that this replaces the politics of collective action with individual sovereignty of the consumer, as they are encouraged to 'exit' from poor service options rather than to 'voice' their concerns and participate in improving the services on offer locally. In these terms, greater conflict amongst social groups may not be surprising and the 2001 riots can be seen as an illustration that this model was inappropriate. The attempt to deal with this by the CCA did not address fully how voice was to be made effective and how bridging social capital between groups was to be built. It is argued that the choice agenda needs to be refined and a greater understanding of how to change the *context* within which people make choices is required, rather than just a focus on providing more choice. Even the definition of a 'community' is an elusive and contested issue in the literature with many pointing out that policies with a strong geographical focus may not always be appropriate given the development of new forms of interaction that utilise informal groups (Henderson, 2003).

As the causes of the social unrest were seen largely as being rooted in specific models of multi-culturalism that had not worked, and exacerbated by segregation, most of the policy action was centred around initiatives to bring communities back together. Local Authorities were given a key role in taking action and the main responsibility for promoting community cohesion rests with them. The Home Office established a Community Cohesion Unit and launched a Community Cohesion Pathfinder Programme in 2002 which was to develop examples of good practice. Fourteen partnerships were funded to develop and assess innovative ways of building community cohesion. The Beacon Council Scheme was implemented and beacon status could be awarded for developing community cohesion. An independent community cohesion panel was set up to advise ministers. Local Authorities are required to consider community cohesion as part of their LSP and community cohesion is also a criteria in the comprehensive performance assessment of local government performance. Some councils also developed local Public Sector Agreements for community cohesion which involved financial rewards for meeting targets.

In particular, housing policy was seen as being key in determining the shape of communities. Robinson (2005) notes that the four 'pillars' of the CCA centre around housing policy. First, there was an acceptance (rather than evidence) that minority ethnic groups self-segregate. Second, that housing policy and practice reinforces this pattern. Even if minority ethnic groups are indeed making choices that lead to segregation, research suggests their choices and thus their housing outcomes, are constrained. In particular, key actors in the housing system and the practices of housing agencies may lead to discrimination and people may then be actively making choices and adopting strategies as a reaction to such racism. The fact that they seek to cluster in order to find support is not necessarily a negative thing although it is viewed as such by the community cohesion agenda. Third, housing interventions may therefore address residential integration through a number of practical measures such as the allocation methods used by social landlords. This is not straightforward to achieve and some pilot work to improve access to certain areas of housing by minority ethnic groups was problematic and very resource intensive. Finally, the CCA assumes that residential integration will produce interethnic interaction. However, such assumptions rest on conditions that are rarely met in this context – such as the equal status of all participants, and some evidence suggests that social mix does not necessarily lead to social interaction between groups of different backgrounds.

The role of young people and youth work also received attention but evidence suggests that the potential for championing young people as leaders of community cohesion developments has not really been achieved. Empirical research that focused on the role of the youth service and its partners in delivering community cohesion found a limited impact of the local authority's community cohesion agenda on the youth service and its work with young people (Green & Pinto, 2005). Very few voluntary youth staff and young people had even heard of the CCA; statutory staff had heard of it but had only a vague understanding of what it meant and had received no training. A high level of segregation in friendships at school and self-segregation outside school was reinforced by perceptions that the scarce resources of the youth service were being unequally divided amongst

different ethnic groups. The role of the youth leader as a potential to aid community cohesion was undermined by lack of funding, local politics, increased bureaucracy and the need to meet national targets.

In essence, the concepts around community cohesion and the precise nature of the links with social capital are rather vague. Indeed, many view the CCA as a convenient narrative that was constructed in response to the crisis of racial unrest in 2001, based less on evidence and more on the basis of 'sounding right' at the time. It sparked off a huge effort to promote community cohesion through a variety of policy initiatives, mainly at local authority level. There are many examples of such initiatives across the country including the Peacemaker project in Oldham; Swapping Cultures programme in Coventry and Warwickshire; Inter-Faith Network in Leeds; West London Community Cohesion Alliance; RESOLVE mediation scheme for young people in Tower Hamlets (Community Cohesion Panel, 2004). However, the evidence on whether the initiatives have been successful is rather scarce because, as with the evidence on partnerships generally, most evaluations focus on describing the initiative and the processes involved, rather than on the impact (LGA, 2004).

## 2.4. Summary

The aim of this review was to explore in brief some of the main concepts of relevance to the analytical element of our project in order to provide general background for the work. We chose to focus on three areas: quality of life; social capital; and the policy context. The reviews were not intended to be comprehensive as this was not feasible or necessary within a project of this nature.

We noted that quality of life can be interpreted very broadly at both the individual and the community level and we explored the way in which it is linked to concepts of happiness and subjective well-being. In exploring the determinants of happiness or well-being it was clear that many aspects of the broader social and environmental context in which people live, are key factors in their well-being. The concept of social capital was considered in order to explore further the importance of factors related to the networks, values and norms that are embedded in the social associations that people encounter in their everyday life and that may contribute to their well-being. We went on to consider the policy agenda which has placed a heavy emphasis on the responsibility of public sector organisations, working together, for the well-being of citizens, especially focusing on the community and neighbourhood level where social capital may have a major role to play.

The quantitative analysis we undertake in this project is based on a number of themes that emerge from the literature review:

- The quality of life indicators we include in our analysis attempt as far as possible (subject to data issues) to reflect broad aspects of the quality of life of citizens.
- The models we use are structured to capture the degree to which public sector organisations may influence aspects of quality of life outside their main domain of influence.
- The analysis includes consideration of the level at which influence on quality of life and well-being of citizens may occur. In particular it goes beyond the traditional organisational boundaries to consider the importance of lower levels which may more closely reflect communities or neighbourhoods.

# 3. Data

In order to address our research questions, we created a comprehensive dataset based on: (1) quality of life indicators, (2) various measures of socio-economic deprivation, and (3) performance indicators of key public sector services. The database has a hierarchical structure enabling us to explore the levels at which variation in quality of life indicators occurs.

## 3.1. Quality of life indicators

The Audit Commission (AC) published a set of quality of life indicators which were to be used by Local Authorities (LAs) to help 'paint a picture' of the quality of life in a local area (Audit Commission, 2005; Audit Commission, 2006). The indicators were developed by the Audit Commission, together with the Department for Environment, Food and Rural Affairs (DEFRA) and the Office of the Deputy Prime Minister (ODPM). We used these data as a basis for our study rather than trying to choose and develop our own indicators as this was beyond the remit of our study.

The set covers diverse aspects of quality of life, such as health, environment and education, all of which contribute to the long-term well-being of citizens. These indicators are reported at Local Authority (LA) and Local Strategic Partnership (LSP) level. Overall, there are 45 quality of life indicators, which cover ten quality of life themes:

1) Health and social well-being
2) Transport and access
3) Community safety
4) Housing
5) Education and life-long learning
6) Community cohesion and involvement
7) Environment
8) Culture
9) Economic well-being
10) People and place.

Each theme has between one and nine measures of quality of life.

In this study, we consider a sub-set of the above quality of life themes. For each theme, we looked for quality of life indicators similar to those published by the Audit Commission, but defined at small area level (the most disaggregated level possible). We selected the following 20 quality of life indicators shown in Table 1. We also show in the table, the sign of the indicator which we assume to be associated with better quality of life (positive or negative) though our analyses later show that sometimes the associations with deprivation can complicate the direction of the indicator, particularly for transport and access. A detailed description of the data sources and the construction of the 20 indicators is given in Appendix B.

Different data sources were used: the 2001 Census, the 2004 Index of Multiple Deprivation (IMD), the British Local Elections Database, Neighbourhood Statistics and the Public Health Observatory. Seventeen of our quality of life measures are defined at lower super output area or LSOA and three are available at ward level, either electoral ward or 2001 Census Standard table ward.

Electoral wards are the spatial units used in the UK to elect local government councillors in metropolitan and non-metropolitan districts, unitary authorities and the London boroughs in England. They constitute the lowest administrative units in the UK; further, all other administrative units are built up of electoral wards[2]. There are 8,797 electoral wards in England.

Standard table wards are a further subset of statistical wards, where statistical wards which have less than 1,000 residents or 400 households have been merged together for confidentiality issues. 2001 Census standard table wards are those for which the 2001 Census standard tables are available. 7,932 standard wards exist in England[3].

[2] Further information is available at http://www.statistics.gov.uk/geography/electoral_wards.asp
[3] Further information is available at http://www.statistics.gov.uk/geography/Statistical_CAS_ST_Wards.asp

**Table 1: Quality of life indicators used in the study, by level, data source and year**

| Theme | QoL indicator | Data source | Level | Year | Better QoL |
|---|---|---|---|---|---|
| Community cohesion and involvement | Election turnout | British Local Elections Database | Electoral ward | 2001-2003 | + |
| Community safety | IMD score on crime | Index of Multiple Deprivation | LSOA | 2004 | - |
| Economic well-being | IMD score on children (IDACI) | Index of Multiple Deprivation | LSOA | 2004 | - |
| | IMD score on older people (IDAOPI) | Index of Multiple Deprivation | LSOA | 2004 | - |
| | All people of working age claiming a key benefit | Neighbourhood Statistics | LSOA | 2004 | - |
| | All people of working age claiming job seekers allowance | Neighbourhood Statistics | LSOA | 2004 | - |
| Education and life-long learning | Secondary school absence | Neighbourhood Statistics | LSOA | 2003-2004 | - |
| | National Curriculum assessments: average point score for Key Stage 4 | Neighbourhood Statistics | LSOA | 2003-2004 | + |
| Environment | Combined air quality indicator | Neighbourhood Statistics | LSOA | 2003 | - |
| | Area of green space | Neighbourhood Statistics | LSOA | 2005 | + |
| Health and social well-being | Life expectancy at birth | Office for National Statistics | Standard ward | 1999-2003 | + |
| | Teenage conceptions | Office for National Statistics – Geographic Mortality | Electoral ward | 2002-2004 | - |
| | Standardised mortality ratio | Public Health Observatory | LSOA | 2001 | - |
| | Households with one or more limiting longstanding illness | Census | LSOA | 2001 | - |
| Housing | People living rough | Census | LSOA | 2001 | - |
| | Households (Occupied) without central heating | Census | LSOA | 2001 | - |
| Transport and access | Population travelling over 20km to work | Census | LSOA | 2001 | - |
| | Population travelling to work by private vehicle | Census | LSOA | 2001 | - |
| | Population travelling to work by public transport | Census | LSOA | 2001 | + |
| | Population travelling to work by bike or foot | Census | LSOA | 2001 | + |

Lower layer super output area (LSOA) is a new geographic hierarchy developed by the Office for National Statistics (ONS) to improve the reporting of small area statistics in England and Wales. The idea behind the design of such a geographic hierarchy is to have a spectrum of areas that would be consistent in size and whose boundaries would not change over time. Super Output Area (SOAs) are a cluster of output areas (OAs) used for the 2001 Census. Three layers of SOA were created. We use the lowest possible level, also known as lower layer super output area or LSOA. The minimum population of each LSOA is 1,000, with mean 1,500. LSOAs are generated by a computer programme which merges together 4 to 6 OAs, "taking into account measures of population size, mutual proximity and social homogeneity" (ONS, 2008). There are 32,482 LSOAs in total in England.

Small areas (both LSOAs and wards) are nested into 150 local authorities, which are in turn nested into 9 governmental regions, as shown in Figure 2.

Our dataset also includes level identifiers for 28 Strategic Health Authorities (SHAs) and 304 Primary Care Trusts (PCTs). The latter are uniquely clustered within strategic health authorities, which in turn are uniquely clustered within governmental regions.

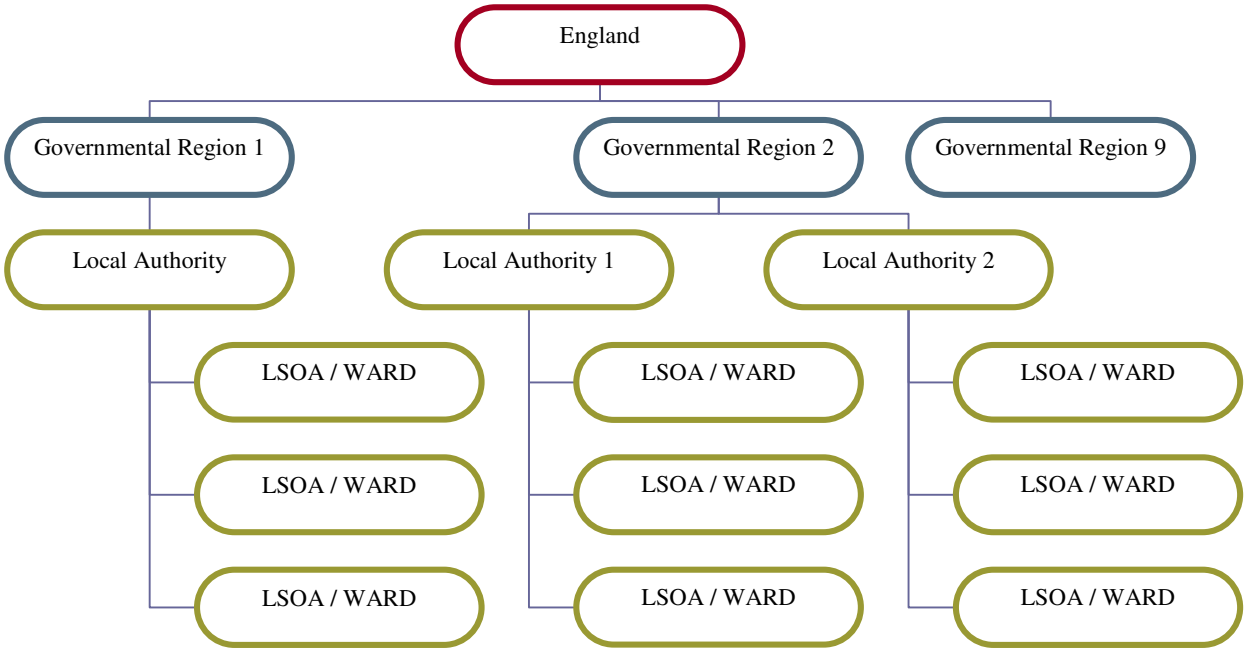



**Figure 2: Hierarchy of database and nesting**

## 3.2. Socio-economic factors

In order to take account of exogenous environmental factors which may impact on the performance of public sector organisations, we used the Index of Multiple Deprivation (ODPM, 2004a). The overall IMD is a weighted area level aggregation of multiple deprivation. The seven Domain Indices in the IMD are:

- Income
- Employment
- Health deprivation and disability
- Education, skills and training
- Barriers to housing and services
- Living environment
- Crime

We used both the IMD overall index as well as the domain-specific sub-indices. The seven domain indices are all defined in different metrics, and hence were standardised using an exponential transformation. This results in greater levels of deprivation being associated with higher scores. Every domain has a weight attached that represents their relative importance in the overall composite IMD. Each of the domain specific indicators is also a composite measure of different aspects that are related and relevant for that particular area. Hence, it is likely that some of the domain specific need indicators include information that is either directly or indirectly related to a quality of life indicator. So, to avoid potential endogeneity bias we exclude the domain specific indicators from any model estimation when the above relation is suspected.

All IMD indices are measured at LSOA level. Further information about the IMD is provided in Appendix B.

## 3.3. Other data

We added data from LAs and PCTs on various performance indicators. Data for LAs used in the Comprehensive Performance Assessment (CPA) (Audit Commission, 2004) and for PCTs used in their annual assessment (Healthcare Commission, 2004) include an overall composite performance score (star rating), and an underlying measure of use of resources/financial management which goes into the composite score. We also added data for LAs on Council Tax (Band D) (Communities and Local Government, 2009) and for PCTs on their distance from target (Department of Health, 2009).

Distance from target gives the difference between their actual allocation and the resource allocation formula target. The intention is to converge to target over a number of years. This therefore indicates the extent to which PCTs are over- or under-funded relative to fair financing and we would expect that overfunding allows them to achieve higher performance. Similarly for Council Tax, this metric offers an indication of the extent to which the local organisation's spending varies from national assessments of budgetary needs.

Table 2 shows the performance data used in the study, the data source and the year. The performance indicators are all at organisational level, to be used as additional control variables in the models.

**Table 2: Performance data used in the study, by level, data source and year**

| Performance variable | Data source | Level | Year |
|---|---|---|---|
| Star rating – composite indicator of performance | Healthcare Commission | PCT | 2003/04 |
| Financial Management – indicator in star rating | Healthcare Commission | PCT | 2003/04 |
| Distance from target | Department of Health | PCT | 2003/04 |
| Star rating - composite indicator of performance from Comprehensive Performance Assessment (CPA) | Audit Commission | LA | 2003/04 |
| Financial Management – indicator in star rating (CPA) | Audit Commission | LA | 2003/04 |
| Band D Council Tax | Communities and Local Government | LA | 2003/04 |

## 3.4. Data linkage

As was seen from Tables 1 and 2, we used data from different years, but chose data that was as contemporaneous as possible, though in some cases, availability was restricted, e.g. the latest Census data is 2001.

We also collected data at postcode level from the MOSAIC geodemographic classification system produced by *Experian* - a company that advertises itself as the leading credit reference agency in the UK. The *MOSAIC* classification, draws on ancillary datasets as a result of its credit referencing activities, including electoral data, credit applications and County Court Judgements by postcode. However, in the end due to the computational complexity, we were unable to run any models at postcode level.

As variables became available at small area level through the course of the project, we added these to our database. In fact, we spent considerable time constructing an education database at school level, but when our indicator on educational attainment, became available at LSOA level, we abandoned the school database in favour of the smaller area level data as this was better aligned with the aims of our project. The biggest data constraint was in the area of crime, where we used the IMD Crime domain. No other national crime data matching our quality of life variables was available during the course of the project, despite extensive searches.

Substantial effort went into linking the data and we spent a great deal of time tracking down, linking, collating and cleaning the data and ensuring the correct geographical and contractual boundaries of the various PSOs. We undertook thorough quality checks on the data to ensure its robustness and consistency.

# 4. Methodology

We employed a number of statistical techniques to tackle the research questions posed. We first used a variety of descriptive statistics to understand the complexity of the dataset. We then used three further statistical methods, namely: a) multilevel (or hierarchical) models (ML); b) models of multiple outcomes or seemingly unrelated regression (SUR) models, and c) an integration of both these approaches, namely the multivariate multilevel model (MVML model).

## 4.1. Descriptive analysis

We first undertook exploratory data analysis. The bivariate correlations between different quality of life indicators and performance indicators were examined. We used factor analysis to draw out the key dimensions in the quality of life indicators. We used Analysis of Variance (ANOVA) to examine the variation in the quality of life indicators. All these methods gave us an important descriptive view of the dataset.

## 4.2. Multilevel modelling

ML models are variations on the familiar regression-based theme. However, the error term is decomposed into parts attributable to each level of the hierarchy. The analysis of the residual variances in ML models provides information on the extent of variability in QoL indicators at different hierarchical levels. ML models offer useful information on relative performance of organisations operating within a hierarchy when a single QoL indicator is under scrutiny.

We consider a simple multi-level (random effect) model with no explanatory variables in a three tier hierarchical structure. Let's assume for the time being that the top level is composed of Strategic Health Authorities (SHAs), the middle level is composed of Primary Care Trusts (PCTs), and the bottom level is given by LSOAs / wards. One can represent this type of multi-level model with the following equation:

$$
\begin{aligned}
y_{ijk} &= \beta_{0jk} + e_{ijk} \\
\beta_{0jk} &= \beta_0 + v_{0k} + u_{0jk} \\
\\
v_{0k} &\sim N\left(0, \sigma^2_{v0}\right) \\
u_{0jk} &\sim N\left(0, \sigma^2_{u0}\right) \\
e_{ijk} &\sim N\left(0, \sigma^2_{e0}\right)
\end{aligned}
\qquad (1)
$$

where $y_{ijk}$ is our quality of life indicator in LSOA / ward *i*, Primary Care Trust *j* and Strategic Health Authority *k*. The terms $v_{0k}$, $u_{0jk}$ and $e_{ijk}$ represent error components. $v_{0k}$ is the random error for the *k*th SHA, $u_{0jk}$ is the random error for the *j*th PCT within the *k*th SHA and $e_{ijk}$ represents the random effect for the *i*th small area within the *j*th PCT within the *k*th SHA. All random errors are assumed to be normally distributed with mean zero and constant variances ($\sigma^2_v$, $\sigma^2_u$, $\sigma^2_e$).

The proportion of total variation (intra-class correlation coefficient) that can be attributed to any level is defined for SHAs by:

$$
\rho_v = \frac{\sigma^2_v}{\left(\sigma^2_v + \sigma^2_u + \sigma^2_e\right)} \qquad (2)
$$

with $0 \leq \rho_v \leq 1$. The closer $\rho_v$ is to 1 the larger the extent to which the variance in the quality of life indicator is attributable to the SHA level.

Similarly, for PCTs the proportion of variance that can be attributed to this level is given by:

$$\rho_u = \frac{\sigma_u^2}{\left(\sigma_v^2 + \sigma_u^2 + \sigma_e^2\right)} \tag{3}$$

with $0 \leq \rho_u \leq 1$. As before, the closer $\rho_u$ is to 1 the larger the extent to which the variance in the quality of life indicator is attributable to the PCT level.

The proportion of variance attributable to the lowest level in our hierarchy (LSOA and ward) is given by:

$$\rho_e = \frac{\sigma_e^2}{\left(\sigma_v^2 + \sigma_u^2 + \sigma_e^2\right)} \tag{4}$$

We estimate two model specifications exploring the hierarchical levels and controlling for socio-demographic characteristics. In the first instance we use one overall need adjuster (the overall IMD index) as in (5), in the second instance we use up to seven domain specific need variables (the IMD domain specific indices) (see equation (6)).

$$\begin{aligned} y_{ijk} &= \beta_{0jk} + \beta_1 x_{ijk} + e_{ijk} \\ \beta_{0jk} &= \beta_0 + v_{0k} + u_{0jk} \\ v_{0k} &\sim N\left(0, \sigma_{v0}^2\right) \\ u_{0jk} &\sim N\left(0, \sigma_{u0}^2\right) \\ e_{ijk} &\sim N\left(0, \sigma_{e0}^2\right) \end{aligned} \tag{5}$$

where $x_{ijk}$ indicates the overall need variable for LSOA / ward $i$ within PCT $j$ and SHA $k$.

$$\begin{aligned} y_{ijk} &= \beta_{0jk} + \sum_{t=1}^{7} \beta_t x_{tijk} + e_{ijk} \\ \beta_{0jk} &= \beta_0 + v_{0k} + u_{0jk} \\ v_{0k} &\sim N\left(0, \sigma_{v0}^2\right) \\ u_{0jk} &\sim N\left(0, \sigma_{u0}^2\right) \\ e_{ijk} &\sim N\left(0, \sigma_{e0}^2\right) \end{aligned} \tag{6}$$

Similar to equation (5), $x_{tijk}$ indicates the domain specific variable $t$ defined for LSOA / ward $i$, which is nested with PCT $j$, and which is nested within SHA $k$.

Equation (7) also incorporates performance indicators ($z_{sjk}$) for PSOs, defined at level *j*, and nested within level *k*.

$$
\begin{aligned}
y_{ijk} &= \beta_{0jk} + \sum_{t=1}^{7} \beta_t x_{tijk} + \sum_{s=1}^{3} z_{sjk} + e_{ijk} \\
\beta_{0jk} &= \beta_0 + v_{0k} + u_{0jk} \\
v_{0k} &\sim N\left(0, \sigma^2_{v0}\right) \\
u_{0jk} &\sim N\left(0, \sigma^2_{u0}\right) \\
e_{ijk} &\sim N\left(0, \sigma^2_{e0}\right)
\end{aligned}
\qquad (7)
$$

We analyse four different hierarchical structures, which differ only with respect to the organisational hierarchy that we assign to the top levels respectively. The lowest level in our analysis always remains the same; that is it is the lower layer super output area or ward.

## 4.3. Seemingly unrelated regression (SUR) model

When important relationships exist between individual quality of life measures, these will be lost if piecemeal univariate regression models are developed. In many circumstances individual regression models, or more precisely the error terms from each regression, will be linked. SUR models seek to explicitly model the covariance between indicators and allow one to explore the correlation across quality of life indicators.

This is achieved by jointly estimating a system of equations of the following form (Zellner, 1962):

$$
y_{ik} = \beta_{0i} + \boldsymbol{\chi}_{1ik} \boldsymbol{\beta}_{1i} + u_{ik}, \quad I = 1,\ 2,\ \ldots,\ I;\ k = 1,\ 2,\ \ldots,\ K \qquad (8)
$$

where $y_{ik}$ is the *i*th quality of life indicator defined at the *k*th organisational level, $\beta_{0i}$ is a coefficient, $\mathbf{x}_{1ik}$ is a $1 \times q_i$ vector of $q_i$ regressors specific to the quality of life indicator *i*, $\boldsymbol{\beta}_{1i}$ is a $q_1 \times 1$ vector of coefficients, and $u_{ik}$ is an error term with $E(u_{ik}) = 0$. By stacking the *k* organisational levels, the multivariate model for the *I* quality if life indicators can be rewritten as:

$$
\begin{bmatrix} y_1 \\ y_2 \\ \ldots \\ y_I \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \ldots \\ \beta_I \end{bmatrix} + \begin{bmatrix} X_{11} & 0 & \ldots & 0 \\ 0 & X_{12} & \ldots & 0 \\ 0 & 0 & \ldots & 0 \\ 0 & 0 & \ldots & X_{1I} \end{bmatrix} \begin{bmatrix} \beta_{11} \\ \beta_{12} \\ \ldots \\ \beta_{1I} \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \\ \ldots \\ u_I \end{bmatrix} \qquad (9)
$$

where $y_i$, $\boldsymbol{\beta}_i$ and $u_i$ are all k × 1 vectors, $\mathbf{X}_{1i}$ a $k \times q_i$ matrix, and $\boldsymbol{\beta}_{1i}$ is a qi × 1 vector.

If quality of life indicators *i* and *p* are related by unobservable factors (e.g. geographical factors, policies, constraints, etc.), then the error terms $u_{ik}$ and $u_{pk}$ should also be correlated. Equation (9) allows for this form of correlation.

## 4.4. Multivariate multilevel model (MVML model)

The multivariate multilevel model (MVML model) is a SUR model in a ML context. By considering the quality of life indicators as the lowest tier in the data hierarchy, the possibility of within-small area and within-higher organisational level correlation among indicators can be assessed. Thus the MVML model is conceptualised as a multilevel model, in which, say quality of life indicators (level 1) are clustered within small areas (level 2), which are themselves clustered within higher organisational levels (level 3). The correlation between the various quality of life indicators can then be explored.

The model exploring just the hierarchical levels for a 2-tier hierarchical structure becomes:

$$y_{ijk} = \beta_{0i} + u_{0ik} + e_{0ijk}, \qquad i = 1, 2, ..., I;\ j = 1, 2, ..., J;\ k = 1, 2, ..., K.$$

$$\begin{bmatrix} u_{1k} \\ u_{2k} \\ \dots \\ u_{9k} \end{bmatrix} \sim N(0, \Omega_u): \begin{bmatrix} \sigma^2_{v1} & & & \\ \sigma^2_{v12} & \sigma^2_{v2} & & \\ \dots & \dots & \dots & \\ \sigma^2_{v19} & \sigma^2_{v29} & \dots & \sigma^2_{v9} \end{bmatrix}$$

$$\begin{bmatrix} e_{1jk} \\ e_{2jk} \\ \dots \\ e_{9jk} \end{bmatrix} \sim N(0, \Omega_e): \begin{bmatrix} \sigma^2_{u1} & & & \\ \sigma^2_{u12} & \sigma^2_{u2} & & \\ \dots & \dots & \dots & \\ \sigma^2_{u19} & \sigma^2_{u29} & \dots & \sigma^2_{u9} \end{bmatrix} \qquad (9)$$

where $y_{ijk}$ is the *i*th quality of life indicator for the *i*th Lower Super Output Area (LSOA) clustered within the *k*th Local Authority. The error terms $u_{0ik}$ and $e_{0ijk}$ are both assumed to be normally distributed with zero mean and constant variance $\Omega_u$ and $\Omega_e$ respectively.

## 4.5. Modelling approach

In our models we included deprivation measures (the IMD overall index and the domain indices respectively) to examine the role of exogenous 'environmental' factors on quality of life. Since there is some overlap between the content of the deprivation indices and quality of life indicators, we set up our models in such a way as to exclude any potential for endogeneity bias. We also included additional performance indicators as control variables to pick up organisational effects.

Given the size and complexity of the datasets, running some of the more computationally complex models presented a considerable challenge. Since we have over 32,000 LSOAs, the MVML could not run with all 17 quality of life variables at LSOA level simultaneously. We had to therefore take subsamples of the quality of life variables to estimate our models. Also, we could not run any models with levels below LSOA, such as postcode, using the MOSAIC data, since the models contained over 1 million observations at the lower level, again making it computationally unmanageable.

We ran our ML models for all 20 quality of life variables, using 4 overall models with different combinations of hierarchical structures, with a number of specifications for each. For example, in addition to the basic model with just the levels, we control for only 1 need variable (the overall IMD score) - variant A, then the domain specific IMD scores - variant B, then the domain specific IMD scores plus performance indicators (where applicable) - variant C, and then the performance indicators only with the basic model – variant D. Models 1 to 3 are a 2-tier structure with the top hierarchical level (Governmental regions) included as 9 dummy variables with the reference dummy being the region London. Regions were included as dummy variables rather than as an additional tier in the ML models because there were so few regions relative to the lower levels.

For the basic model alone, we therefore ran 20 x 4 models, for variant A another 80 models, for variant B another 80 models, and so on. These specifications are summarised in Table 3.

**Table 3: Summary of all ML models for 20 quality of life variables**

| | | Basic model | A: 1 Need variable | B: 7 Domain specific need variables | C & D: Performance indicators |
|---|---|---|---|---|---|
| 2-tier structure | **Model 1** | LA<br>LSOA / Ward | Overall IMD score | • Income deprivation,<br>• Employment deprivation,<br>• Health deprivation and disability,<br>• Education, skills and training deprivation,<br>• Barriers to housing and services,<br>• Living environment deprivation,<br>• Crime | • LA - star rating<br>• LA - use of resources<br>• LA - Band D council tax |
| | **Model 2** | SHA<br>LSOA / Ward | | | • No indicators |
| | **Model 3** | PCT<br>LSOA / Ward | | | • PCT - star rating<br>• PCT - financial management<br>• PCT - distance from target |
| 3-tier structure | **Model 4** | SHA<br>PCT<br>LSOA / Ward | | | |

# 5. Results

## 5.1. Descriptive statistics

In this section we present the results from our descriptive analyses, namely the descriptive statistics, the correlations, the factor analysis and the ANOVA.

Table 4 reports the descriptive statistics alongside a description for all 20 quality of life indicators. A full description of all quality of life indicators is given in Appendix B.

All indicators are reported at LSOA level, except for election turnout, teenage conception and life expectancy. The first two are reported at electoral ward level, whilst the latter is reported at 2001 Census standard table ward. The number of observations in Table 4 are all around 32,400, the approximate number of LSOAs. Table 4 also gives the mean, median, standard deviation and variance, as well as measures of skewness and kurtosis which give an indication of the type of distribution of the variable. Skewness is a measure of the lack of symmetry of a distribution. If the coefficient of skewness is zero, the distribution is symmetric. If the coefficient is negative, the median is usually greater than the mean and the distribution is skewed left. If the coefficient is positive, the median is usually less than the mean and the distribution is skewed right. Kurtosis is a measure of peakedness of a distribution. The smaller the coefficient of kurtosis, the flatter the distribution. The normal distribution has a coefficient of kurtosis of 3 and provides a convenient benchmark. Quite a large number of the indicators appear to have approximately normal distributions, however the area of green space per head (area_green) and percentage of people living rough (perc_rough) have very peaked distributions with a right skew.

The coefficient of variation is a normalised measure of dispersion. It is defined as the ratio of the standard deviation to the mean. The coefficient of variation can only be computed for data measured on a ratio scale, it does not have any meaning for data on an interval scale, hence it has not been shown for the IMD data.

The coefficient of variation is useful because the standard deviation can then be understood in the context of the mean of the data. The coefficient of variation is a dimensionless number so one can compare it between datasets. However, when the mean is close to zero, the coefficient of variation is sensitive to small changes, limiting its usefulness.

We notice again that area of green space per head (area_green) and percentage of people living rough (perc_rough) have a higher coefficient of variation than the other indicators.

**Table 4: Descriptive statistics for 20 quality of life variables in 8 domains**

| Variable name | Variable label | level | mean | median | N | min | max | sd | variance | skewness | kurtosis | coeff. variation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Community cohesion* | | | | | | | | | | | | |
| turnout | Election turnout | ward* | 33.4188 | 32 | 29152 | 10.4900 | 76.4100 | 9.3093 | 86.6636 | 0.6764 | 3.2855 | 0.2786 |
| *Community safety* | | | | | | | | | | | | |
| imd_score_crime | IMD score on crime | lsoa | 0.0000 | 0.0000 | 32482 | -3.4600 | 3.1300 | 0.8387 | 0.7034 | 0.0328 | 2.7158 | - |
| *Economic well-being* | | | | | | | | | | | | |
| imd_score_kids | Children IMD score - IDACI | lsoa | 0.1992 | 0.1429 | 32482 | 0.0032 | 0.9931 | 0.1695 | 0.0287 | 1.1725 | 3.9235 | - |
| imd_score_elderly | Older people IMD score - IDAOPI | lsoa | 0.1614 | 0.1344 | 32482 | 0.0084 | 0.9209 | 0.1064 | 0.0113 | 1.3437 | 5.3625 | - |
| wa_tot_ben | All people of working age claiming a key benefit: percentage | lsoa | 14.3793 | 12.000 | 32482 | 0.0000 | 68.0000 | 9.1784 | 84.2439 | 1.2926 | 4.6495 | 0.6383 |
| wa_jsa | All people of working age claiming job seekers allowance: percentage | lsoa | 2.1817 | 2.000 | 32482 | 0.0000 | 19.0000 | 1.7932 | 3.2156 | 1.9540 | 8.6842 | 0.8219 |
| *Education* | | | | | | | | | | | | |
| sec_school_absence | Secondary school absence indicator: rate | lsoa | 8.1035 | 8.0000 | 32262 | 2.0000 | 20.0000 | 1.8562 | 3.4453 | 0.7485 | 4.9240 | 0.2291 |
| ks4_mean_points_score | Nat. curri assessments: average points score Key Stage 4 indicator | lsoa | 34.5914 | 34.9600 | 32415 | 0.0000 | 64.0000 | 7.5501 | 57.0039 | -0.1964 | 2.8782 | 0.2183 |
| *Environment* | | | | | | | | | | | | |
| combi_air_qual_ind | Combined air quality indicator: 26/10/2007 | lsoa | 1.1634 | 1.1500 | 32482 | 0.4000 | 2.3500 | 0.2911 | 0.0847 | 0.1694 | 2.9988 | 0.2502 |
| area_green | Area of green space per head: m2(thsnds) | lsoa | 2.2824 | 0.1018 | 32480 | 0.0000 | 402.9088 | 8.1526 | 66.4651 | 11.5308 | 302.6789 | 3.5720 |
| *Health* | | | | | | | | | | | | |
| le_all | Life expectancy at birth (years): all people | ward* | 78.4785 | 78.6000 | 32477 | 65.4000 | 93.4000 | 2.5636 | 6.5719 | -0.0871 | 3.3034 | 0.0327 |
| concept_teen | Conceptions teenagers: 2002 and 2004 figures combined | ward* | 27.7464 | 21.0000 | 27416 | 5.0000 | 168.0000 | 22.3346 | 498.8333 | 1.7077 | 6.7827 | 0.8050 |
| smr_lsoa_01 | Standardised mortality ratio at lsoa level: 2001 | lsoa | 1.1217 | 1.0499 | 32482 | 0.0000 | 7.4606 | 0.4736 | 0.2243 | 1.6194 | 11.0776 | 0.4222 |
| pphhlds_limlong_ill | Percentage of households with 1 ore more limiting longstanding illnesses | lsoa | 33.4493 | 32.9100 | 32482 | 5.6400 | 70.4400 | 8.3675 | 70.0150 | 0.2553 | 3.0184 | 0.2502 |
| *Housing* | | | | | | | | | | | | |
| perc_rough | Percentage of people living rough | lsoa | 0.0016 | 0.0000 | 32482 | 0.0000 | 1.4867 | 0.0278 | 0.0008 | 28.5482 | 1144.4580 | 17.0029 |
| phhlds_noheating | Percentage of all occupied households without central heating | lsoa | 8.4209 | 5.9968 | 32482 | 0.0000 | 82.6498 | 8.1894 | 67.0657 | 2.4683 | 11.4508 | 0.9725 |
| *Transport* | | | | | | | | | | | | |
| perc_commute_wrk | Percentage of population travelling over 20km to work | lsoa | 5.7258 | 4.6512 | 32482 | 0.1886 | 44.1308 | 3.9106 | 15.2927 | 1.2235 | 4.8627 | 0.6830 |
| perc_privtrans_wrk | Percentage of population travelling to work by private vehicle | lsoa | 25.6133 | 26.3574 | 32482 | 2.2551 | 54.5161 | 8.8557 | 78.4234 | -0.2053 | 2.4753 | 0.3457 |
| perc_pubtrans_wrk | Percentage of population travelling to work by public transport | lsoa | 6.8371 | 4.7850 | 32482 | 0.0000 | 54.7890 | 6.5118 | 42.4037 | 2.2076 | 8.7670 | 0.9524 |
| perc_footbike_wrk | Percentage of population travelling to work by bike or on foot | lsoa | 5.8431 | 4.9225 | 32482 | 0.1924 | 66.0511 | 3.6854 | 13.5820 | 2.3425 | 14.1693 | 0.6307 |

* Election turnout and teenage conception data are available at electoral ward, whereas life expectancy is available at 2001 Census Standard table ward

### *5.1.1. Correlations*

In order to explore the underlying relationships between the quality of life indicators, we ran correlations between them. We also ran correlations between the performance indicators used in our analysis at PSO level and the quality of life indicators.

The correlations between the 20 quality of life indicators are shown in Table 5. We put in bold the correlations that are greater than ±0.6. We find that IMD deprivation index for children (imd_score_kids) and the elderly (imd_score_elderly), percentage of working age people claiming key benefits (wa_tot_ben) and job seekers allowance (wa_jsa) show a positive and high correlation. Further, we find that all the above indicators are highly and negatively correlated with the quality of life indicator percentage of people commuting to work by private transport (perc_privtrans_wrk). This suggests these indicators all pick up some aspect of deprivation (or in the latter case wealth).

A less intuitive result is the high correlation found in our data between the indicators life expectancy at birth (le_all) and percentage of working age people claiming key benefits (wa_tot_ben).

It is also worth noting that both quality of life indicators average points score for Key Stage 4 examinations (ks4_mean_points_score) and area of green space per head (area_green) show very low correlations with all other quality of life indicators.

Table 6 reports the correlations between the 20 quality of life indicators and performance indicators of PSOs, namely for Primary Care Trusts and Local Authorities. We find generally very low correlations, all below ±0.3. This is perhaps not surprising given that we are measuring these indicators at different levels.

**Table 5: Correlations between 20 quality of life variables**

| Quality of Life indicators | turnout | imd_score_crime | imd_score_kids | imd_score_elderly | wa_tot_ben | wa_jsa | sec_school_absence | ks4_mean_points_score | combi_air_qual_ind | area_green |
|---|---|---|---|---|---|---|---|---|---|---|
| **turnout** | 1 | | | | | | | | | |
| **imd_score_crime** | 0.2623 | 1 | | | | | | | | |
| **imd_score_kids** | 0.2997 | 0.5874 | 1 | | | | | | | |
| **imd_score_elderly** | 0.2537 | 0.5725 | **0.7826** | 1 | | | | | | |
| **wa_tot_ben** | 0.2584 | 0.5500 | **0.8734** | **0.7376** | 1 | | | | | |
| **wa_jsa** | 0.2308 | 0.5506 | **0.7680** | **0.7363** | **0.7947** | 1 | | | | |
| **sec_school_absence** | 0.2160 | 0.3855 | 0.3967 | 0.3508 | 0.4197 | 0.3427 | 1 | | | |
| **ks4_mean_points_score** | 0.0297 | 0.0540 | 0.0712 | 0.0601 | 0.0695 | 0.0654 | 0.0452 | 1 | | |
| **combi_air_qual_ind** | 0.2031 | 0.4710 | 0.3502 | 0.4056 | 0.2008 | 0.3933 | 0.1634 | 0.0352 | 1 | |
| **area_green** | 0.0020 | 0.0019 | 0.0111 | 0.0336 | 0.0019 | 0.0226 | -0.004 | -0.0002 | 0.0465 | 1 |
| **smr_lsoa_01** | 0.1184 | 0.2573 | 0.3200 | 0.4067 | 0.3496 | 0.2941 | 0.1696 | 0.0262 | 0.1042 | -0.0021 |
| **le_all** | 0.3219 | 0.5377 | 0.5734 | 0.5995 | **0.6042** | 0.5335 | 0.3819 | 0.0564 | 0.2728 | 0.0121 |
| **concept_teen** | 0.3128 | 0.5260 | 0.5106 | 0.5067 | 0.5144 | 0.5445 | 0.3755 | 0.0376 | 0.3940 | 0.0183 |
| **pphhlds_limlong_ill** | 0.0787 | 0.3269 | 0.5479 | 0.4844 | 0.7441 | 0.4309 | 0.3203 | 0.0331 | -0.0453 | -0.0135 |
| **perc_rough** | 0.0439 | 0.0526 | 0.0382 | 0.0421 | 0.0258 | 0.0428 | 0.0202 | 0.0018 | 0.0362 | -0.0004 |
| **phhlds_noheating** | 0.1840 | 0.3298 | 0.3281 | 0.3746 | 0.3458 | 0.3477 | 0.3008 | 0.0355 | 0.0943 | 0.0241 |
| **perc_commute_wrk** | -0.0919 | -0.4749 | -0.4972 | -0.4831 | -0.5085 | -0.4502 | -0.3029 | -0.0305 | -0.4033 | -0.0272 |
| **perc_privtrans_wrk** | -0.1706 | -0.5570 | **-0.7533** | **-0.7121** | **-0.6681** | **-0.6776** | -0.3119 | -0.0792 | -0.4831 | -0.0451 |
| **perc_pubtrans_wrk** | -0.1001 | -0.2975 | -0.2141 | -0.2181 | -0.1428 | -0.2355 | -0.1073 | -0.0229 | -0.5171 | -0.0267 |
| **perc_footbike_wrk** | -0.1254 | -0.1914 | -0.1878 | -0.1858 | -0.1476 | -0.1208 | -0.1463 | -0.0410 | -0.0353 | -0.0101 |

**Table 5 continued**

| Quality of Life indicators | smr_lsoa_01 | le_all | concept_teen | pphhlds_limlong_ill | perc_rough | phhlds_noheating | perc_commute_wrk | perc_privtrans_wrk | perc_pubtrans_wrk | perc_footbike_wrk |
|---|---|---|---|---|---|---|---|---|---|---|
| **smr_lsoa_01** | 1 | | | | | | | | | |
| **le_all** | 0.4048 | 1 | | | | | | | | |
| **concept_teen** | 0.1966 | 0.5382 | 1 | | | | | | | |
| **pphhlds_limlong_ill** | 0.2335 | 0.4316 | 0.3250 | 1 | | | | | | |
| **perc_rough** | 0.0286 | 0.0438 | -0.0055 | -0.0163 | 1 | | | | | |
| **phhlds_noheating** | 0.1504 | 0.3356 | 0.3853 | 0.2422 | 0.0163 | 1 | | | | |
| **perc_commute_wrk** | -0.1725 | -0.3792 | -0.4484 | -0.4732 | -0.0065 | -0.3123 | 1 | | | |
| **perc_privtrans_wrk** | -0.2626 | -0.4711 | -0.4249 | -0.4552 | -0.0614 | -0.3352 | 0.5671 | 1 | | |
| **perc_pubtrans_wrk** | -0.0670 | -0.1583 | -0.2836 | 0.0312 | -0.0125 | -0.0881 | 0.2267 | 0.2781 | 1 | |
| **perc_footbike_wrk** | -0.1078 | -0.2056 | 0.0025 | -0.0582 | -0.0479 | -0.2090 | 0.0858 | 0.2459 | -0.0754 | 1 |

**Table 6: Correlations between 20 quality of life variables and PSO performance indicators**

| Quality of Life indicators | PCT performance indicators | | | LA performance indicators | | |
|---|---|---|---|---|---|---|
| | finman | star_rating | curr_dft_percent | band_d_counciltax | star_rating | use_resources |
| **turnout** | 0.009 | -0.1711 | -0.0005 | 0.1108 | 0.0801 | 0.0483 |
| **imd_score_crime** | 0.0727 | -0.1104 | -0.1458 | -0.1002 | -0.0239 | -0.0478 |
| **imd_score_kids** | 0.0243 | -0.0874 | -0.0996 | -0.0456 | -0.0281 | -0.0184 |
| **imd_score_elderly** | 0.0524 | -0.1056 | -0.1328 | -0.0711 | -0.0366 | -0.0187 |
| **wa_tot_ben** | 0.0537 | -0.0184 | -0.0898 | 0.0473 | -0.0353 | -0.032 |
| **wa_jsa** | 0.0526 | -0.0961 | -0.1178 | -0.0497 | -0.0146 | 0.0041 |
| **sec_school_absence** | -0.0039 | -0.0222 | -0.0376 | 0.0357 | -0.0738 | -0.0821 |
| **ks4_mean_points_score** | 0.0080 | -0.0069 | -0.0239 | 0.0117 | 0.0175 | 0.0259 |
| **combi_air_qual_ind** | 0.0591 | -0.2885 | -0.0937 | -0.2149 | 0.0507 | -0.0101 |
| **area_green** | 0.0054 | -0.0226 | -0.0282 | 0.0453 | -0.0186 | 0.0085 |
| **smr_lsoa_01** | 0.0352 | -0.0143 | -0.0488 | 0.0065 | -0.0195 | -0.0182 |
| **le_all** | 0.0727 | -0.0422 | -0.1291 | -0.0047 | 0.0417 | 0.0407 |
| **concept_teen** | 0.0942 | -0.0465 | -0.0821 | -0.1240 | -0.0405 | -0.0763 |
| **pphhlds_limlong_ill** | 0.0580 | 0.0930 | -0.0557 | 0.1326 | -0.0474 | -0.0411 |
| **perc_rough** | -0.0017 | -0.0174 | -0.0169 | -0.0108 | 0.0072 | 0.0057 |
| **phhlds_noheating** | -0.0003 | 0.0162 | -0.1208 | -0.0700 | -0.1277 | -0.0585 |
| **perc_commute_wrk** | -0.0858 | -0.0219 | 0.1397 | 0.0793 | -0.0291 | 0.0198 |
| **perc_privtrans_wrk** | -0.0053 | 0.0962 | 0.1082 | 0.1236 | 0.0015 | 0.0083 |
| **perc_pubtrans_wrk** | -0.0474 | 0.2132 | 0.0483 | -0.2443 | 0.0654 | 0.0098 |
| **perc_footbike_wrk** | 0.0090 | -0.0487 | 0.1077 | -0.0535 | -0.0172 | -0.005 |

We find that the correlations between PCT performance indicators are very small (see Table 7). The negative correlation (though small) between the current distance from target (curr_dft_percent) and the financial management (finman) indicators is to be expected.

**Table 7: Correlations of PCT performance indicators used in analysis**

| PCT performance indicators | finman | star_rating | curr_dft_percent |
|---|---|---|---|
| **finman** | 1 | | |
| **star_rating** | 0.2300 | 1 | |
| **curr_dft_percent** | -0.1531 | 0.0074 | 1 |

Similarly to PCTs, the performance indicators for LAs do not exhibit very strong correlations (see Table 8). As with PCTs, there is a positive correlation again between the overall rating (star_rating) and their use of resources or financial management (use_resources) which is not surprising, since the latter is a component of the former composite score.

**Table 8: Correlations of LA performance indicators used in analysis**

| LA performance indicators | band_d_counciltax | star_rating | use_resources |
|---|---|---|---|
| **band_d_counciltax** | 1 | | |
| **star_rating** | -0.0279 | 1 | |
| **use_resources** | 0.0409 | 0.4974 | 1 |

Finally, we find very low correlations between PCT and LA performance indictors, as shown in Table 9.

**Table 9: Correlations of PCT and LA performance indicators**

| PCT performance indicators / LA performance indicators | finman | star_rating | curr_dft_percent |
|---|---|---|---|
| **band_d_counciltax** | 0.0445 | 0.1008 | 0.0518 |
| **star_rating** | 0.0925 | 0.0277 | 0.1354 |
| **use_resources** | 0.0113 | 0.0279 | 0.0902 |

### *5.1.2. Factor analysis*

Factor analysis (FA) has been performed to investigate whether the quality of life indicators used in this study show any interrelationships and to explain these indicators in terms of common underlying dimensions (or factors). Further, the variable 'uniqueness' shows the variance that is 'unique' to the variable and not shared with other variables. The greater the value taken by the variable 'uniqueness' the lower variance shared with other variables in the models and the lower the relevance of the variable in the factor model.

Results of the FA analysis for the 20 quality of life indicators are shown in Table 10. Again we have highlighted only values greater than ±0.6.

**Table 10: Factor analysis of 20 quality of life indicators**

| Quality of Life indicator | Factor1 | Factor2 | Factor3 | Factor4 | Factor5 | Factor6 | Factor7 | Factor8 | Factor9 | Factor10 | Uniqueness |
|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.5392 | 0.3030 | 0.3490 | 0.1273 | 0.1009 | 0.1208 | -0.0922 | -0.0517 | 0.0887 | 0.0477 | 0.4333 |
| imd_score_kids | **0.9121** | 0.1841 | 0.0651 | 0.0557 | -0.0275 | 0.0029 | -0.0125 | -0.1316 | -0.0138 | -0.0157 | 0.1082 |
| imd_score_elderly | **0.7859** | 0.2256 | 0.1488 | 0.0861 | 0.0233 | 0.2267 | 0.0131 | 0.0716 | -0.0050 | -0.0784 | 0.2385 |
| wa_tot_ben | **0.9567** | -0.0479 | 0.0951 | -0.0461 | 0.1064 | 0.0031 | -0.0530 | -0.0111 | 0.0040 | 0.0422 | 0.0552 |
| wa_jsa | **0.8098** | 0.2254 | 0.1669 | 0.0049 | -0.0899 | -0.0021 | -0.0191 | 0.1933 | 0.0493 | -0.0067 | 0.2172 |
| combi_air_qual_ind | 0.2283 | **0.7198** | 0.1887 | 0.0115 | 0.0204 | 0.0687 | -0.2356 | 0.0137 | 0.0268 | 0.0072 | 0.3325 |
| area_green | -0.1118 | -0.2272 | -0.0985 | -0.1219 | -0.1006 | 0.0178 | 0.2923 | 0.0145 | 0.0155 | 0.0049 | **0.8150** |
| ks4_mean_points_score | **-0.6717** | 0.0210 | -0.1823 | -0.1311 | -0.0205 | 0.0256 | 0.0289 | 0.2708 | -0.0105 | -0.0003 | 0.4226 |
| sec_school_absence | 0.3935 | 0.0152 | 0.3382 | 0.0892 | 0.1002 | 0.0077 | 0.0208 | -0.1513 | 0.0620 | 0.0280 | **0.6845** |
| smr_lsoa_01 | 0.3551 | -0.0090 | 0.0720 | 0.0479 | -0.0126 | 0.3750 | 0.0162 | 0.0108 | 0.0055 | -0.0077 | **0.7251** |
| pphhlds_limlong_ill | **0.6846** | -0.2907 | 0.0318 | -0.1390 | 0.4998 | 0.0242 | -0.0081 | -0.0284 | -0.0224 | 0.0171 | 0.1745 |
| perc_rough | 0.0331 | 0.0273 | -0.0151 | 0.1402 | -0.0330 | 0.0354 | -0.0135 | 0.0275 | 0.0274 | 0.0840 | **0.9672** |
| phhlds_noheating | 0.3386 | 0.0186 | 0.3872 | 0.1974 | 0.0826 | -0.0206 | 0.1486 | 0.0428 | -0.0107 | -0.0667 | **0.6603** |
| perc_commute_wrk | -0.4795 | -0.2992 | -0.2139 | 0.0172 | -0.4119 | 0.0158 | 0.0363 | -0.0218 | -0.0509 | 0.0318 | 0.4592 |
| perc_privtrans_wrk | **-0.7179** | -0.4875 | 0.0241 | -0.2524 | -0.2163 | -0.0142 | -0.1517 | -0.0497 | 0.0335 | 0.0113 | 0.1091 |
| perc_pubtrans_wrk | 0.0811 | **0.8759** | -0.0050 | -0.0522 | -0.0598 | -0.0244 | 0.0745 | -0.0098 | -0.0104 | -0.0045 | 0.2135 |
| perc_footbike_wrk | 0.0657 | -0.0463 | 0.0128 | **0.6922** | -0.0590 | 0.0253 | -0.0145 | -0.0148 | 0.0014 | 0.0010 | 0.5097 |
| turnout | -0.1782 | -0.1132 | -0.3013 | -0.1102 | 0.1769 | -0.0147 | 0.1206 | 0.1246 | 0.1015 | -0.0039 | **0.7806** |
| le_all | -0.5799 | -0.0536 | -0.3676 | -0.0995 | -0.0561 | -0.3236 | 0.0462 | 0.0221 | 0.0054 | -0.0358 | 0.4040 |
| concept_teen | 0.4873 | 0.2142 | 0.5388 | -0.1094 | 0.0554 | 0.0417 | -0.0545 | 0.0075 | -0.0104 | -0.0066 | 0.4064 |

The column 'uniqueness' in our results shows that a number of quality of life indicators are unique and therefore do not load onto any factors in the factor analysis. These are: area of green space per head (area_green) (confirmed by low correlations with all other variables), average proportion of sessions missed through both authorised and unauthorised absence (sec_school_absence), age-sex standardised mortality ratios (smr_lsoa_01), percentage of people living rough (perc_rough), percentage of households without central heating (phhlds_noheating), and turnout at various political elections (turnout).

The second part of the factor analysis entails the identification of the underlying (related) factors across the quality of life indicators used in this study. Ten different factors were identified, although only the first two are really significant in terms of having high loadings. The first factor has a considerable number of indicators loading onto it, and it may be thought of in terms of an income deprivation variable. In fact, the highest (positive) interrelationships are with the percentage of all people of working age claiming a key benefit (wa_tot_ben) and the level of deprivation amongst children (imd_score_kids). A high and positive correlation exists also with the percentage of people of working age claiming a job seekers allowance (wa_jsa).

Further, negative and high correlations exist between factor 1 (income deprivation) and the percentage of all people travelling to work by private transport (perc_privtrans_wrk) and the average point score for Key Stage 4 examinations (ks4_mean_points_score). The former may be explained by the fact that individuals with higher income may more often be car owners than individuals at the bottom end of the income distribution, while the latter suggests that pupils from higher income families tend to attain higher qualifications than their poorer counterparts.

Only two quality of life indicators appear to have a high relationship with the second factor. The combined air quality indicator (combi_air_qual_ind) and the percentage of people that commute to work by public transport (perc_pubtrans_wrk) which show a positive association. Given that higher values of the combined air quality indicator correspond to poorer overall air quality (see Table 1 for the sign of the indicator) and that the relationship between the former and factor 2 is positive, we tend to identify this underlying factor with some measure of environment deprivation. This is corroborated by the positive relationship with the percentage of people using public transport to travel to work, which we assume may be more prominent amongst individuals living in an area oh higher deprivation.

### *5.1.3. Analysis of variance*

Analysis of variance (ANOVA) allows one to decompose the observed variance into different components related to the different explanatory variables introduced in the model.

We use the analysis of variance to examine the differences in performance across public sector organisations. In particular, we calculated ANOVA models for each quality of life indicator and the six organisational hierarchies identified in our model. Each ANOVA model uses as the dependent variable a given organisational hierarchy, say local authority, and decomposed the variance in the quality of life indicator under consideration into a **between** organisational hierarchy variation and a **within** organisational hierarchy variation.

The results are presented in Table 11. Our figures suggest that variation in any given quality of life indicator is particularly marked at small area level. An exception is, for example, the percentage of households with one or more limiting longstanding illness (pphhlds_limlong_ill) for which a quite large variation occurs at governmental regional level. All results are highly significant. Some significant variation is also detected at Local Authority level.

**Table 11: ANOVA results for organisational variation in quality of life indicators**

| Quality of life indicators | $\sigma^2_{gors}$ | $\sigma^2_{la}$ | $\sigma^2_{sha}$ | $\sigma^2_{pct}$ | $\sigma^2_{lsoa}$ | $\sigma^{2\ *}_{ward}$ |
|---|---|---|---|---|---|---|
| turnout | 0.007011 | 0.0092427 | 0.000354 | 0.000156 | - | 0.010136 |
| imd_score_crime | 0.032685 | 0.1814579 | 0.002607 | 0.003055 | 0.189649 | - |
| imd_score_kids | 0.018602 | 0.1056104 | 0.006443 | 0.001176 | 0.117413 | - |
| imd_score_elderly | 0.034235 | 0.1244752 | 0.002338 | 0.000036 | 0.137078 | - |
| wa_tot_ben | 0.082545 | 0.081383 | 0.000058 | 0.000037 | 0.082296 | - |
| wa_jsa | 0.023365 | 0.1202894 | 0.003482 | 0.000027 | 0.133751 | - |
| sec_school_absence | 0.038421 | 0.0295659 | 0.000159 | 0.003250 | 0.029577 | - |
| ks4_mean_points_score | 0.015620 | 0.0226885 | 0.000000 | 0.000057 | 0.021247 | - |
| combi_air_qual_ind | 0.000006 | 0.2746124 | 0.043796 | 0.000003 | 0.354494 | - |
| area_green | 0.000007 | 0.0373521 | 0.001051 | 0.000006 | 0.040657 | - |
| le_all | 0.103933 | 0.0829133 | 0.000545 | 0.000001 | - | 0.082821 |
| concept_teen | 0.032266 | 0.1899956 | 0.007564 | 0.001464 | - | 0.192194 |
| smr_lsoa_01 | 0.022783 | 0.0125719 | 0.000026 | 0.000002 | 0.012824 | - |
| pphhlds_limlong_ill | 0.135962 | 0.0232276 | 0.016511 | 0.000003 | 0.018275 | - |
| perc_rough | 0.000749 | 0.000349 | 0.000025 | 0.000079 | 0.000275 | - |
| phhlds_noheating | 0.014768 | 0.0393086 | 0.008991 | 0.004032 | 0.031625 | - |
| perc_commute_wrk | 0.042139 | 0.2274039 | 0.001117 | 0.000174 | 0.254053 | - |
| perc_privtrans_wrk | 0.001231 | 0.168183 | 0.045744 | 0.001503 | 0.209223 | - |
| perc_pubtrans_wrk | 0.027171 | 0.2647287 | 0.172781 | 0.001464 | 0.374033 | - |
| perc_footbike_wrk | 0.008412 | 0.017444 | 0.000720 | 0.000199 | 0.024470 | - |

* Election turnout and teenage conception data are available at electoral ward, whereas life expectancy is available at 2001 Census Standard table ward.

ANOVA models are not helpful when one wants to analyse the residual variances in hierarchical (multi-level) structures. This information is provided through a multi-level modelling approach which enables one to account for the several hierarchical levels and to analyse the extent of variability in performance that is attributable to these different hierarchical levels. We therefore turn to these results next.

## 5.2. Multi-level models

In this section we present the results for our hierarchical models. As mentioned, we analyse four different models, 3 two-tier models, and 1 three-tier model, which differ only with respect to the organisational hierarchy that we assign to the PSO levels. The lowest level in our analysis always stays the same, namely the lower layer super output area or ward.

### *5.2.1. Model 1*

Our first model has a two-tier hierarchical structure, with lower super output areas or wards as the lowest level (level 1), which are nested within LAs (level 2). Governmental regions are introduced as dummy variables with the reference dummy being the region London. Within this framework we estimate 20 separate models, one for each quality of life indicator. We start from a simple (basic) model specification, where we have no explanatory variables with the aim of eliciting pure level effects. Results for the basic model are shown in Section 5.2.1.1. We then control for socio-demographic characteristics in two ways. Firstly, we introduce the overall score Index of Multiple Deprivation (IMD) as model 1A. Since the overall IMD score is a weighted aggregation of deprivation indicators that are similar to some of the quality of life indicators, which may potentially cause problems of endogeneity, we also run models with domain specific indicators of deprivation. Further, the use of domain specific indicators of deprivation have the advantage of enabling us to elicit the effect that each individual domain has on any of the quality of life indicators. The model which uses domain specific need variables is model 1B. Results for these two model specifications are shown respectively in Sections 5.2.1.2 and 5.2.1.3. In the last model we introduce three explanatory variables defined at local authority level to capture different aspects of performance for local authorities, alongside the domain specific need variables (model 1C). The results for this model specification are analysed in Section 5.2.1.4. In order to fully understand the effect that the performance indicators may exert in explaining total variation at the two different levels, we also estimate a model which incorporates only the three performance indicators for Local Authorities (model 1D). Results for this latter model are also discussed in Section 5.2.1.4.

#### *5.2.1.1. Model 1 – basic specification*

The estimates of residual variance at local authority level for all quality of life indicators are significant at the 5 percent level. Our results suggest that the proportion of variance (or intra-class correlation) attributable to local authorities, albeit significant, is negligible for standardised mortality ratios (smr_lsoa_01) and for the percentage of people living rough (perc_rough). On the contrary, more than 50 percent of variation is explained at local authority level for the indicators for combined air quality (combi_air_qual_ind) (68 percent) and election turnout (turnout) (51 percent). For all remaining quality of life measures the proportion of variance attributable to local authorities lies somewhere in between these two extremes. Most variation in quality of life indicators is, however, attributable to small area levels.

**Table 12: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to LAs and small areas (Model 1 – levels only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.3396 | 0.091 | 0.27181 | 0.021 | 0.3702 | 0.003 | 0.4234 | 0.5766 |
| imd_score_kids | 0.2809 | 0.012 | 0.00474 | 0.000 | 0.02031 | 0.000 | 0.1891 | 0.8109 |
| imd_score_elderly | 0.208 | 0.0079 | 0.00197 | 0.000 | 0.00738 | 0.000 | 0.2108 | 0.7892 |
| wa_tot_ben | 14.938 | 0.691 | 15.1531 | 1.204 | 58.3129 | 0.460 | 0.2063 | 0.7937 |
| wa_jsa | 3.059 | 0.131 | 0.54411 | 0.043 | 2.107 | 0.017 | 0.2052 | 0.7948 |
| sec_school_absence | 8.119 | 0.1907 | 1.177 | 0.091 | 2.0462 | 0.016 | 0.3651 | 0.6349 |
| ks4_mean_points_score | 34.233 | 0.492 | 7.4786 | 0.615 | 48.2896 | 0.381 | 0.1341 | 0.8659 |
| combi_air_qual_ind | 1.5829 | 0.033 | 0.03623 | 0.003 | 0.01693 | 0.000 | 0.6815 | 0.3185 |
| area_green | 0.0795 | 0.941 | 28.6085 | 2.193 | 51.0399 | 0.403 | 0.3592 | 0.6408 |
| smr_lsoa_01 | 1.1222 | 0.016 | 0.00372 | 0.001 | 0.211 | 0.002 | 0.0174 | 0.9826 |
| pphhlds_limlong_ill | 29.803 | 0.682 | 14.899 | 1.168 | 43.516 | 0.343 | 0.2551 | 0.7449 |
| perc_rough | 0.0035 | 0.001 | 1.3E-05 | 0.000 | 0.00076 | 0.000 | 0.0173 | 0.9827 |
| phhlds_noheating | 7.6594 | 0.678 | 14.7344 | 1.152 | 38.5757 | 0.304 | 0.2764 | 0.7236 |
| perc_commute_wrk | 3.0494 | 0.414 | 5.592 | 0.427 | 5.62207 | 0.044 | 0.4986 | 0.5014 |
| perc_privtrans_wrk | 15.685 | 0.697 | 15.5929 | 1.219 | 41.667 | 0.329 | 0.2723 | 0.7277 |
| perc_pubtrans_wrk | 19.509 | 0.414 | 5.561 | 0.424 | 6.91331 | 0.055 | 0.4458 | 0.5542 |
| perc_footbike_wrk | 5.6375 | 0.341 | 3.719 | 0.291 | 10.2402 | 0.081 | 0.2664 | 0.7336 |
| turnout | 31.602 | 1.2121 | 44.811 | 3.630 | 42.477 | 0.7575 | 0.5134 | 0.4866 |
| le_all | 78.362 | 0.2064 | 1.107 | 0.101 | 4.934 | 0.0802 | 0.1833 | 0.8167 |
| concept_teen | 30.897 | 1.8675 | 103.383 | 8.726 | 154.582 | 3.1015 | 0.4008 | 0.5992 |

$\beta_0$, coefficient intercept; SE, standard error: $\sigma^2_{u0}$, variance of local authority effects; $\sigma^2_{e0}$,variance of the small area effects; $\rho_u$, proportion of variance attributable to local authorities and $\rho_e$ proportion of variance attributable to small areas (LSOAs and wards).

Figure 3 shows the intra-class correlations or proportions of variance attributable to both LAs and LSOAs / wards for all 20 quality of life indicators, where the latter have been ranked in ascending order of proportion of variance existing at Local Authority level. For example, for the two indicators at the bottom left - percentage of people living rough (perc_rough) and standardised mortality ratio (smr_lsoa_01) - over 99 percent of total variance exists at LSOA / ward level.

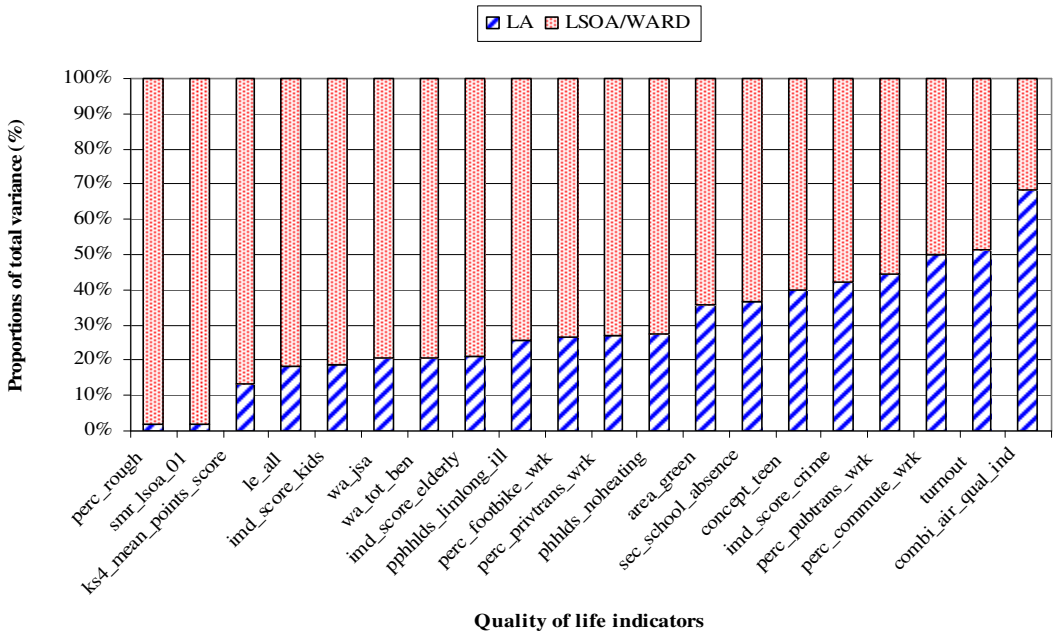



**Figure 3: Proportion of variation in quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1 – levels only)**

Table 13 shows for each quality of life indicator the coefficient of variation. This measure allows one to compare total variance across different indicators. The majority of quality of life indicators show comparable coefficients of variation. An exception is represented by the indicator percentage of people living rough (perc_rough) and to a lesser extent by the indicator area of green space per head (area_green). We recall though from our descriptive statistics that these variables already had a higher coefficient of variation than other indicators (see Table 4 ).

**Table 13: Total variation in quality of life indicator models attributable to LAs and small areas (Model 1 – levels only)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.2718 | - |
| imd_score_kids | 0.0047 | - |
| imd_score_elderly | 0.0020 | - |
| wa_tot_ben | 15.1531 | 0.5961 |
| wa_jsa | 0.5441 | 0.7463 |
| sec_school_absence | 1.1767 | 0.2215 |
| ks4_mean_points_score | 7.4786 | 0.2159 |
| combi_air_qual_ind | 0.0362 | 0.1982 |
| area_green | 28.6085 | 3.9102 |
| smr_lsoa_01 | 0.0037 | 0.4128 |
| pphhlds_limlong_ill | 14.8995 | 0.2285 |
| perc_rough | 0.0000 | 17.0145 |
| phhlds_noheating | 14.7344 | 0.8671 |
| perc_commute_wrk | 5.5918 | 0.5849 |
| perc_privtrans_wrk | 15.5929 | 0.2954 |
| perc_pubtrans_wrk | 5.5613 | 0.5166 |
| perc_footbike_wrk | 3.7192 | 0.6394 |
| turnout | 44.8107 | 0.2796 |
| le_all | 1.1073 | 0.0313 |
| concept_teen | 103.3825 | 0.5789 |

### *5.2.1.2. Model 1A - overall need variable*

In this model specification we introduce an overall need indicator as captured by the IMD overall need score defined at LSOA level (See Section 9.2 in Appendix B for further details). Results are shown in Table 14. β-overall shows the estimates of the overall IMD score for each quality of life indicator. Figures in bold italic are statistically significant at the 5 percent level.

The estimates of residual variance at both local authority and small area level are all significant at the 5 percent level. Similar to the basic model, our results show that most variation occurs at small area level, with two exceptions, namely the combined air quality indicator (combi_air_qual_ind) and election turnout (turnout), for which the opposite is true. More than 90 percent of total variance exists at small area level for standardised mortality ratio, percentage of people living rough, overall life expectancy, average points score for Key Stage 4 and for the IMD score for children (see Figure 4 for a graphical representation). Compared to previous results, the effect of controlling for need is to decrease the proportion of total variance explained at local authority level as well as decreasing the coefficients of variation across all quality of life indicators (see Table 15).

**Table 14: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to LAs and small areas (Model 1A – controlling for overall need)**

| Quality of life indicators | β | SE | β-overall | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.4200 | 0.6609 | ***0.0303*** | 0.0002 | 0.1404 | 0.0108 | 0.2373 | 0.0019 | 0.3717 | 0.6283 |
| imd_score_kids | 0.1307 | 0.0036 | ***0.0106*** | 0.0000 | 0.0004 | 0.0000 | 0.0036 | 0.0000 | 0.0971 | 0.9029 |
| imd_score_elderly | 0.6698 | 0.0034 | ***0.0006*** | 0.0000 | 0.0003 | 0.0000 | 0.0027 | 0.0000 | 0.1125 | 0.8875 |
| wa_tot_ben | 0.0833 | 0.2483 | ***0.5893*** | 0.0012 | 1.9262 | 0.1522 | 7.2385 | 0.0571 | 0.2102 | 0.7898 |
| wa_jsa | 0.7019 | 0.0676 | ***0.0936*** | 0.0004 | 0.1392 | 0.0114 | 0.8200 | 0.0065 | 0.1451 | 0.8549 |
| sec_school_absence | 6.9223 | 0.1661 | ***0.0475*** | 0.0006 | 0.8834 | 0.0684 | 1.7189 | 0.0136 | 0.3395 | 0.6605 |
| ks4_mean_points_score | 44.0259 | 0.2851 | -0.3841 | 0.0023 | 2.3190 | 0.2021 | 26.3412 | 0.2080 | 0.0809 | 0.9191 |
| combi_air_qual_ind | 1.5033 | 0.0317 | ***0.0032*** | 0.0001 | 0.0329 | 0.0025 | 0.0155 | 0.0001 | 0.6800 | 0.3200 |
| area_green | 0.6348 | 0.9334 | -0.0221 | 0.0033 | 27.9478 | 2.1585 | 50.9810 | 0.4022 | 0.3541 | 0.6459 |
| smr_lsoa_01 | 0.8273 | 0.0118 | ***0.0117*** | 0.0002 | 0.0025 | 0.0004 | 0.1889 | 0.0015 | 0.0129 | 0.9871 |
| pphhlds_limlong_ill | 21.0306 | 0.4598 | ***0.3488*** | 0.0023 | 6.5960 | 0.5242 | 25.7688 | 0.2033 | 0.2038 | 0.7962 |
| perc_rough | 0.0011 | 0.0008 | ***0.0001*** | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0001 | 0.0158 | 0.9842 |
| phhlds_noheating | 1.9900 | 0.5850 | ***0.2252*** | 0.0026 | 10.8200 | 0.8489 | 31.1873 | 0.2461 | 0.2576 | 0.7424 |
| perc_commute_wrk | 5.2035 | 0.3554 | -0.0857 | 0.0010 | 4.0944 | 0.3120 | 4.5606 | 0.3598 | 0.4731 | 0.5269 |
| perc_privtrans_wrk | 25.9081 | 0.4512 | -0.4059 | 0.0019 | 6.4504 | 0.5045 | 17.5493 | 0.1385 | 0.2688 | 0.7312 |
| perc_pubtrans_wrk | 19.4856 | 0.4142 | 0.0009 | 0.0012 | 5.5489 | 0.4239 | 6.9134 | 0.0545 | 0.4453 | 0.5547 |
| perc_footbike_wrk | 4.2611 | 0.3468 | ***0.0551*** | 0.0014 | 3.8177 | 0.2976 | 9.7883 | 0.0772 | 0.2806 | 0.7194 |
| turnout | 36.4152 | 1.1848 | -0.1876 | 0.0072 | 41.8226 | 3.3837 | 38.4948 | 0.6865 | 0.5207 | 0.4793 |
| le_all | 81.0780 | 0.1245 | -0.1060 | 0.0019 | 0.2229 | 0.0301 | 3.8126 | 0.0619 | 0.0552 | 0.9448 |
| concept_teen | 16.9284 | 14.5458 | ***0.5405*** | 0.0123 | 67.1260 | 5.7463 | 114.4711 | 2.2966 | 0.3696 | 0.6304 |

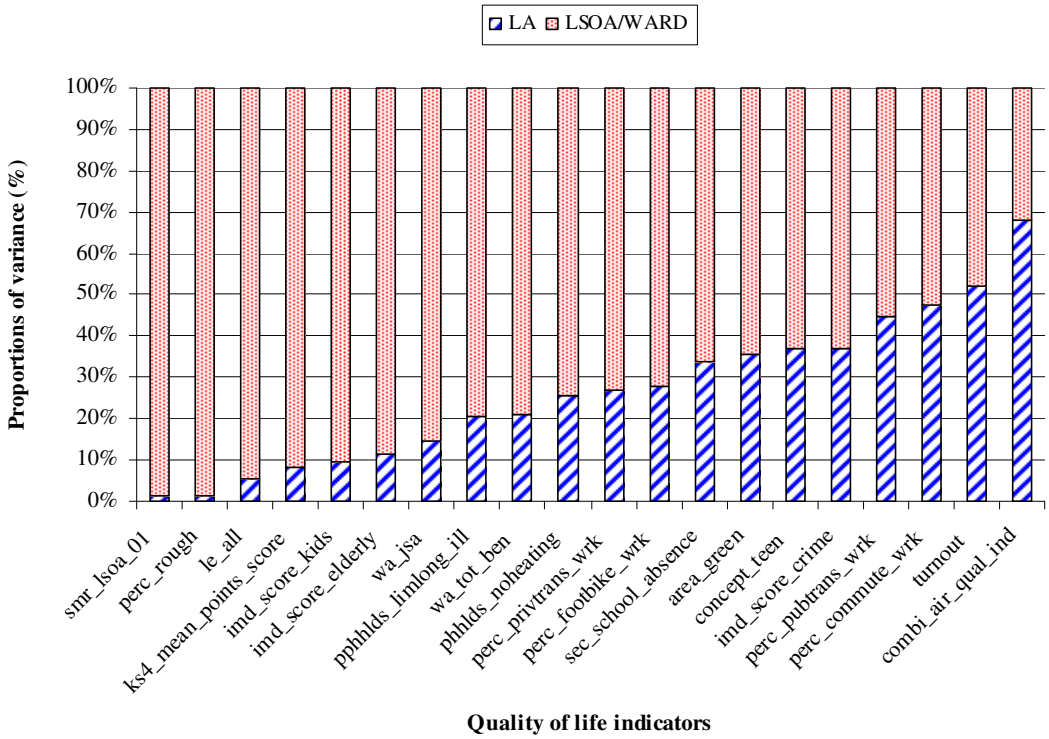



**Figure 4: Proportion of variation in quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1A – controlling for overall need)**

**Table 15: Total variation in quality of life indicator models attributable to LAs and small areas (Model 1A – controlling for overall need)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3777 | - |
| imd_score_kids | 0.0039 | - |
| imd_score_elderly | 0.0031 | - |
| wa_tot_ben | 9.1647 | 0.2105 |
| wa_jsa | 0.9592 | 0.4489 |
| sec_school_absence | 2.6023 | 0.1991 |
| ks4_mean_points_score | 28.6601 | 0.1548 |
| combi_air_qual_ind | 0.0484 | 0.1890 |
| area_green | 78.9287 | 3.8925 |
| smr_lsoa_01 | 0.1913 | 0.3900 |
| pphhlds_limlong_ill | 32.3647 | 0.1701 |
| perc_rough | 0.0008 | 16.9914 |
| phhlds_noheating | 42.0072 | 0.7697 |
| perc_commute_wrk | 8.6549 | 0.5138 |
| perc_privtrans_wrk | 23.9997 | 0.1913 |
| perc_pubtrans_wrk | 12.4623 | 0.5163 |
| perc_footbike_wrk | 13.6060 | 0.6313 |
| turnout | 80.3173 | 0.2682 |
| le_all | 4.0354 | 0.0256 |
| concept_teen | 181.5971 | 0.4857 |

The IMD overall score is a composite measure and is built using indicators that may be correlated with the same quality of life indicators that are used in this study. Hence, we use the seven domain specific IMD need indicators in the next section.

#### *5.2.1.3. Model 1B - domain specific need variables*

Introducing domain specific need variables has the effect of increasing the estimates of total variance attributable to local authorities (see Table 16 and Figure 5), with a number of exceptions: the IMD score on crime (imd_score_crime), the average proportion of sessions missed through absence in secondary schools (sec_school_absence), the indicator of combined air quality (combi_air_qula_ind), the area of green space per head (area_green), the percentage of households with one or more limiting longstanding illnesses (pphhlds_limlong_ill) and the level of life expectancy (le_all). However, the coefficients of variation (see Table 17) have actually decreased compared to the one obtained with the overall need indicator for all quality of life indicators, except for total number of individuals of working age claiming key benefits (wa_tot_ben) and job seekers allowance (wa_jsa), standardised mortality ratios (smr_lsoa_01) and percentage of households without central heating (phhlds_noheating).

**Table 16: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to LAs and small areas (Model 1B – controlling for domain specific need variables)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.0145 | 0.065 | 0.128 | 0.010 | 0.233 | 0.002 | 0.3545 | 0.6455 |
| imd_score_kids | 0.0954 | 0.006 | 0.001 | 0.000 | 0.004 | 0.000 | 0.1934 | 0.8066 |
| imd_score_elderly | 0.1349 | 0.006 | 0.001 | 0.000 | 0.003 | 0.000 | 0.2658 | 0.7342 |
| wa_tot_ben | 11.107 | 0.374 | 4.192 | 0.327 | 10.649 | 0.084 | 0.2825 | 0.7175 |
| wa_jsa | 1.966 | 0.093 | 0.247 | 0.020 | 1.079 | 0.009 | 0.1862 | 0.8138 |
| sec_school_absence | 7.568 | 0.169 | 0.861 | 0.067 | 1.727 | 0.014 | 0.3327 | 0.6673 |
| ks4_mean_points_score | 38.326 | 0.353 | 2.929 | 0.247 | 25.442 | 0.201 | 0.1032 | 0.8968 |
| combi_air_qual_ind | 1.6828 | 0.029 | 0.028 | 0.002 | 0.014 | 0.000 | 0.6667 | 0.3333 |
| area_green | -15.59 | 0.772 | 18.186 | 1.408 | 35.913 | 0.283 | 0.3362 | 0.6638 |
| smr_lsoa_01 | 0.8196 | 0.016 | 0.003 | 0.000 | 0.189 | 0.001 | 0.0143 | 0.9857 |
| pphhlds_limlong_ill | 26.018 | 0.385 | 4.129 | 0.334 | 21.482 | 0.169 | 0.1612 | 0.8388 |
| perc_rough | 0.0018 | 0.001 | 0.000 | 0.000 | 0.001 | 0.000 | 0.0160 | 0.9840 |
| phhlds_noheating | 6.4401 | 0.648 | 12.525 | 0.980 | 32.692 | 0.258 | 0.2770 | 0.7230 |
| perc_commute_wrk | 2.1371 | 0.348 | 3.795 | 0.288 | 4.038 | 0.032 | 0.4845 | 0.5155 |
| perc_privtrans_wrk | 24.228 | 0.475 | 6.679 | 0.519 | 15.982 | 0.126 | 0.2947 | 0.7053 |
| perc_pubtrans_wrk | 19.832 | 0.397 | 4.874 | 0.374 | 6.346 | 0.050 | 0.4344 | 0.5656 |
| perc_footbike_wrk | 8.0744 | 0.425 | 5.604 | 0.429 | 7.301 | 0.058 | 0.4342 | 0.5658 |
| turnout | 26.341 | 1.246 | 42.727 | 3.425 | 32.023 | 0.571 | 0.5716 | 0.4284 |
| le_all | 80.541 | 0.140 | 0.161 | 0.025 | 3.756 | 0.061 | 0.0411 | 0.9589 |
| concept_teen | 20.152 | 1.687 | 65.545 | 5.591 | 109.048 | 2.188 | 0.3754 | 0.6246 |

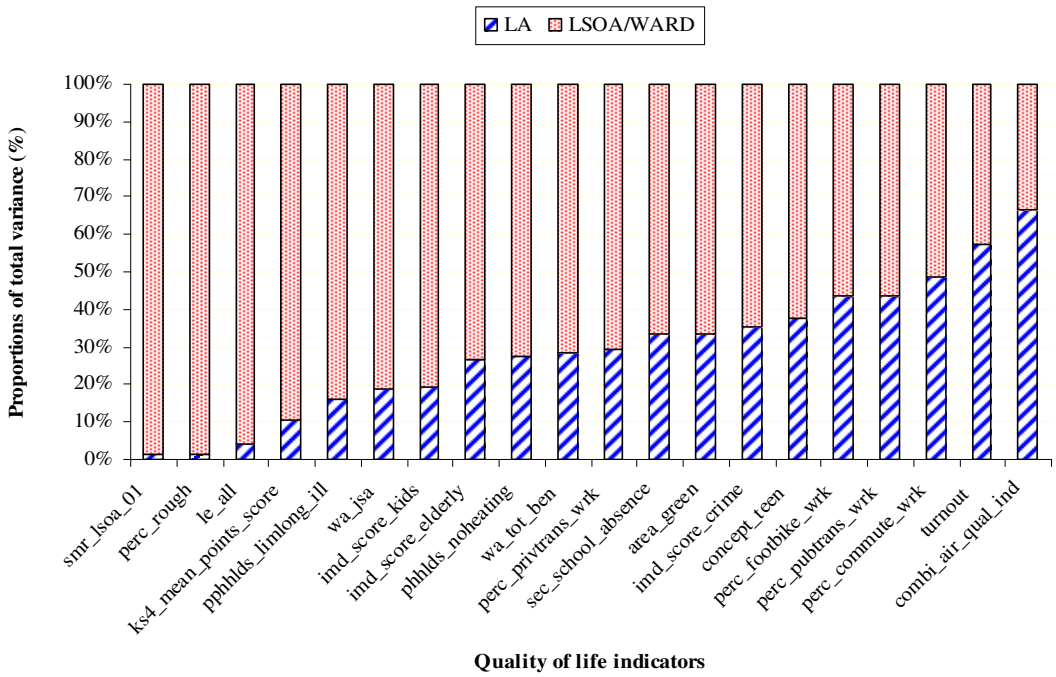



**Figure 5: Proportion of variation in quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1B – controlling for domain specific need variables)**

Table 17 shows the total variance and coefficient of variation for this model specification. Compared to the results of both the basic model and the model with one overall need indicator, the coefficients of variation decrease even further; an indication that introducing domain specific need indicators reduces the amount of total residual variation. There are, however, a few exceptions, for example the percentage of households without central heating (phhlds_noheating).

**Table 17: Total variation in quality of life indicator models attributable to LAs and small areas (Model 1B – controlling for domain specific need variables)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3615 | - |
| imd_score_kids | 0.0052 | - |
| imd_score_elderly | 0.0037 | - |
| wa_tot_ben | 14.8415 | 0.2679 |
| wa_jsa | 1.3256 | 0.5277 |
| sec_school_absence | 2.5887 | 0.1985 |
| ks4_mean_points_score | 28.3700 | 0.1540 |
| combi_air_qual_ind | 0.0416 | 0.1753 |
| area_green | 54.0991 | 3.2226 |
| smr_lsoa_01 | 0.1917 | 0.3903 |
| pphhlds_limlong_ill | 25.6114 | 0.1513 |
| perc_rough | 0.0008 | 16.9325 |
| phhlds_noheating | 45.2172 | 0.7985 |
| perc_commute_wrk | 7.8333 | 0.4888 |
| perc_privtrans_wrk | 22.6614 | 0.1859 |
| perc_pubtrans_wrk | 11.2199 | 0.4899 |
| perc_footbike_wrk | 12.9058 | 0.6148 |
| turnout | 74.7494 | 0.2587 |
| le_all | 3.9167 | 0.0252 |
| concept_teen | 174.5931 | 0.4762 |

Table 18 shows the estimated coefficients of the various domain specific need variables for the 20 quality of life indicators. Estimates significant at the 5 percent level are shown in bold italic. These show the expected sign in the majority of cases; thus, for example, one would expect the total number of individuals of working age claiming key benefits (wa_tot_ben) to be positively related to the deprivation indicator for health, which measures amongst other things the proportion of people whose quality of life is impaired by poor health or disability. Further, a high and positive association exists for the percentage of households reporting one or more limiting longstanding illness (pphhlds_limlong_ill) and the IMD score for employment. A counter-intuitive result is the positive association between the average points score for Key Stage 4 examinations and the IMD score for employment deprivation, suggesting that better educational attainment is associated with greater employment deprivation. It is possible that despite carefully specifying the models, there remains some collinearity between the need variables.

*5.2.1.4. Model 1C and Model 1D - model with LA performance indicators with and without domain specific need variables*

The estimates of residual variance of all quality of life indicators for the model including both domain specific need indicators and performance indicators for local authorities are shown in Table 19 and Figure 6 (for a graphical representation). These are statistically significant at the 5 percent level at both local authority and LSOA and ward level, with the only exception being the standardised mortality ratio indicator (smr_lsoa_01) at local authority level. Estimates of residual variance are in general smaller in model 1C than in other previous models (with the exception of the total number of individuals of working age claiming key benefits (wa_tot_ben) and the percentage of individuals living rough (perc_rough)).

Only two quality of life indicators, the combined air quality indicator (combi_air_qual_ind) and election turnout (turnout), show a proportion of variance greater than 50 percent at local authority level; for the remaining quality of life indicators the proportion of variance is greatest at small area level. The higher proportion of variance that exists for the combined air quality indicator may be due to the existence of differential policies in terms of $CO_2$ emissions implemented at local authority level to tackle existing poor air quality. These may include a range of policies such as congestion charges, the creation of wider areas of pedestrian only zones within city centres, etc. The high proportion of variance attributable at local authority level for election turnout may well be an indication of differential levels of community involvement that is present at this administrative level.

**Table 18: The beta coefficients for domain specific need variables for models attributable to LAs and small areas (Model 1B – controlling for domain specific need variables)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***0.7419*** | 0.0818 | ***0.3701*** | 0.1286 | ***0.2933*** | 0.0101 | ***0.0017*** | 0.0003 | -0.0079 | 0.0003 | ***0.0126*** | 0.0002 | - | - |
| imd_score_kids | - | - | ***0.9497*** | 0.0135 | ***0.0518*** | 0.0013 | ***0.0032*** | 0.0000 | ***0.0010*** | 0.0000 | ***0.0002*** | 0.0000 | ***0.0114*** | 0.0007 |
| imd_score_elderly | - | - | ***0.2519*** | 0.0108 | ***0.0832*** | 0.0011 | ***0.0004*** | 0.0000 | ***0.0005*** | 0.0000 | ***0.0010*** | 0.0000 | -0.0003 | 0.0006 |
| wa_tot_ben | - | - | - | - | ***7.1148*** | 0.0519 | ***0.2156*** | 0.0016 | ***0.0319*** | 0.0023 | -0.0126 | 0.0017 | ***0.4934*** | 0.0372 |
| wa_jsa | - | - | - | - | ***1.0570*** | 0.0164 | ***0.0213*** | 0.0005 | ***0.0087*** | 0.0007 | ***0.0148*** | 0.0005 | ***0.1843*** | 0.0118 |
| sec_school_absence | ***1.6562*** | 0.1958 | ***1.2749*** | 0.3516 | ***0.4523*** | 0.0278 | - | - | -0.0017 | 0.0009 | ***0.0044*** | 0.0007 | ***0.2104*** | 0.0151 |
| ks4_mean_points_score | -38.9692 | 0.7402 | ***25.8705*** | 1.3337 | -4.0984 | 0.1038 | - | - | ***0.0174*** | 0.0035 | -0.0053 | 0.0026 | -0.6760 | 0.0570 |
| combi_air_qual_ind | ***0.1605*** | 0.0200 | -0.2363 | 0.0314 | ***0.0499*** | 0.0025 | -0.0004 | 0.0001 | -0.0035 | 0.0001 | - | - | ***0.0421*** | 0.0013 |
| area_green | -0.6863 | 1.0134 | ***10.6809*** | 1.5948 | -1.8746 | 0.1260 | -0.0094 | 0.0037 | ***0.4685*** | 0.0043 | - | - | -0.0381 | 0.0661 |
| smr_lsoa_01 | ***1.3248*** | 0.0688 | ***0.2827*** | 0.1005 | - | - | -0.0015 | 0.0003 | 0.0004 | 0.0003 | ***0.0012*** | 0.0002 | ***0.0361*** | 0.0012 |
| pphhlds_limlong_ill | -5.4140 | 0.7695 | ***67.3198*** | 1.1312 | - | - | ***0.1252*** | 0.0029 | -0.0654 | 0.0033 | -0.0564 | 0.0024 | -0.3934 | 0.0520 |
| perc_rough | -0.0260 | 0.0044 | ***0.0644*** | 0.0070 | ***0.0021*** | 0.0005 | -0.0001 | 0.0000 | ***0.0000*** | 0.0000 | - | - | ***0.0014*** | 0.0003 |
| phhlds_noheating | ***4.1397*** | 0.0966 | -6.8471 | 1.5203 | ***1.6104*** | 0.1198 | ***0.0694*** | 0.0035 | -0.0102 | 0.0041 | - | - | ***1.3380*** | 0.0629 |
| perc_commute_wrk | ***1.2702*** | 0.3413 | ***1.1009*** | 0.5354 | -1.0716 | 0.0428 | -0.0518 | 0.0012 | ***0.0404*** | 0.0014 | ***0.0040*** | 0.0010 | -0.1481 | 0.0231 |
| perc_privtrans_wrk | -23.5550 | 0.6771 | -22.3031 | 1.0633 | -0.7508 | 0.0844 | -0.0239 | 0.0025 | ***0.0619*** | 0.0028 | -0.1171 | 0.0021 | -0.2709 | 0.0458 |
| perc_pubtrans_wrk | -10.1733 | 0.4276 | ***3.9317*** | 0.6710 | ***0.3568*** | 0.0535 | ***0.0098*** | 0.0016 | -0.0227 | 0.0018 | ***0.0482*** | 0.0013 | ***0.3736*** | 0.0290 |
| perc_footbike_wrk | -5.1313 | 0.4587 | -7.7318 | 0.7197 | ***2.3588*** | 0.0574 | -0.0168 | 0.0017 | -0.0936 | 0.0019 | ***0.0804*** | 0.0014 | ***0.4705*** | 0.0311 |
| turnout | ***9.4284*** | 2.4527 | ***28.0667*** | 3.6291 | -3.4769 | 0.2664 | -0.1668 | 0.0090 | ***0.1107*** | 0.0079 | ***0.0191*** | 0.0072 | -1.7102 | 0.1444 |
| le_all | -2.9598 | 0.7130 | -8.5108 | 0.9707 | - | - | -0.0148 | 0.0027 | ***0.0054*** | 0.0022 | -0.0153 | 0.0021 | -0.5497 | 0.0393 |
| concept_teen | ***15.1176*** | 4.5217 | 0.5983 | 6.2618 | - | - | ***0.2878*** | 0.0166 | 0.0337 | 0.0196 | ***0.0323*** | 0.0140 | ***2.5326*** | 0.2944 |

**Table 19: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to LAs and small areas (Model 1C – controlling for domain specific need variables and LA performance indicators)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.5121 | 0.299 | 0.127 | 0.010 | 0.234 | 0.002 | 0.3525 | 0.6475 |
| imd_score_kids | 0.1267 | 0.027 | 0.001 | 0.000 | 0.004 | 0.000 | 0.1904 | 0.8096 |
| imd_score_elderly | 0.1624 | 0.026 | 0.001 | 0.000 | 0.003 | 0.000 | 0.2626 | 0.7374 |
| wa_tot_ben | 6.752 | 1.747 | 4.290 | 0.335 | 10.608 | 0.084 | 0.2880 | 0.7120 |
| wa_jsa | 1.5543 | 0.423 | 0.243 | 0.020 | 1.081 | 0.009 | 0.1835 | 0.8165 |
| sec_school_absence | 7.327 | 0.783 | 0.859 | 0.067 | 1.728 | 0.014 | 0.3321 | 0.6679 |
| ks4_mean_points_score | 39.999 | 1.509 | 2.869 | 0.243 | 25.481 | 0.202 | 0.1012 | 0.8988 |
| combi_air_qual_ind | 2.2989 | 0.132 | 0.026 | 0.002 | 0.014 | 0.000 | 0.6513 | 0.3487 |
| area_green | -24.6 | 3.542 | 17.820 | 1.384 | 35.998 | 0.285 | 0.3311 | 0.6689 |
| smr_lsoa_01 | 0.7963 | 0.060 | 0.003 | 0.003 | 0.189 | 0.001 | 0.0140 | 0.9860 |
| pphhlds_limlong_ill | 19.824 | 1.717 | 3.937 | 0.320 | 21.512 | 0.170 | 0.1547 | 0.8453 |
| perc_rough | 0.0111 | 0.004 | 0.000 | 0.000 | 0.001 | 0.000 | 0.0161 | 0.9839 |
| phhlds_noheating | 10.453 | 2.987 | 12.519 | 0.982 | 32.779 | 0.259 | 0.2764 | 0.7236 |
| perc_commute_wrk | -1.337 | 1.598 | 3.707 | 0.283 | 4.028 | 0.032 | 0.4793 | 0.5207 |
| perc_privtrans_wrk | 22.238 | 2.174 | 6.647 | 0.518 | 16.003 | 0.127 | 0.2935 | 0.7065 |
| perc_pubtrans_wrk | 25.8 | 1.803 | 4.682 | 0.360 | 6.366 | 0.050 | 0.4238 | 0.5762 |
| perc_footbike_wrk | 12.552 | 1.956 | 5.516 | 0.424 | 7.314 | 0.058 | 0.4299 | 0.5701 |
| turnout | 16.031 | 5.831 | 42.317 | 3.405 | 32.114 | 0.575 | 0.5685 | 0.4315 |
| le_all | 79.971 | 0.508 | 0.154 | 0.025 | 3.758 | 0.061 | 0.0393 | 0.9607 |
| concept_teen | 42.409 | 7.265 | 63.925 | 5.486 | 109.419 | 2.200 | 0.3688 | 0.6312 |

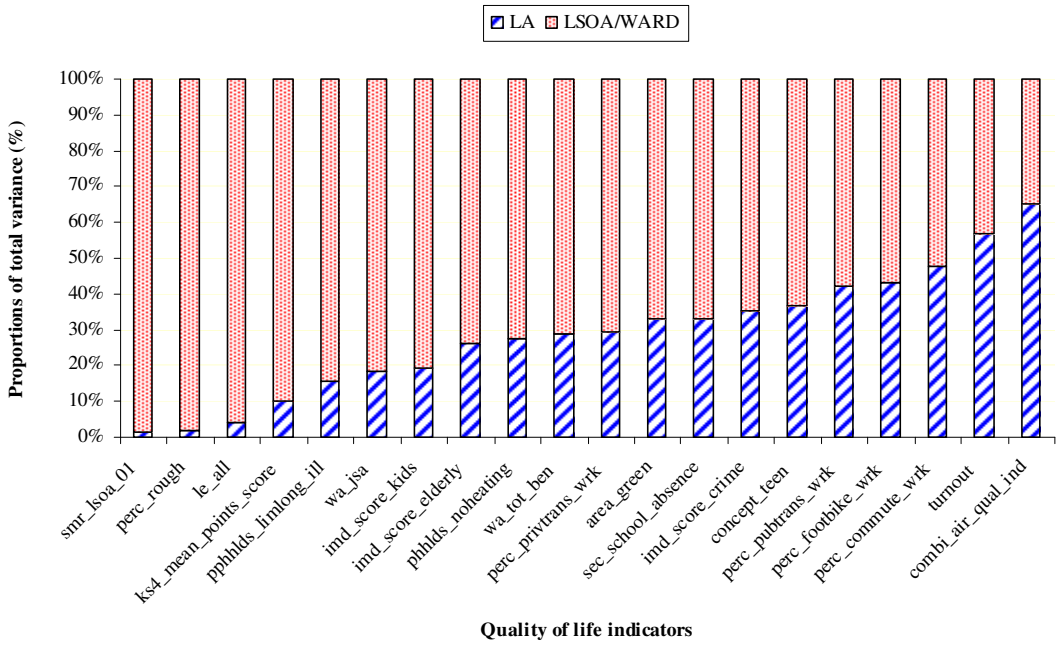



**Figure 6: Proportion of variation in quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1C – controlling for domain specific need variables and LA performance indicators)**

Looking at the coefficients of variance, introducing performance indicators alongside domain specific need variables slightly reduces total variances for the majority of quality of life indicators, except for the percentage of working age population claiming key benefits (wa_tot_ben), the percentage of people living rough (perc-rough) and the percentage of households without central heating (phhlds_noheating), for all of which it is possible to detect a slight increase. However, when we look at the estimates of the coefficients of the performance indicators used in this particular specification of model 1, only the one for council tax band D appears to be significantly related to three quality of life indicators (see Table 21); although the estimates of these coefficients are negligible.

**Table 20: Total variation in quality of life indicator models attributable to LAs and small areas (Model 1C – controlling for domain specific need variables and LA performance indicators)**

| Quality of life indicators | Total variance | Coefficient of Variation |
|---|---|---|
| imd_score_crime | 0.3609 | - |
| imd_score_kids | 0.0052 | - |
| imd_score_elderly | 0.0036 | - |
| wa_tot_ben | 14.8978 | 0.2684 |
| wa_jsa | 1.3242 | 0.5275 |
| sec_school_absence | 2.5865 | 0.1985 |
| ks4_mean_points_score | 28.3497 | 0.1539 |
| combi_air_qual_ind | 0.0398 | 0.1716 |
| area_green | 53.8180 | 3.2142 |
| smr_lsoa_01 | 0.1914 | 0.3900 |
| pphhlds_limlong_ill | 25.4492 | 0.1508 |
| perc_rough | 0.0008 | 16.9620 |
| phhlds_noheating | 45.2975 | 0.7992 |
| perc_commute_wrk | 7.7350 | 0.4857 |
| perc_privtrans_wrk | 22.6499 | 0.1858 |
| perc_pubtrans_wrk | 11.0475 | 0.4861 |
| perc_footbike_wrk | 12.8308 | 0.6130 |
| turnout | 74.4310 | 0.2582 |
| le_all | 3.9112 | 0.0252 |
| concept_teen | 173.3440 | 0.4745 |

**Table 21: The beta coefficients for LA performance indicators for models attributable to LAs and small areas (Model 1C – controlling for domain specific need variables and LA performance indicators)**

| Quality of life indicators | β-counciltax | SE | β-star | SE | β-resource | SE |
|---|---|---|---|---|---|---|
| imd_score_crime | -0.0003 | 0.0003 | -0.0151 | 0.0235 | -0.0272 | 0.0383 |
| imd_score_kids | 0.0000 | 0.0000 | -0.0005 | 0.0021 | 0.0059 | 0.0034 |
| imd_score_elderly | 0.0000 | 0.0000 | 0.0004 | 0.0021 | 0.0042 | 0.0033 |
| wa_tot_ben | 0.0029 | 0.0015 | 0.1810 | 0.1370 | 0.1558 | 0.2232 |
| wa_jsa | 0.0000 | 0.0004 | 0.0045 | 0.0330 | 0.1081 | 0.0538 |
| sec_school_absence | 0.0006 | 0.0007 | 0.0315 | 0.0612 | -0.1350 | 0.0996 |
| ks4_mean_points_score | -0.0011 | 0.0013 | -0.3105 | 0.1165 | 0.1635 | 0.1902 |
| combi_air_qual_ind | -0.0006 | 0.0001 | -0.0080 | 0.0105 | 0.0499 | 0.0025 |
| area_green | ***0.0089*** | 0.0030 | 0.0950 | 0.2784 | -0.2393 | 0.4535 |
| smr_lsoa_01 | 0.0001 | 0.0000 | 0.0036 | 0.0046 | -0.0134 | 0.0076 |
| pphhlds_limlong_ill | ***0.0062*** | 0.0015 | 0.0197 | 0.1337 | -0.1353 | 0.2181 |
| perc_rough | 0.0000 | 0.0000 | 0.0003 | 0.0003 | 0.0002 | 0.0005 |
| phhlds_noheating | -0.0031 | 0.0026 | -0.1624 | 0.2342 | -0.0409 | 0.3817 |
| perc_commute_wrk | ***0.0031*** | 0.0014 | -0.1096 | 0.1262 | 0.1715 | 0.2054 |
| perc_privtrans_wrk | 0.0029 | 0.0019 | -0.0278 | 0.1704 | -0.2845 | 0.2777 |
| perc_pubtrans_wrk | -0.0058 | 0.0015 | -0.0372 | 0.1421 | 0.0813 | 0.2313 |
| perc_footbike_wrk | -0.0052 | 0.0017 | 0.0678 | 0.1542 | 0.2327 | 0.2511 |
| turnout | 0.0085 | 0.0050 | 0.4437 | 0.4399 | -0.1056 | 0.7224 |
| le_all | 0.0004 | 0.0004 | 0.0059 | 0.0371 | 0.0195 | 0.0606 |
| concept_teen | -0.0194 | 0.0062 | 0.0871 | 0.5522 | -0.5183 | 0.9030 |

**Table 22: The beta coefficients for domain specific need variables for models attributable to LAs and small areas (Model 1C – controlling for domain specific need variables and LA performance indicators)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***0.7410*** | 0.0819 | ***0.3677*** | 0.1288 | ***0.2937*** | 0.0101 | ***0.0017*** | 0.0003 | -0.0079 | 0.0003 | ***0.0126*** | 0.0002 | | |
| imd_score_kids | | | ***0.9493*** | 0.0135 | ***0.0519*** | 0.0013 | ***0.0032*** | 0.0000 | ***0.0011*** | 0.0000 | ***0.0002*** | 0.0000 | ***0.0113*** | 0.0007 |
| imd_score_elderly | | | ***0.2520*** | 0.0109 | ***0.0832*** | 0.0011 | ***0.0004*** | 0.0000 | ***0.0005*** | 0.0000 | ***0.0010*** | 0.0000 | -0.0003 | 0.0006 |
| wa_tot_ben | | | | | ***7.1150*** | 0.0520 | ***0.2155*** | 0.0016 | ***0.0321*** | 0.0023 | -0.0125 | 0.0017 | ***0.4927*** | 0.0373 |
| wa_jsa | | | | | ***1.0580*** | 0.0165 | ***0.0213*** | 0.0005 | ***0.0087*** | 0.0007 | ***0.0148*** | 0.0005 | ***0.1847*** | 0.0118 |
| sec_school_absence | ***1.6641*** | 0.1960 | ***1.2548*** | 0.3519 | ***0.4544*** | 0.0278 | | | -0.0017 | 0.0009 | ***0.0044*** | 0.0007 | ***0.2086*** | 0.0151 |
| ks4_mean_points_score | -39.0092 | 0.7412 | ***25.9793*** | 1.3359 | -4.1053 | 0.1037 | | | ***0.0174*** | 0.0035 | -0.0054 | 0.0026 | -0.6743 | 0.0571 |
| combi_air_qual_ind | ***0.1600*** | 0.0200 | -0.2342 | 0.0315 | ***0.0499*** | 0.0025 | -0.0004 | 0.0001 | -0.0035 | 0.0001 | | | ***0.0421*** | 0.0013 |
| area_green | -0.6484 | 1.0155 | ***10.6122*** | 1.5979 | -1.8806 | 0.1263 | -0.0093 | 0.0037 | ***0.4683*** | 0.0043 | | | -0.0371 | 0.0662 |
| smr_lsoa_01 | ***1.3309*** | 0.0689 | ***0.2759*** | 0.1006 | | | -0.0015 | 0.0003 | 0.0004 | 0.0003 | ***0.0012*** | 0.0002 | ***0.0364*** | 0.0018 |
| pphhlds_limlong_ill | -5.4238 | 0.7705 | ***67.3047*** | 1.1326 | | | ***0.1252*** | 0.0029 | -0.0653 | 0.0003 | -0.0562 | 0.0024 | -0.3922 | 0.0521 |
| perc_rough | -0.0266 | 0.0044 | ***0.0653*** | 0.0070 | ***0.0021*** | 0.0005 | -0.0001 | 0.0000 | ***0.0000*** | 0.0000 | | | ***0.0013*** | 0.0003 |
| phhlds_noheating | ***4.1457*** | 0.9678 | -6.8008 | 1.5236 | ***1.6028*** | 0.1201 | ***0.0694*** | 0.0035 | -0.0106 | 0.0041 | | | ***1.3381*** | 0.0631 |
| perc_commute_wrk | ***1.2908*** | 0.3412 | ***1.1388*** | 0.5351 | -1.0749 | 0.0427 | -0.0519 | 0.0012 | ***0.0401*** | 0.0014 | ***0.0041*** | 0.0010 | -0.1485 | 0.0231 |
| perc_privtrans_wrk | -23.5182 | 0.6782 | -22.2802 | 1.0649 | -0.7529 | 0.0846 | -0.0239 | 0.0025 | ***0.0617*** | 0.0029 | -0.1170 | 0.0021 | -0.2707 | 0.0459 |
| perc_pubtrans_wrk | -10.2005 | 0.4287 | ***3.9456*** | 0.6725 | ***0.3579*** | 0.0536 | ***0.0099*** | 0.0016 | -0.0225 | 0.0018 | ***0.0482*** | 0.0013 | ***0.3740*** | 0.0291 |
| perc_footbike_wrk | -5.1394 | 0.4595 | -7.7112 | 0.7209 | ***2.3612*** | 0.0575 | -0.0169 | 0.0017 | -0.0936 | 0.0019 | ***0.0804*** | 0.0014 | ***0.4691*** | 0.0311 |
| turnout | ***9.3773*** | 2.4626 | ***27.9489*** | 3.6409 | -3.4730 | 0.2673 | -0.1663 | 0.0090 | ***0.1103*** | 0.0080 | ***0.0192*** | 0.0073 | -1.7053 | 0.1450 |
| le_all | -2.9776 | 0.7148 | -8.5557 | 0.9730 | | | -0.0147 | 0.0027 | ***0.0056*** | 0.0022 | -0.0151 | 0.0021 | -0.5509 | 0.0394 |
| concept_teen | ***14.9366*** | 4.5375 | 0.9975 | 6.2803 | | | ***0.2884*** | 0.0166 | 0.0323 | 0.0196 | ***0.0311*** | 0.0140 | ***2.5184*** | 0.2953 |

Table 22 shows the estimates of the coefficient for the domain specific deprivation indices for all quality of life indicators. Statistically significant results are shown in bold italic. The majority of these have the expected sign, albeit showing only a negligible influence. It is worth noting that for two quality of life indicators (average point score at KS 4 examinations (ks4_mean_points_score) and the area of green space per head (area_green)), the direction of the influence with the IMD score for employment is counter-intuitive, as both higher attainment at school and greater areas of green space are associated with higher deprivation in terms of involuntary unemployment. Further, it is also worth noticing that election turnout is positively associated with higher levels of deprivation in terms of involuntary unemployment. This may be interpreted in terms of either lower opportunity costs for unemployed to make time to vote or a more active democratic participation of the unemployed in order to make their voices heard and to vote for the political party that may more likely be successful in creating more employment opportunities.

Last, we estimated a simple model with only the three performance indicators for local authorities, with the aim of eliciting the influence of a pure local authority effect over and above that determined by the existence of differences in the socio-economic characteristics of the population at small area level. The estimates of total variance obtained in model 1D (Table 24) are higher than those obtained by the full model specification (see Table 20). In particular, it appears that differences in socio-economic characteristics at small area level account for an important part of total variance for any of the quality of life indicators. However, it also emerges from our results that the proportion of total variance attributable at local authority level is hardly unchanged, thus confirming the robustness of our findings in Model 1C.

**Table 23: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to LAs and small areas (Model 1D – controlling for LA performance indicators only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 1.3166 | 0.430 | 0.26652 | 0.020 | 0.37081 | 0.003 | 0.4182 | 0.5818 |
| imd_score_kids | 0.4039 | 0.058 | 0.00466 | 0.000 | 0.02036 | 0.000 | 0.1863 | 0.8137 |
| imd_score_elderly | 0.314 | 0.037 | 0.002 | 0.000 | 0.0074 | 0.000 | 0.2062 | 0.7938 |
| wa_tot_ben | 16.295 | 3.309 | 15.1076 | 1.204 | 58.4479 | 0.462 | 0.2054 | 0.7946 |
| wa_jsa | 3.932 | 0.626 | 0.5404 | 0.043 | 2.00196 | 0.017 | 0.2126 | 0.7874 |
| sec_school_absence | 8.6218 | 0.911 | 1.17146 | 0.091 | 2.04711 | 0.016 | 0.3640 | 0.6360 |
| ks4_mean_points_score | 29.727 | 2.366 | 7.38069 | 0.609 | 48.3952 | 0.383 | 0.1323 | 0.8677 |
| combi_air_qual_ind | 2.2537 | 0.051 | 0.03418 | 0.003 | 0.01697 | 0.000 | 0.6682 | 0.3318 |
| area_green | -8.953 | 4.450 | 28.336 | 2.178 | 51.0885 | 0.404 | 0.3568 | 0.6432 |
| smr_lsoa_01 | 1.2671 | 0.079 | 0.0065 | 0.001 | 0.211 | 0.002 | 0.0299 | 0.9701 |
| pphhlds_limlong_ill | 23.635 | 3.229 | 14.5953 | 1.148 | 43.5819 | 0.345 | 0.2509 | 0.7491 |
| perc_rough | 0.0152 | 0.004 | 1.3E-05 | 0.000 | 0.00076 | 0.000 | 0.0174 | 0.9826 |
| phhlds_noheating | 14.45 | 3.217 | 14.5663 | 1.142 | 38.6773 | 0.306 | 0.2736 | 0.7264 |
| perc_commute_wrk | -1.096 | 1.944 | 5.510 | 0.422 | 5.61253 | 0.044 | 0.4954 | 0.5046 |
| perc_privtrans_wrk | 8.2304 | 3.311 | 15.4198 | 1.210 | 41.7124 | 0.330 | 0.2699 | 0.7301 |
| perc_pubtrans_wrk | 26.58 | 1.916 | 5.31472 | 0.407 | 6.93553 | 0.055 | 0.4338 | 0.5662 |
| perc_footbike_wrk | 11.847 | 1.603 | 3.60309 | 0.281 | 10.2585 | 0.081 | 0.2599 | 0.7401 |
| turnout | 17.567 | 5.950 | 43.9290 | 3.5737 | 42.5914 | 0.7623 | 0.5077 | 0.4923 |
| le_all | 76.344 | 0.975 | 1.0824 | 0.0995 | 4.9483 | 0.0807 | 0.1795 | 0.8205 |
| concept_teen | 58.021 | 8.978 | 100.788 | 8.557 | 155.092 | 3.1183 | 0.3939 | 0.6061 |

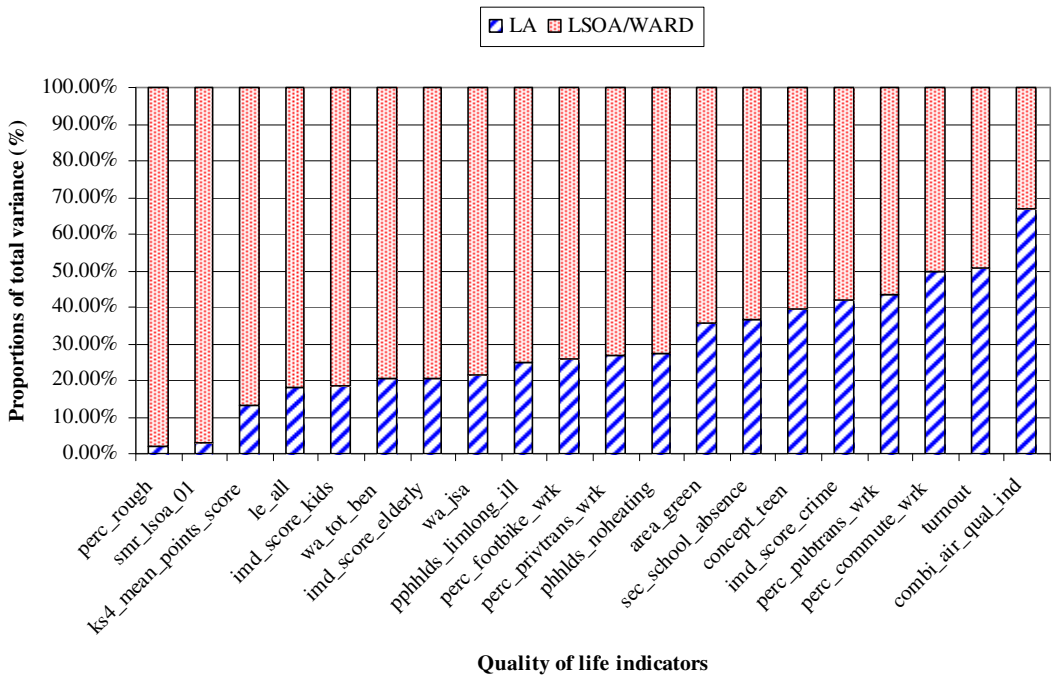



**Figure 7: Proportion of variation in quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1D – controlling for LA performance indicators only)**

**Table 24: Total variation in quality of life indicator models attributable to LAs and small areas (Model 1D – controlling for LA performance indicators only)**

| Quality of life indicators | Total variance | Coefficient of Variation |
|---|---|---|
| imd_score_crime | 0.6373 | - |
| imd_score_kids | 0.0250 | - |
| imd_score_elderly | 0.0093 | - |
| wa_tot_ben | 73.5554 | 0.5964 |
| wa_jsa | 2.5424 | 0.7309 |
| sec_school_absence | 3.2186 | 0.2214 |
| ks4_mean_points_score | 55.7759 | 0.2159 |
| combi_air_qual_ind | 0.0511 | 0.1944 |
| area_green | 79.4245 | 3.9047 |
| smr_lsoa_01 | 0.2170 | 0.4153 |
| pphhlds_limlong_ill | 58.1772 | 0.2280 |
| perc_rough | 0.0008 | 17.0438 |
| phhlds_noheating | 53.2436 | 0.8665 |
| perc_commute_wrk | 11.1226 | 0.5825 |
| perc_privtrans_wrk | 57.1322 | 0.2951 |
| perc_pubtrans_wrk | 12.2502 | 0.5119 |
| perc_footbike_wrk | 13.8616 | 0.6372 |
| turnout | 86.5204 | 0.2783 |
| le_all | 6.0307 | 0.0313 |
| concept_teen | 255.8799 | 0.5765 |

**Table 25: The beta coefficients for LA performance indicators for models attributable to LAs and small areas (Model 1D – controlling for LA performance indicators only)**

| Quality of life indicators | β-counciltax | SE | β-star | SE | β-resource |
|---|---|---|---|---|---|
| imd_score_crime | -0.0006 | 0.0004 | -0.0370 | 0.0339 | -0.0560 |
| imd_score_kids | -0.0001 | 0.0000 | -0.0056 | 0.0046 | -0.0031 |
| imd_score_elderly | -0.0001 | 0.0000 | -0.0038 | 0.0029 | -0.0008 |
| wa_tot_ben | 0.0006 | 0.0028 | -0.1493 | 0.2593 | -0.4246 |
| wa_jsa | -0.0007 | 0.0005 | -0.0587 | 0.0049 | 0.0282 |
| sec_school_absence | 0.0001 | 0.0008 | -0.0023 | 0.0713 | -0.1805 |
| ks4_mean_points_score | 0.0030 | 0.0020 | -0.0164 | 0.1843 | 0.3977 |
| combi_air_qual_ind | -0.0006 | 0.0001 | -0.0110 | 0.0121 | -0.0067 |
| area_green | ***0.0075*** | 0.0038 | 0.0589 | 0.3505 | 0.2398 |
| smr_lsoa_01 | -0.0001 | 0.0001 | -0.0053 | 0.0062 | -0.0162 |
| pphhlds_limlong_ill | ***0.0076*** | 0.0028 | -0.0306 | 0.2535 | -0.5190 |
| perc_rough | 0.0000 | 0.0000 | 0.0002 | 0.0003 | 0.0000 |
| phhlds_noheating | -0.0045 | 0.0028 | -0.2930 | 0.2527 | -0.2648 |
| perc_commute_wrk | 0.0031 | 0.0017 | -0.0673 | 0.1537 | 0.3144 |
| perc_privtrans_wrk | ***0.0063*** | 0.0028 | 0.2205 | 0.2601 | -0.0012 |
| perc_pubtrans_wrk | -0.0065 | 0.0016 | -0.0614 | 0.1513 | 0.0115 |
| perc_footbike_wrk | -0.0059 | 0.0014 | -0.0459 | 0.1258 | 0.0587 |
| turnout | 0.0105 | 0.0051 | 0.5256 | 0.4506 | 0.2599 |
| le_all | 0.0013 | 0.0008 | 0.0771 | 0.0745 | 0.0938 |
| concept_teen | ***-0.0212*** | 0.0077 | -0.2349 | 0.6893 | -1.0365 |

*5.2.1.5. Conclusions for model 1*

This section briefly summaries the main findings of the five model specifications of the 2-level random effect model for LSOA / ward (level 1) and local authorities (level 2). First of all, it emerges quite clearly that the greatest variation in our quality of life indicators in any of the five models specified exists at small area level. The introduction of more sophisticated model specifications has the effect, in general, of reducing total variance for most quality of life indicators, whilst not changing significantly the share of variance at small area level.

All five model specifications yielded similar and consistent results for the coefficient estimates of the regional dummies with the reference region of London (results were not presented for these). All coefficient estimates were highly significant (at the 5 percent level). There were however a few exceptions and these varied across model specifications.

For example, it appears from our results that in the model for the quality of life indicator on community safety (imd_score_crime), all governmental region dummies have a negative coefficient estimate, suggesting that for this particular quality of life indicator the governmental region of London performs worse than all other regions. This result is not surprising as one would expect the levels of crime to be comparably higher in London when compared with other governmental regions.

In the case of the quality of life indicators for environment, we find that in the model for the indicator area of green space per head (area_green), the governmental region dummies have a positive coefficient estimate compared to London. This result is also to be expected.

To summarise all our results for Model 1, we ranked all quality of life indicators from the one with the least variation at local authority level to the one with the highest variation in each of the five model specifications. We have then used these rankings to construct a chart of the most frequent ranking, the highest ranking and the lowest ranking reached by any given quality of life indicator. Figure 8 shows the variation (if any exists) in the rankings for all 20 quality of life indicators. The vertical line indicates the range between the highest and lowest position held in the overall ranking in terms of variance at small area level. Quality of life indicators towards the origin of the axes, e.g. standardised mortality ratio (smr_lsoa_01) and percentage of individuals living rough (perc_rough) always have a

large variation at small area level. The more one moves to the right the higher the proportion of variance attributable to local authorities.

As Figure 8 clearly shows, the different model specification present similar results in terms of variation explained at any of the two levels investigated in Model 1. The greatest variation in terms of ranking occurs for the indicator percentage of individuals commuting to work on foot or by bike, which jumps 6 ranking positions; for all other quality of life indicators, the proportions of variance attributable to any level do not change dramatically. This suggests results are relatively robust regardless of the specification used.

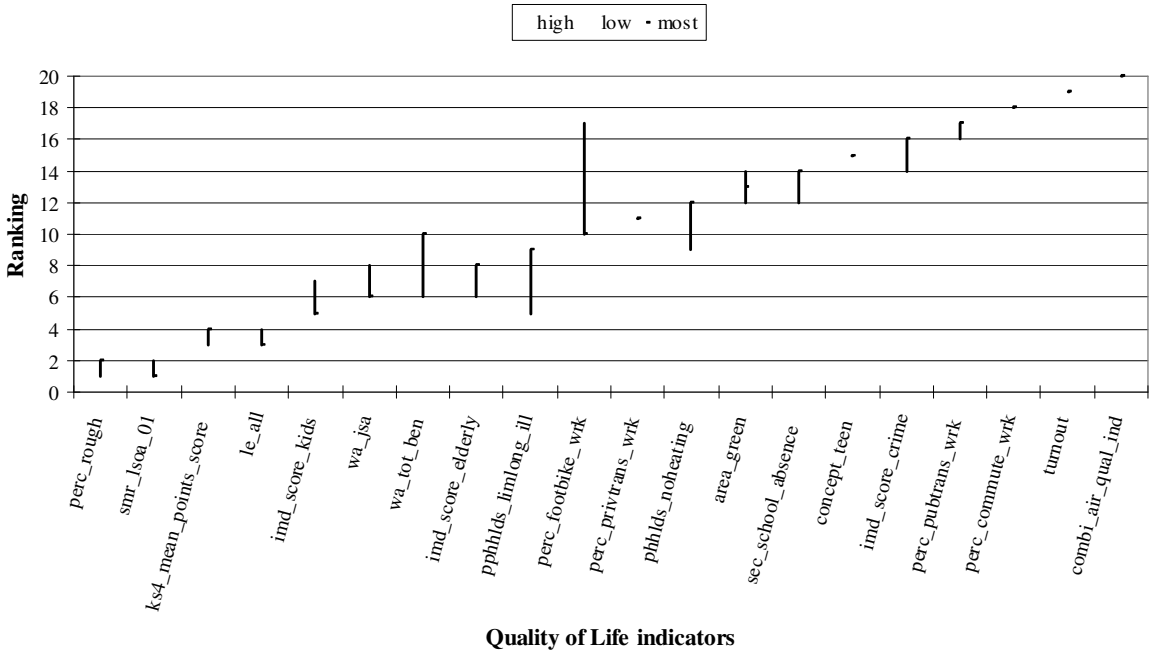



**Figure 8: Changes in rankings of the proportion of variation attributable to higher levels (LAs) in quality of life indicators (across all variants of Model 1)**

### *5.2.2. Model 2*

Our second model is also a two-level random-effect model, with LSOAs/wards as the lowest level (level 1), which are nested within Strategic Health Authorities (SHAs) (level 2). Governmental regions are introduced as dummy variables with the reference dummy being the region London.

Similarly to Model 1, we estimate 20 separate models, one for each quality of life indicator, and in three different model specifications. Firstly, we start by estimating models with no explanatory variables. We then control for socio-demographic characteristics at small area level by using both the IMD 2004 overall index of multiple deprivation (Model 2A) and 7 domain specific indices of deprivation (Model 2B). Results for the above model specifications are presented respectively in Sections 5.2.2.1, 5.2.2.2 and 5.2.2.3. We draw some preliminary conclusions in Section 5.2.2.4.

#### *5.2.2.1. Model 2 – basic specification*

The estimates of residual variance at strategic health authority level and small area level are all statistically significant at the 5 percent level (see Table 26 and Figure 9 for a graphical representation). The proportion of variance attributable to SHAs is quite small, with most variance existing at LSOA or ward level. A few exceptions are the IMD score on crime (imd_score_crime), the combined air quality (combi_air_qual-ind), the percentage of households without central heating (phhlds_noheating), the percentage of people that commute to work for over 20 km (perc_commute_wrk), the percentage of people that travel to work by public transport (perc_pubtrans_wrk)) and the percentage of teenage pregnancies (concept_teen). Although for all of the above quality of life indicators the intra-class correlation is less than 50 percent of total residual variance.

**Table 26: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs and small areas (Model 2 – levels only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.3887 | 0.143 | 0.102 | 0.027 | 0.567 | 0.004 | 0.1519 | 0.8481 |
| imd_score_kids | 0.2815 | 0.016 | 0.001 | 0.000 | 0.025 | 2E-04 | 0.0471 | 0.9529 |
| imd_score_elderly | 0.2089 | 0.011 | 0.001 | 0.000 | 0.009 | 7E-05 | 0.0695 | 0.9305 |
| wa_tot_ben | 15.1 | 0.926 | 4.210 | 1.141 | 70.720 | 0.555 | 0.0562 | 0.9438 |
| wa_jsa | 3.1049 | 0.212 | 0.223 | 0.060 | 2.650 | 0.021 | 0.0775 | 0.9225 |
| sec_school_absence | 8.0714 | 0.149 | 0.107 | 0.029 | 3.133 | 0.025 | 0.0331 | 0.9669 |
| ks4_mean_points_score | 34.38 | 0.338 | 0.511 | 0.149 | 55.241 | 0.434 | 0.0092 | 0.9908 |
| combi_air_qual_ind | 1.5517 | 0.067 | 0.023 | 0.006 | 0.038 | 3E-04 | 0.3722 | 0.6278 |
| area_green | 0.0845 | 0.655 | 2.078 | 0.570 | 63.098 | 0.495 | 0.0319 | 0.9681 |
| smr_lsoa_01 | 1.1269 | 0.018 | 0.001 | 0.000 | 0.217 | 0.002 | 0.0062 | 0.9938 |
| pphhlds_limlong_ill | 29.93 | 1.049 | 5.450 | 1.467 | 52.695 | 0.414 | 0.0937 | 0.9063 |
| perc_rough | 0.0027 | 6E-04 | 0.000 | 0.000 | 0.001 | 6E-06 | 0.0013 | 0.9987 |
| phhlds_noheating | 7.5814 | 1.327 | 8.752 | 2.349 | 49.855 | 0.391 | 0.1493 | 0.8507 |
| perc_commute_wrk | 3.0706 | 0.802 | 3.209 | 0.855 | 9.378 | 0.074 | 0.2549 | 0.7451 |
| perc_privtrans_wrk | 16.136 | 0.82 | 3.299 | 0.894 | 57.288 | 0.45 | 0.0545 | 0.9455 |
| perc_pubtrans_wrk | 19.58 | 0.646 | 2.073 | 0.556 | 12.279 | 0.096 | 0.1445 | 0.8555 |
| perc_footbike_wrk | 4.9805 | 0.371 | 0.674 | 0.182 | 12.517 | 0.098 | 0.0511 | 0.9489 |
| turnout | 31.683 | 1.161 | 6.056 | 1.725 | 83.122 | 1.447 | 0.0679 | 0.9321 |
| le_all | 78.344 | 0.284 | 0.354 | 0.101 | 5.796 | 0.092 | 0.0576 | 0.9424 |
| concept_teen | 31.746 | 3.506 | 59.4674 | 16.22 | 235.17 | 4.573 | 0.2018 | 0.7982 |

$\beta_0$ coefficient intercept; SE, standard error: $\sigma^2_{u0}$ variance of strategic health authority effects; $\sigma^2_{e0}$ variance of the small area effects; $\rho_u$, proportion of variance attributable to local authorities and $\rho_e$ proportion of variance attributable to small areas.

Figure 9 shows the intra-class correlations or proportion of variance attributable to both SHAs and LSOAs/wards for all 20 quality of life indicators, where the latter have been ranked in ascending order of proportion of variance existing at strategic health authority level. For example, for the two indicators at the bottom left - percentage of people living rough (perc_rough) and standardised mortality ratio (smr_lsoa_01) - over 99 percent of total variance exists at LSOA / ward level.

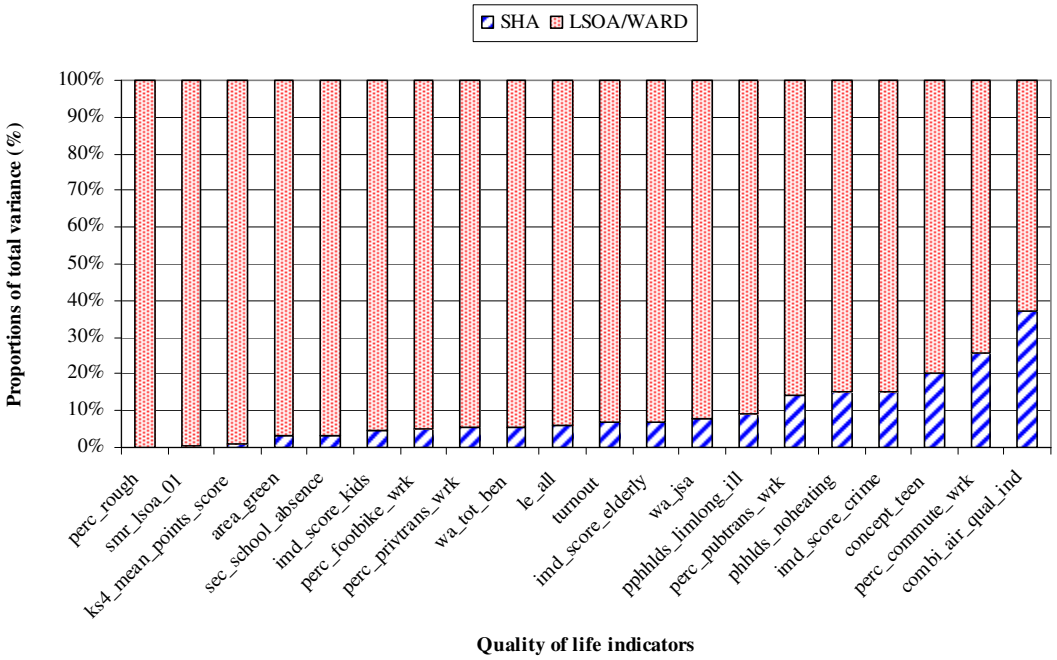



**Figure 9: Proportion of variation in quality of life indicators attributable to SHAs and small areas (intra-class correlation coefficients) (Model 2 – levels only)**

Table 27 shows the total variance and coefficients of variation for our quality of life indicators. Similarly to the previous models, the vast majority of quality of life indicators show comparable coefficients of variation, with the exception of the indicator percentage of people living rough (perc_rough) and to a much lesser extent the indicator area of green space per head (area_green).

**Table 27: Total variation in quality of life indicator models attributable to LAs and small areas (Model 2 – levels only)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.6684 | - |
| imd_score_kids | 0.0264 | - |
| imd_score_elderly | 0.0101 | - |
| wa_tot_ben | 74.9300 | 0.6020 |
| wa_jsa | 2.8728 | 0.7769 |
| sec_school_absence | 3.2407 | 0.2222 |
| ks4_mean_points_score | 55.7520 | 0.2159 |
| combi_air_qual_ind | 0.0608 | 0.2120 |
| area_green | 65.1762 | 3.5372 |
| smr_lsoa_01 | 0.2180 | 0.4163 |
| pphhlds_limlong_ill | 58.1457 | 0.2280 |
| perc_rough | 0.0008 | 16.9945 |
| phhlds_noheating | 58.6071 | 0.9091 |
| perc_commute_wrk | 12.5868 | 0.6196 |
| perc_privtrans_wrk | 60.5875 | 0.3039 |
| perc_pubtrans_wrk | 14.3517 | 0.5541 |
| perc_footbike_wrk | 13.1910 | 0.6216 |
| turnout | 89.1779 | 0.2826 |
| le_all | 6.1502 | 0.0316 |
| concept_teen | 294.6407 | 0.6186 |

#### *5.2.2.2. Model 2A – overall need variable*

In order to control for socio-demographic characteristics at small area level, we introduce the IMD overall need indicator. Estimates of residual variance attributable to the two levels are all statistically significant at the 5 percent level. Similarly to results obtained in the basic model specification, the proportions of variance are the greatest at small area level. However for six quality of life indicators, 10 percent or more of residual variance is attributable to SHAs. These are the IMD score on crime (imd_score_crime), the combined air quality (combi-air_qual-ind), the percentage of households without central heating (phhlds_noheating), the percentage of people that commute to work for over 20 km (perc_commute_wrk), the percentage of people that travel to work by public transport (perc_pubtrans_wrk) and the percentage of teenage pregnancies (concept_teen) (see Table 28).

The effect of controlling for need is that of decreasing the proportion of total residual variance explained at strategic health authority level as well as decreasing the coefficient of variation across all quality of life indicators (see Table 29). The only exception is given by the indicator percentage of households without central heating (phhlds_noheating) for which an opposite change is observed only in the proportion of variance attributable to SHAs. This is also the case when domain specific need variables are introduced in the model specification (see the following Section 5.5.2.3). This may be due to the existence of different policies implemented at SHAs that may have an indirect effect on this specific dimension of quality of life.

**Table 28: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs and small areas (Model 2A – controlling for overall need)**

| Quality of life indicators | β | SE | β-overall | SE | $\sigma_{u0}$ | SE | $\sigma_e$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.4975 | 0.1027 | ***0.0353*** | 0.0002 | 0.0523 | 0.0140 | 0.3469 | 0.0025 | 0.1309 | 0.8691 |
| imd_score_kids | 0.0232 | 0.0042 | 0.0103 | 0.0000 | 0.0001 | 0.0000 | 0.0038 | 0.0000 | 0.0206 | 0.9794 |
| imd_score_elderly | 0.0675 | 0.0047 | 0.0056 | 0.0000 | 0.0001 | 0.0000 | 0.0031 | 0.0000 | 0.0335 | 0.9665 |
| wa_tot_ben | 1.2130 | 0.2648 | ***0.5531*** | 0.0012 | 0.3362 | 0.0919 | 9.2899 | 0.7293 | 0.0349 | 0.9651 |
| wa_jsa | 0.7826 | 0.1100 | ***0.0925*** | 0.0004 | 0.0591 | 0.0160 | 0.9332 | 0.0073 | 0.0595 | 0.9405 |
| sec_school_absence | 6.6280 | 0.1462 | ***0.0575*** | 0.0006 | 0.1030 | 0.0280 | 2.4699 | 0.0195 | 0.0400 | 0.9600 |
| ks4_mean_points_score | 43.6442 | 0.4242 | ***-0.3674*** | 0.0021 | 0.8559 | 0.2355 | 28.0428 | 0.2204 | 0.0296 | 0.9704 |
| combi_air_qual_ind | 1.4225 | 0.0599 | ***0.0051*** | 0.0001 | 0.0179 | 0.0018 | 0.0329 | 0.0003 | 0.3525 | 0.6475 |
| area_green | 1.6215 | 0.6138 | ***-0.0612*** | 0.0031 | 1.7873 | 0.4925 | 62.3530 | 0.4895 | 0.0279 | 0.9721 |
| smr_lsoa_01 | 0.8427 | 0.0132 | 0.0113 | 0.0002 | 0.0006 | 0.0002 | 0.1908 | 0.0015 | 0.0030 | 0.9970 |
| pphhlds_limlong_ill | 21.6727 | 0.6431 | ***0.3289*** | 0.0022 | 2.0200 | 0.5442 | 30.9987 | 0.2433 | 0.0612 | 0.9388 |
| perc_rough | 0.0002 | 0.0007 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0012 | 0.9988 |
| phhlds_noheating | 1.6080 | 1.2838 | ***0.2379*** | 0.0024 | 8.1813 | 2.1759 | 38.1910 | 0.3022 | 0.1764 | 0.8236 |
| perc_commute_wrk | 5.8003 | 0.6712 | ***-0.1087*** | 0.0010 | 2.2414 | 0.5981 | 7.0074 | 0.0550 | 0.2423 | 0.7577 |
| perc_privtrans_wrk | 26.5662 | 0.4089 | ***-0.4154*** | 0.0019 | 0.8010 | 0.2194 | 22.6416 | 0.1777 | 0.0342 | 0.9658 |
| perc_pubtrans_wrk | 18.5205 | 0.6164 | ***0.0422*** | 0.0014 | 1.8814 | 0.8083 | 11.9222 | 0.0936 | 0.1363 | 0.8637 |
| perc_footbike_wrk | 3.5802 | 0.4485 | ***0.0558*** | 0.0014 | 0.9873 | 0.2661 | 11.8883 | 0.0933 | 0.0767 | 0.9233 |
| turnout | 36.7573 | 1.0273 | ***-0.1989*** | 0.0086 | 4.4003 | 1.2764 | 77.0342 | 1.3410 | 0.0540 | 0.9460 |
| le_all | 81.1515 | 0.1496 | ***-0.1098*** | 0.0018 | 0.0690 | 0.0227 | 3.9693 | 0.0632 | 0.0171 | 0.9829 |
| concept_teen | 16.2132 | 2.7951 | ***0.6037*** | 0.0129 | 37.1057 | 10.1448 | 166.8524 | 3.2447 | 0.1819 | 0.8181 |

Table 28 also shows the estimated coefficients of the overall need variable for each quality of life indicator; statistically significant (at the 5 percent level) coefficients are shown in bold italic. These show all the expected signs.

Intra-class correlation coefficients are shown in Figure 10 for all 20 quality of life indicators, where the latter have been ranked in ascending order of the proportion of total variance attributable to Strategic Health Authorities.

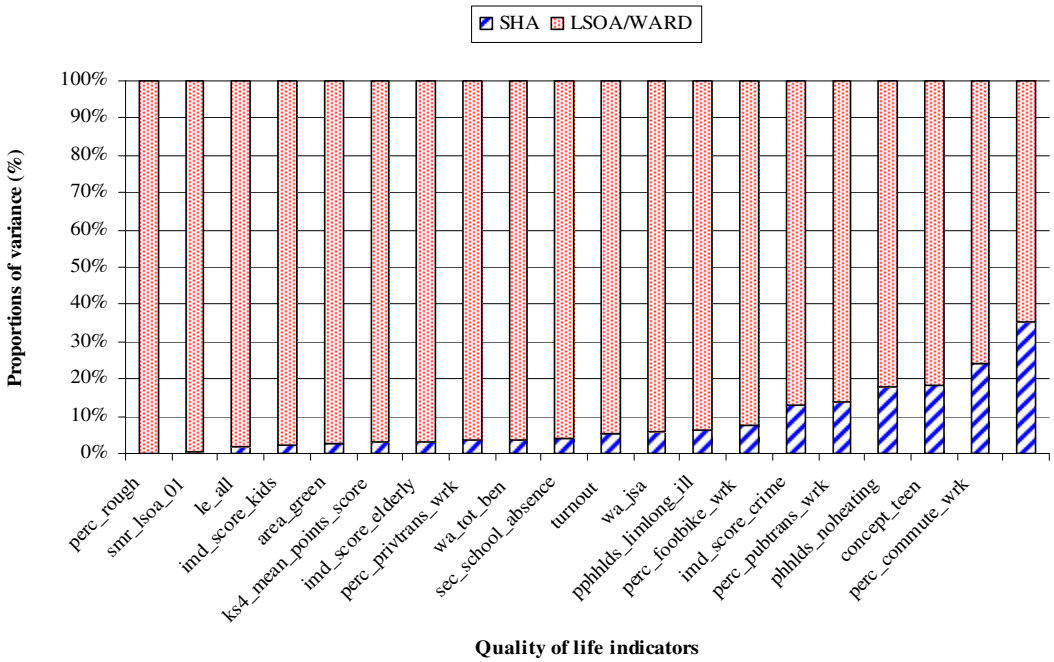



**Figure 10: Proportion of variation in quality of life indicators attributable to SHAs and small areas (intra-class correlation coefficients) (Model 2A – controlling for overall need)**

**Table 29: Total variation in quality of life indicator models attributable to LAs and small areas (Model 2A – controlling for overall need)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3992 | - |
| imd_score_kids | 0.0039 | - |
| imd_score_elderly | 0.0032 | - |
| wa_tot_ben | 9.6261 | 0.2158 |
| wa_jsa | 0.9923 | 0.4566 |
| sec_school_absence | 2.5729 | 0.1979 |
| ks4_mean_points_score | 28.8987 | 0.1554 |
| combi_air_qual_ind | 0.0508 | 0.1937 |
| area_green | 64.1403 | 3.5090 |
| smr_lsoa_01 | 0.1914 | 0.3900 |
| pphhlds_limlong_ill | 33.0187 | 0.1718 |
| perc_rough | 0.0008 | 16.9726 |
| phhlds_noheating | 46.3723 | 0.8087 |
| perc_commute_wrk | 9.2488 | 0.5311 |
| perc_privtrans_wrk | 23.4426 | 0.1890 |
| perc_pubtrans_wrk | 13.8036 | 0.5434 |
| perc_footbike_wrk | 12.8756 | 0.6141 |
| turnout | 81.4345 | 0.2700 |
| le_all | 4.0382 | 0.0256 |
| concept_teen | 203.9581 | 0.5147 |

### *5.2.2.3. Model 2B – domain specific need variables*

In this section we discuss the results obtained by introducing in the estimation model, the seven domain specific indices of deprivation. The estimates of residual variance attributable to SHAs and LSOAs/wards are all statistically significant at the 5 percent level (see Table 30). For the majority of quality of life indicators, the effect of introducing domain specific indicators of deprivation is that of increasing the proportion of total variance attributable to SHAs. However, in the case of the six quality of life indicators previously identified as having a proportion of variance attributable to SHA level equal to more than 10 percent, the effect is varied, increasing for some and decreasing for others. Further, for the indicator percentage of people commuting to work on foot or by bike (perc_footbike_wrk), introducing the domain specific need adjusters has the effect of increasing the proportion of variance attributable to SHAs from 5 percent and 7 percent respectively in the basic and one overall need indicator models to about 13 percent in this model specification.

**Table 30: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs and small areas (Model 2B - controlling for domain specific need variables)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.1325 | 0.1052 | 0.0538 | 0.0144 | 0.2997 | 0.0024 | 0.1521 | 0.8479 |
| imd_score_kids | 0.0651 | 0.0056 | 0.0001 | 0.0000 | 0.0048 | 0.0000 | 0.0265 | 0.9735 |
| imd_score_elderly | 0.1126 | 0.0064 | 0.0002 | 0.0001 | 0.0033 | 0.0000 | 0.0543 | 0.9457 |
| wa_tot_ben | 11.5375 | 0.3214 | 0.4620 | 0.1257 | 13.3249 | 0.1046 | 0.0335 | 0.9665 |
| wa_jsa | 1.8940 | 0.1342 | 0.0849 | 0.0230 | 1.2536 | 0.0098 | 0.0634 | 0.9366 |
| sec_school_absence | 7.3164 | 0.1669 | 0.1266 | 0.0344 | 2.4531 | 0.0193 | 0.0491 | 0.9509 |
| ks4_mean_points_score | 38.2167 | 0.4833 | 1.0279 | 0.2807 | 27.2463 | 0.2141 | 0.0364 | 0.9636 |
| combi_air_qual_ind | 1.6324 | 0.0510 | 0.0129 | 0.0034 | 0.0280 | 0.0002 | 0.3152 | 0.6848 |
| area_green | -13.7913 | 0.6520 | 1.9267 | 0.5227 | 43.9797 | 0.3453 | 0.0420 | 0.9580 |
| smr_lsoa_01 | 0.8492 | 0.0156 | 0.0006 | 0.0002 | 0.1911 | 0.0015 | 0.0029 | 0.9971 |
| pphhlds_limlong_ill | 25.6903 | 0.5661 | 1.5194 | 0.4079 | 23.6023 | 0.0853 | 0.0605 | 0.9395 |
| perc_rough | 0.0007 | 0.0009 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0014 | 0.9986 |
| phhlds_noheating | 5.0522 | 1.3647 | 9.1276 | 2.4469 | 40.8218 | 0.3205 | 0.1827 | 0.8173 |
| perc_commute_wrk | 2.7771 | 0.6079 | 1.8157 | 0.4842 | 6.2651 | 0.0492 | 0.2247 | 0.7753 |
| perc_privtrans_wrk | 27.5798 | 0.4055 | 0.7163 | 0.1958 | 20.5807 | 0.1616 | 0.0336 | 0.9664 |
| perc_pubtrans_wrk | 18.0499 | 0.5813 | 1.6367 | 0.4358 | 10.2254 | 0.0803 | 0.1380 | 0.8620 |
| perc_footbike_wrk | 5.8422 | 0.5564 | 1.4984 | 0.4000 | 9.6562 | 0.0758 | 0.1343 | 0.8657 |
| turnout | 28.8875 | 1.1311 | 4.4303 | 1.2768 | 70.6577 | 1.2300 | 0.0590 | 0.9410 |
| le_all | 80.5874 | 0.1511 | 0.0442 | 0.0160 | 3.8731 | 0.0616 | 0.0113 | 0.9887 |
| concept_teen | 16.2429 | 2.6828 | 31.7549 | 8.7176 | 159.8454 | 3.1084 | 0.1657 | 0.8343 |

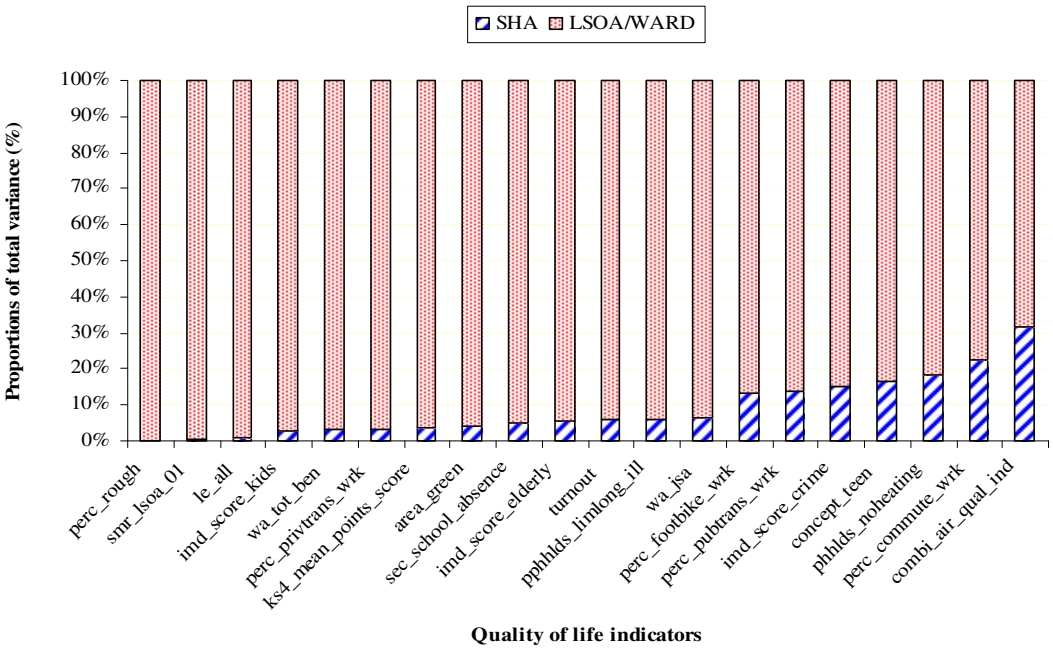



**Figure 11: Proportion of variation in quality of life indicators attributable to SHAs and small areas (intra-class correlation coefficients) (Model 2B - controlling for domain specific need variables)**

Moreover, looking at total residual variances and coefficients of variation (shown in Table 31), the effect of introducing domain specific need indicators is not uniform. In most cases the direction of change of these measures is in line with the changes which occurred in terms of proportions of variances; however, in two cases, namely percentage of individuals travelling to work by public transport (perc_pubtrans_wrk) and on foot or bike (perc_footbike_wrk), total variance is actually decreasing, whilst the proportion of variance attributable to SHAs is increasing. This may be an indication that there may be differences across SHAs in the way they influence these particular quality of life indicators.

**Table 31 : Total variation in quality of life indicator models attributable to LAs and small areas (Model 2B - controlling for domain specific need variables)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3535 | - |
| imd_score_kids | 0.0050 | - |
| imd_score_elderly | 0.0034 | - |
| wa_tot_ben | 13.7869 | 0.2582 |
| wa_jsa | 1.3385 | 0.5303 |
| sec_school_absence | 2.5797 | 0.1982 |
| ks4_mean_points_score | 28.2742 | 0.1537 |
| combi_air_qual_ind | 0.0409 | 0.1739 |
| area_green | 45.9064 | 2.9686 |
| smr_lsoa_01 | 0.1917 | 0.3903 |
| pphhlds_limlong_ill | 25.1217 | 0.1498 |
| perc_rough | 0.0008 | 16.9107 |
| phhlds_noheating | 49.9494 | 0.8393 |
| perc_commute_wrk | 8.0808 | 0.4965 |
| perc_privtrans_wrk | 21.2970 | 0.1802 |
| perc_pubtrans_wrk | 11.8621 | 0.5037 |
| perc_footbike_wrk | 11.1546 | 0.5716 |
| turnout | 75.0880 | 0.2593 |
| le_all | 3.9173 | 0.0252 |
| concept_teen | 191.6003 | 0.4989 |

**Table 32: The beta coefficients for domain specific need variables for models attributable to SHAs and small areas (Model 2B – controlling for domain specific need variables)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***0.9367*** | 0.0825 | -1.1364 | 0.1328 | ***0.4367*** | 0.0087 | ***0.0031*** | 0.0003 | -0.0080 | 0.0003 | ***0.0138*** | 0.0002 | | |
| imd_score_kids | | | ***1.0590*** | 0.0130 | ***0.0331*** | 0.0011 | ***0.0029*** | 0.0000 | ***0.0014*** | 0.0000 | ***0.0005*** | 0.0000 | ***0.0121*** | 0.0007 |
| imd_score_elderly | | | ***0.3820*** | 0.0106 | ***0.0567*** | 0.0009 | ***0.0004*** | 0.0000 | ***0.0006*** | 0.0000 | ***0.0011*** | 0.0000 | 0.0008 | 0.0006 |
| wa_tot_ben | | | | | ***5.8570*** | 0.0473 | ***0.2257*** | 0.0017 | ***0.0114*** | 0.0021 | -0.0046 | 0.0017 | 0.0136 | 0.0369 |
| wa_jsa | | | | | ***0.8745*** | 0.0145 | ***0.0218*** | 0.0005 | ***0.0087*** | 0.0007 | ***0.0185*** | 0.0005 | ***0.1577*** | 0.0113 |
| sec_school_absence | ***0.8677*** | 0.2119 | ***2.5625*** | 0.3826 | ***0.4442*** | 0.0257 | | | -0.0008 | 0.0009 | ***0.0081*** | 0.0007 | ***0.3650*** | 0.0159 |
| ks4_mean_points_score | -38.7882 | 0.7036 | ***21.2568*** | 1.2698 | -3.3623 | 0.0859 | | | ***0.0299*** | 0.0031 | 0.0032 | 0.0024 | -0.5505 | 0.0529 |
| combi_air_qual_ind | ***0.3529*** | 0.0251 | -0.8035 | 0.0406 | ***0.0699*** | 0.0027 | ***-0.0006*** | 0.0001 | -0.0028 | 0.0001 | | | ***0.0951*** | 0.0016 |
| area_green | -4.4904 | 0.9934 | ***20.3611*** | 1.6095 | -2.9697 | 0.1091 | ***0.0172*** | 0.0037 | ***0.4039*** | 0.0039 | | | -1.1201 | 0.0641 |
| smr_lsoa_01 | ***1.1947*** | 0.0655 | ***0.3653*** | 0.0957 | | | -0.0009 | 0.0002 | 0.0001 | 0.0204 | ***0.0009*** | 0.0002 | ***0.0337*** | 0.0042 |
| pphhlds_limlong_ill | -11.4002 | 0.7310 | ***80.2011*** | 1.0710 | | | 0.1294 | 0.0027 | -0.0572 | 0.0029 | -0.0590 | 0.0022 | -0.6199 | 0.0474 |
| perc_rough | -0.0245 | 0.0041 | ***0.0642*** | 0.0067 | ***0.0016*** | 0.0004 | ***-0.0001*** | 0.0000 | ***0.000045*** | 0.0000 | | | ***0.0015*** | 0.0003 |
| phhlds_noheating | ***9.9310*** | 0.9574 | -4.2073 | 1.5512 | ***1.1983*** | 0.1043 | ***0.0473*** | 0.0036 | -0.0001 | 0.0038 | | | ***1.2724*** | 0.0618 |
| perc_commute_wrk | -0.7919 | 0.3778 | ***4.4999*** | 0.6078 | -1.5573 | 0.0412 | ***-0.0353*** | 0.0014 | ***0.0325*** | 0.0015 | -0.0135 | 0.0012 | -0.3277 | 0.0254 |
| perc_privtrans_wrk | -28.3176 | 0.6844 | -21.0752 | 1.1011 | -0.6865 | 0.0746 | ***0.0049*** | 0.0026 | ***0.0067*** | 0.0027 | -0.1494 | 0.0021 | -0.0759 | 0.0459 |
| perc_pubtrans_wrk | -3.1446 | 0.4826 | -4.6416 | 0.7765 | ***0.6676*** | 0.0526 | ***-0.0223*** | 0.0081 | ***0.0063*** | 0.0019 | ***0.0789*** | 0.0015 | ***0.7996*** | 0.0324 |
| perc_footbike_wrk | -2.2359 | 0.4690 | -9.9685 | 0.7545 | ***1.7212*** | 0.0511 | ***-0.0177*** | 0.0018 | ***0.0589*** | 0.0018 | ***0.0861*** | 0.0014 | ***0.2224*** | 0.0315 |
| turnout | 5.1975 | 3.1963 | ***19.2347*** | 4.8595 | ***1.8604*** | 0.3113 | ***-0.1592*** | 0.0119 | ***0.1007*** | 0.0101 | 0.0001 | 0.0096 | -1.6494 | 0.1879 |
| le_all | -2.8477 | 0.6900 | -8.8167 | 0.9372 | | | -0.0161 | 0.0026 | ***0.0046*** | 0.0021 | -0.0153 | 0.0020 | ***0.5693*** | 0.0375 |
| concept_teen | ***30.6798*** | 4.8675 | -18.2948 | 6.7210 | | | 0.2379 | 0.0179 | ***0.1061*** | 0.0197 | ***0.0896*** | 0.0150 | ***4.1365*** | 0.3097 |

Table 32 shows the estimated coefficients of the various domain specific need variables for the 20 quality of life indicators. Coefficients significant at 5 percent level are shown in bold italic. These show the expected sign in the vast majority of cases; thus, for example, one would expect the percentage of households without central heating to be positively related to the deprivation indicator for income, health, education and crime. Further, a high and positive association exists for the percentage of households reporting one or more limiting longstanding illnesses and the IMD score for employment (as in previous Model 1B). Two counter-intuitive results are the high and positive association between the IMD score for employment and the average points score for Key Stage 4 examinations (ks4_mean_points_score) and the area of green space per head (area_green).

*5.2.2.4. Conclusions for model 2*

This section briefly summaries the main findings of the three model specifications of the 2-level random effect model defined at LSOA/ward (level 1) and SHAs (level 2). A first clear result that emerges is that the greatest variation in our quality of life indicators in any of the three model specifications exists once again at small area level. The introduction of more sophisticated model specifications has the effect, in general, of reducing total variance for most quality of life indicators, with the few exceptions highlighted in previous Sections.

Results for the regional dummies (results not shown) were consistent in all model specifications 2 (basic, 2A and 2B) to those found in Model 1.

As for Model 1, we ranked all quality of life indicators from the one with the least variation at strategic health authority level to the one with the highest variation in each of the three model specifications of model 2, as shown in Figure 12. It is worth noting that the rankings of the quality of life indicators in all the model specifications analysed do not vary at all at the two extremes. Some variation in the ranking positions held occurs in the middle of the distribution according to the proportion of total variance attributable to the two levels. In particular, we note that the greatest variation in terms of ranking occurs for the two indicators: percentage of individuals commuting to work on foot or by bike (perc_footbike_wrk) and life expectancy at birth (le_all), which jump seven ranking positions.

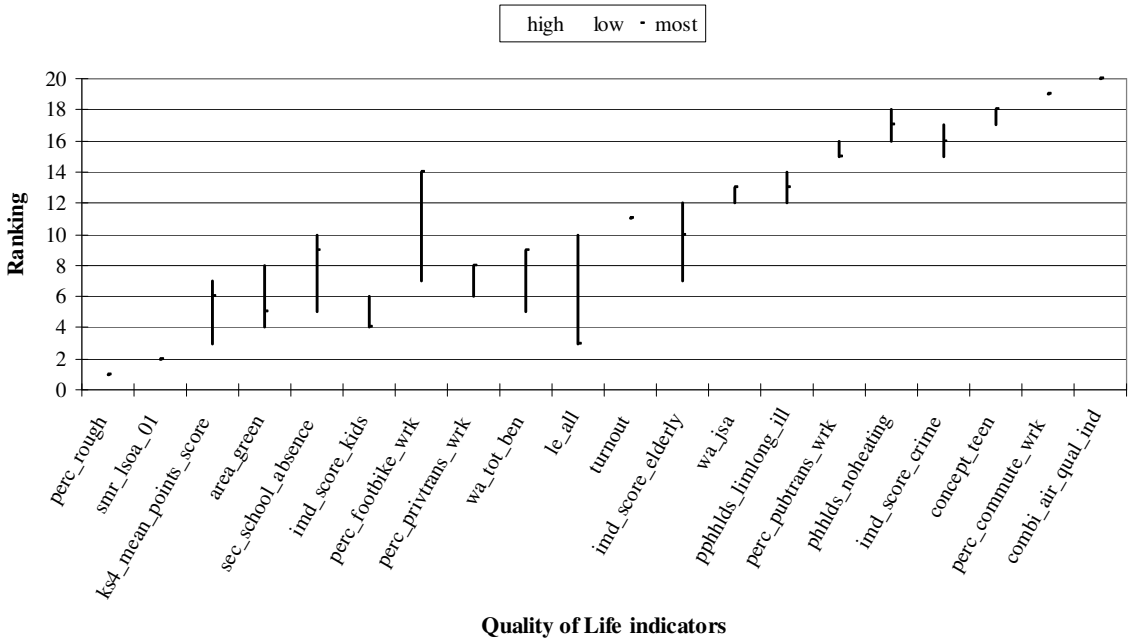



**Figure 12: Changes in rankings of the proportion of variation attributable to higher levels (SHAs) in quality of life indicators (across all variants of Model 2)**

### *5.2.3. Model 3*

The third model is also a two-level random-effect model, with LSOAs/wards as the lowest level (level 1), which are nested within Primary Care Trusts (PCTs) (level 2). Governmental regions are introduced as dummy variables with the reference dummy being the region London.

Similarly to Models 1 and 2, we estimate 20 separate models, one for each quality of life indicator. Under this specific hierarchical structure, we are able to estimate five different model specifications. The first model is the basic one, with no explanatory variables. Results for this model are analysed in Section 5.2.3.1. Socio-demographic characteristics at small area level are introduced in two ways: through the IMD overall index of multiple deprivation (Model 3A) and seven domain specific indices of deprivation (Model 3B). Results for these two model specifications are presented respectively in Sections 5.2.3.2 and 5.2.3.3. Performance indicators for PCTs are then introduced alongside the seven domain specific deprivation indices. These are Star rating, Financial Management and Current distance from target (in percentage terms). We call this Model 3C and its results are discussed in Section 5.2.3.4. In order to investigate the sensitivity of the estimation results in Model 3C to the domain specific IMD deprivation indices, we also estimate a model which includes only the PCT performance indicators (Model 3D). Some preliminary conclusions are drawn in Section 5.2.3.5.

#### *5.2.3.1. Model 3 – basic specification*

Estimates of residual variance attributable to both PCTs and LSOAs / wards are all statistically significant at the 5 percent level. For the majority of quality of life indicators the greatest residual variance occurs at small area level (see Table 33 and Figure 13 for a graphical representation), with the exception of the following quality of life indicators: the IMD deprivation index for crime (imd_score_crime); combined air quality indicator (combi_air_qual_ind) with a proportion of residual variance attributable to PCTs equal to more than 70 percent of the total variance; percentage of people commuting to work for over 20 km (perc_commute_wrk); percentage of people travelling to work on foot or by bike (perc_footbike_wrk); election turnout (turnout) and the percentage of teenage pregnancies (concept_teen), with more that 50 percent of total residual variance attributable to PCTs.

**Table 33: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to PCTs and small areas (Model 3 – levels only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.4070 | 0.0922 | 0.2693 | 0.0222 | 0.3853 | 0.0030 | 0.4114 | 0.5886 |
| imd_score_kids | 0.2858 | 0.0142 | 0.0063 | 0.0005 | 0.0198 | 0.0002 | 0.2410 | 0.7590 |
| imd_score_elderly | 0.2120 | 0.0096 | 0.0029 | 0.0002 | 0.0070 | 0.0001 | 0.2925 | 0.7075 |
| wa_tot_ben | 15.1995 | 0.7667 | 18.4076 | 1.5405 | 56.6991 | 0.4470 | 0.2451 | 0.7549 |
| wa_jsa | 3.1084 | 0.1622 | 0.8274 | 0.0689 | 1.9866 | 0.0157 | 0.2940 | 0.7060 |
| sec_school_absence | 8.0954 | 0.1976 | 1.2354 | 0.1020 | 2.0482 | 0.0162 | 0.3762 | 0.6238 |
| ks4_mean_points_score | 34.2708 | 0.5247 | 8.4630 | 0.7266 | 47.7284 | 0.3767 | 0.1506 | 0.8494 |
| combi_air_qual_ind | 1.5689 | 3579405 | 0.0409 | 0.0033 | 0.0170 | 0.0001 | 0.7058 | 0.2942 |
| area_green | 0.0812 | 0.6517 | 13.2014 | 1.1175 | 54.6832 | 0.4311 | 0.1945 | 0.8055 |
| smr_lsoa_01 | 1.1263 | 0.0174 | 0.0082 | 0.0008 | 0.2097 | 0.0017 | 0.0378 | 0.9622 |
| pphhlds_limlong_ill | 30.1134 | 0.7037 | 15.5398 | 1.2924 | 42.9136 | 0.3383 | 0.2658 | 0.7342 |
| perc_rough | 0.0028 | 0.0007 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0133 | 0.9867 |
| phhlds_noheating | 7.7183 | 0.8271 | 21.6187 | 1.7848 | 37.8341 | 0.2983 | 0.3636 | 0.6364 |
| perc_commute_wrk | 3.0663 | 0.4207 | 5.6229 | 0.4606 | 5.8780 | 0.4634 | 0.4889 | 0.5111 |
| perc_privtrans_wrk | 15.8033 | 0.7609 | 18.2320 | 1.5172 | 41.1157 | 0.3245 | 0.3072 | 0.6928 |
| perc_pubtrans_wrk | 19.5720 | 0.4457 | 6.3077 | 0.5200 | 7.0591 | 0.0557 | 0.4719 | 0.5281 |
| perc_footbike_wrk | 5.0429 | 0.2904 | 2.6225 | 0.2214 | 10.6085 | 0.0836 | 0.1982 | 0.8018 |
| turnout | 31.5817 | 1.1903 | 42.7263 | 3.7456 | 49.0337 | 0.8715 | 0.4656 | 0.5344 |
| le_all | 78.3334 | 0.2154 | 1.2203 | 0.1187 | 4.9977 | 0.0809 | 0.1963 | 0.8037 |
| concept_teen | 31.1124 | 2.3456 | 168.1157 | 14.4271 | 145.8908 | 2.9142 | 0.5354 | 0.4646 |

$\beta_0$ coefficient intercept; SE, standard error: $\sigma^2_{u0}$ variance of primary care trust effects; $\sigma^2_{e0}$ variance of the small area effects; $\rho_u$ proportion of variance attributable to primary care trusts and $\rho_e$, proportion of variance attributable to small areas.

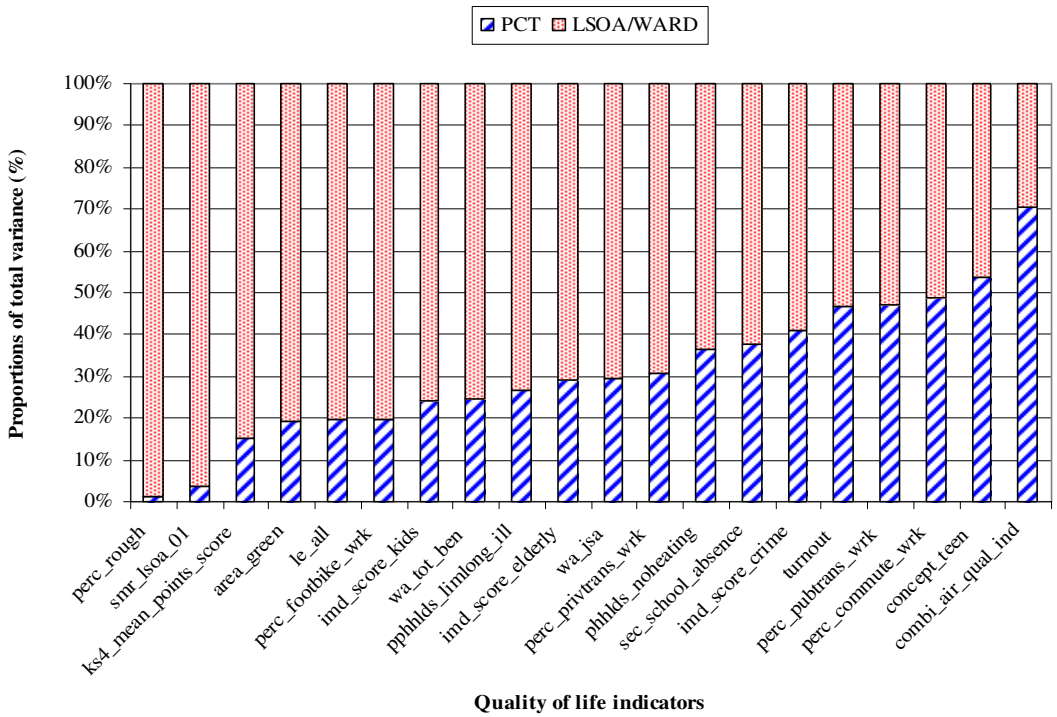



**Figure 13: Proportion of variation in quality of life indicators attributable to PCTs and small areas (intra-class correlation coefficients) (Model 3 – levels only)**

All quality of life indicators show comparable results in terms of their coefficients of variation with the exception of the space of green area per head (area_green) and to a much greater extent the percentage of people living rough (perc_rough). These results are very similar to findings from the previous two models.

**Table 34: Total variation in quality of life indicator models attributable to PCTs and small areas (Model 3 – levels only)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.6546 | - |
| imd_score_kids | 0.0261 | - |
| imd_score_elderly | 0.0099 | - |
| wa_tot_ben | 75.1067 | 0.6027 |
| wa_jsa | 2.8139 | 0.7689 |
| sec_school_absence | 3.2836 | 0.2236 |
| ks4_mean_points_score | 56.1914 | 0.2167 |
| combi_air_qual_ind | 0.0579 | 0.2068 |
| area_green | 67.8846 | 3.6099 |
| smr_lsoa_01 | 0.2179 | 0.4162 |
| pphhlds_limlong_ill | 58.4533 | 0.2286 |
| perc_rough | 0.0008 | 16.9964 |
| phhlds_noheating | 59.4528 | 0.9157 |
| perc_commute_wrk | 11.5009 | 0.5923 |
| perc_privtrans_wrk | 59.3476 | 0.3008 |
| perc_pubtrans_wrk | 13.3667 | 0.5347 |
| perc_footbike_wrk | 13.2310 | 0.6225 |
| turnout | 91.7601 | 0.2866 |
| le_all | 6.2180 | 0.0318 |
| concept_teen | 314.0065 | 0.6386 |

### *5.2.3.2. Model 3A - overall need variable*

Estimates of residual variance attributable to either PCTS or LSOAs / wards are all statistically significant at the 5 percent level. The introduction of the overall IMD needs variable has in general the effect of decreasing the proportion of residual variance attributable to PCTs (see Table 35 and Figure 14). Thus, compared to the basic model, even more variation exists at small area level.

Also shown in the table are estimates of the coefficient of the IMD overall need index for each quality of life indicator. Statistically significant (at the 5 percent level) coefficients are shown in bold italic. All coefficients seem to show the expected sign with respect to the quality of life indicators.

**Table 35: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to PCTs and small areas (Model 3A – controlling for overall need)**

| Quality of life indicators | β | SE | β-overall | SE | $\sigma_{u0}$ | SE | $\sigma_e$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.4002 | 0.0620 | ***0.0315*** | 0.0002 | 0.1200 | 0.0099 | 0.2471 | 0.0019 | 0.3270 | 0.6730 |
| imd_score_kids | 0.0122 | 0.0039 | ***0.0107*** | 0.0000 | 0.0004 | 0.0000 | 0.0035 | 0.0000 | 0.1101 | 0.8899 |
| imd_score_elderly | 0.0699 | 0.0040 | ***0.0055*** | 0.0000 | 0.0005 | 0.0000 | 0.0027 | 0.0000 | 0.1553 | 0.8447 |
| wa_tot_ben | 0.0363 | 0.2936 | ***0.5918*** | 0.0013 | 2.6748 | 0.2223 | 7.1793 | 0.0566 | 0.2714 | 0.7286 |
| wa_jsa | 0.7449 | 0.0811 | ***0.0923*** | 0.0004 | 0.2015 | 0.0170 | 0.7889 | 0.0062 | 0.2034 | 0.7966 |
| sec_school_absence | 6.9258 | 0.1650 | ***0.0456*** | 0.0006 | 0.8509 | 0.0705 | 1.7598 | 0.0139 | 0.3259 | 0.6741 |
| ks4_mean_points_score | 44.2493 | 0.3064 | -0.3873 | 0.0024 | 2.6968 | 0.2409 | 26.1937 | 0.2067 | 0.0933 | 0.9067 |
| combi_air_qual_ind | 1.4932 | 0.0335 | ***0.0030*** | 0.0006 | 0.0357 | 0.0029 | 0.0158 | 0.0001 | 0.6925 | 0.3075 |
| area_green | 0.9822 | 0.6402 | -0.0352 | 0.0031 | 12.4782 | 1.0584 | 54.5341 | 0.4300 | 0.1862 | 0.8138 |
| smr_lsoa_01 | 0.8293 | 0.0119 | ***0.0116*** | 0.0002 | 0.0025 | 0.0003 | 0.1890 | 0.0015 | 0.0128 | 0.9872 |
| pphhlds_limlong_ill | 21.1531 | 0.4870 | ***0.3498*** | 0.0024 | 7.2900 | 0.6133 | 25.6807 | 0.2025 | 0.2211 | 0.7789 |
| perc_rough | 0.0006 | 0.0007 | ***0.0001*** | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0119 | 0.9881 |
| phhlds_noheating | 2.0759 | 0.7064 | ***0.2202*** | 0.0026 | 15.6045 | 1.2900 | 31.0576 | 0.2449 | 0.3344 | 0.6656 |
| perc_commute_wrk | 5.3218 | 0.3482 | -0.0880 | 0.0010 | 3.8232 | 0.3137 | 4.8024 | 0.0379 | 0.4432 | 0.5568 |
| perc_privtrans_wrk | 26.2521 | 0.4268 | -0.4078 | 0.0020 | 5.6226 | 0.4747 | 17.7336 | 0.1400 | 0.2407 | 0.7593 |
| perc_pubtrans_wrk | 19.5129 | 0.4455 | 0.0023 | 0.0012 | 6.2666 | 0.5154 | 7.0588 | 0.0556 | 0.4703 | 0.5297 |
| perc_footbike_wrk | 3.6173 | 0.2994 | ***0.0596*** | 0.0015 | 2.7511 | 0.2318 | 10.0964 | 0.0796 | 0.2141 | 0.7859 |
| turnout | 36.2927 | 1.1303 | -0.1815 | 0.0078 | 37.1582 | 3.2783 | 45.4416 | 0.8075 | 0.4499 | 0.5501 |
| le_all | 81.0904 | 0.1218 | -0.1063 | 0.0019 | 0.1972 | 0.0293 | 3.8406 | 0.0621 | 0.0488 | 0.9512 |
| concept_teen | 17.5173 | 1.9199 | ***0.5200*** | 0.0122 | 108.6957 | 9.4060 | 109.8788 | 2.1941 | 0.4973 | 0.5027 |

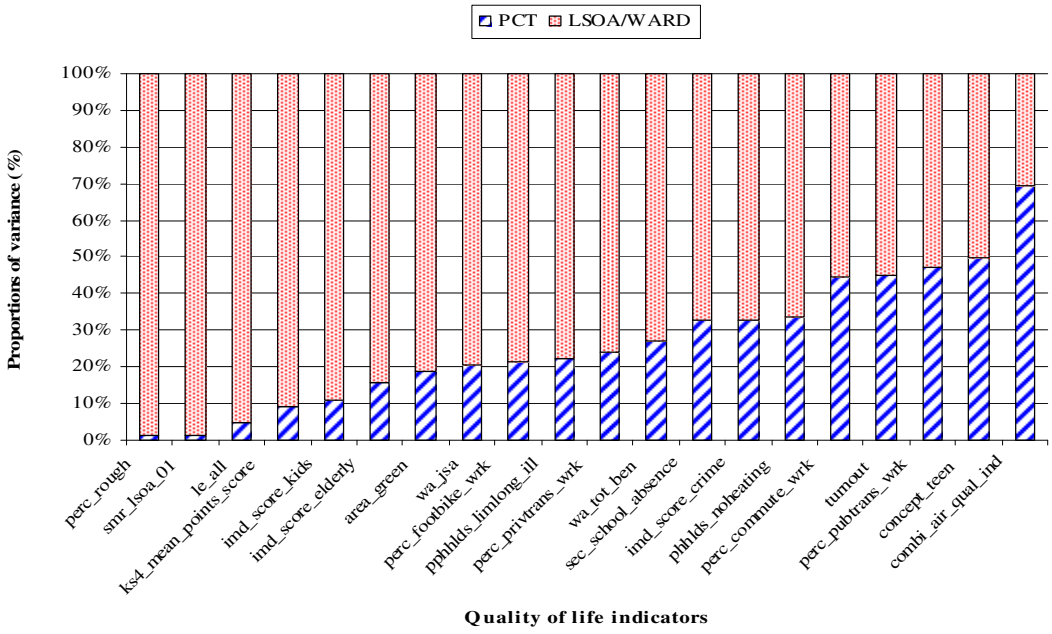



**Figure 14: Proportion of variation in quality of life indicators attributable to PCTs and small areas (intra-class correlation coefficients) (Model 3A – controlling for overall need)**

Coefficients of variation are comparable across all quality of life indicators (with the two usual exceptions (see Table 36), and decrease once differences in need are accounted for (compared to the basic Model 3), with some showing much higher reductions than others. Two indicators, area of green space per head (area_green) and percentage of people living rough (perc_rough), do not however show marked differences compared to the basic Model 3 specification (see Table 36).

**Table 36: Total variation in quality of life indicator models attributable to PCTs and small areas (Model 3A – controlling for overall need)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3671 | - |
| imd_score_kids | 0.0040 | - |
| imd_score_elderly | 0.0032 | - |
| wa_tot_ben | 9.8541 | 0.2183 |
| wa_jsa | 0.9904 | 0.4562 |
| sec_school_absence | 2.6108 | 0.1994 |
| ks4_mean_points_score | 28.8906 | 0.1554 |
| combi_air_qual_ind | 0.0515 | 0.1950 |
| area_green | 67.0123 | 3.5867 |
| smr_lsoa_01 | 0.1914 | 0.3901 |
| pphhlds_limlong_ill | 32.9707 | 0.1717 |
| perc_rough | 0.0008 | 16.9746 |
| phhlds_noheating | 46.6621 | 0.8112 |
| perc_commute_wrk | 8.6256 | 0.5129 |
| perc_privtrans_wrk | 23.3561 | 0.1887 |
| perc_pubtrans_wrk | 13.3254 | 0.5339 |
| perc_footbike_wrk | 12.8475 | 0.6134 |
| turnout | 82.5998 | 0.2720 |
| le_all | 4.0378 | 0.0256 |
| concept_teen | 218.5745 | 0.5328 |

#### *5.2.3.3. Model 3B - domain specific need variables*

Introducing domain specific need indicators has a varied effect on the proportion of residual variance attributable to PCTs and LSOAs/wards (Table 37). Compared to the basic Model 3, it is that of reducing the proportion of variance of PCTs in the majority of cases and with the exception of area of green space per head (area_green), percentage of people commuting to work on foot or by bike (perc_footbike_wrk), and election turnout (turnout). Overall, the largest variations are registered for small areas. However, for combined air quality indicator (combi_air_qual_ind) and percentage of teenage conceptions (concept_teen), over 50 percent of total residual variance is attributable to PCT level. Variations in percentage of people commuting to work over 20 km, percentage of people commuting to work by public transport and election turnout also show a substantial (more than 45 percent) proportion of variation at PCT level.

**Table 37: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to PCTs and small areas (Model 3B - controlling for domain specific need variables)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.0818 | 0.0624 | 0.1142 | 0.0095 | 0.2402 | 0.0019 | 0.3222 | 0.6778 |
| imd_score_kids | 0.0900 | 0.0058 | 0.0009 | 0.0001 | 0.0042 | 0.0000 | 0.1790 | 0.8210 |
| imd_score_elderly | 0.1354 | 0.0057 | 0.0009 | 0.0001 | 0.0027 | 0.0000 | 0.2581 | 0.7419 |
| wa_tot_ben | 10.9793 | 0.3485 | 3.5113 | 0.2938 | 10.9510 | 0.0863 | 0.2428 | 0.7572 |
| wa_jsa | 2.0294 | 0.1031 | 0.3052 | 0.0256 | 1.0382 | 0.0082 | 0.2272 | 0.7728 |
| sec_school_absence | 7.7325 | 0.1724 | 0.8764 | 0.0726 | 1.7452 | 0.0138 | 0.3343 | 0.6657 |
| ks4_mean_points_score | 38.7804 | 0.3620 | 3.1338 | 0.2739 | 25.2857 | 0.1996 | 0.1103 | 0.8897 |
| combi_air_qual_ind | 1.6861 | 0.0321 | 0.0325 | 0.0264 | 0.0138 | 0.0001 | 0.7023 | 0.2977 |
| area_green | -15.9762 | 0.6159 | 10.8013 | 0.9079 | 37.9354 | 0.2991 | 0.2216 | 0.7784 |
| smr_lsoa_01 | 0.8210 | 0.0158 | 0.0028 | 0.0004 | 0.1890 | 0.0015 | 0.0147 | 0.9853 |
| pphhlds_limlong_ill | 26.0887 | 0.3773 | 3.8665 | 0.3304 | 21.4888 | 0.1694 | 0.1525 | 0.8475 |
| perc_rough | 0.0014 | 0.0010 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0116 | 0.9884 |
| phhlds_noheating | 6.5576 | 0.7644 | 17.5480 | 1.4459 | 32.4539 | 0.2559 | 0.3509 | 0.6491 |
| perc_commute_wrk | 2.0548 | 0.3522 | 3.7894 | 0.3106 | 4.2157 | 0.0332 | 0.4734 | 0.5266 |
| perc_privtrans_wrk | 24.8296 | 0.4422 | 5.5675 | 0.4641 | 16.2193 | 0.1279 | 0.2555 | 0.7445 |
| perc_pubtrans_wrk | 19.9055 | 0.4245 | 5.4904 | 0.4505 | 6.4713 | 0.0510 | 0.4590 | 0.5410 |
| perc_footbike_wrk | 7.0814 | 0.3616 | 3.8615 | 0.3197 | 7.5692 | 0.0597 | 0.3378 | 0.6622 |
| turnout | 26.9231 | 1.1967 | 37.4411 | 3.2702 | 39.4062 | 0.7003 | 0.4872 | 0.5128 |
| le_all | 80.5416 | 0.1383 | 0.1430 | 0.0243 | 3.7782 | 0.0611 | 0.0365 | 0.9635 |
| concept_teen | 20.7564 | 2.0368 | 107.9011 | 9.2963 | 104.9521 | 2.0968 | 0.5069 | 0.4931 |

Estimates of residual variance are all statistically significant at the 5 percent level at both PCT and LSOA/ward level, except for the average points score for KS4 examinations (ks4_mean_points_score), which is not significant for PCTs only.

A graphical representation of the distribution of residual variances for quality of life indicators is shown in Figure 15.

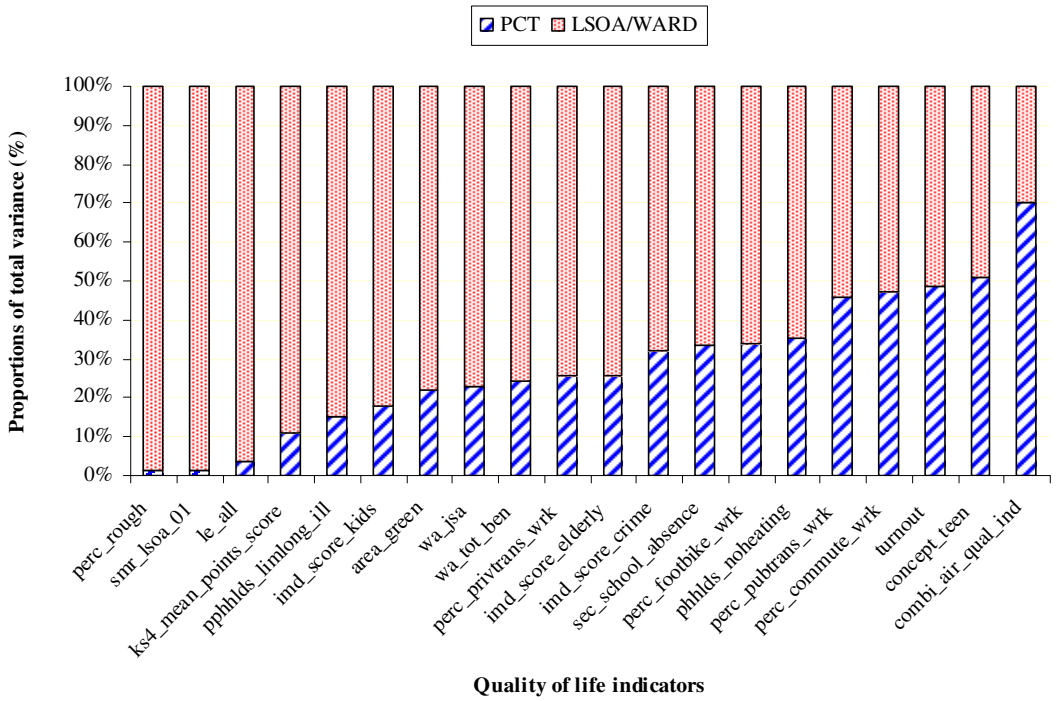



**Figure 15: Proportion of variation in quality of life indicators attributable to PCTs and small areas (intra-class correlation coefficients) (Model 3B - controlling for domain specific need variables)**

Table 38 reports the total variances and coefficients of variation for each quality of life indicator. These are of comparable value across all indicators, with the usual exception of the area of green space per head (area_green) and the percentage of people living rough (perc_rough). Further, the results for the model considered here are all smaller than those obtained in the basic Model 3; whilst a unique direction of change emerges when comparing them with those obtained in Model 3A. In general these results imply that socio-demographic characteristics at small area level account for an important part of existing variation in the quality of life indicators and that for some of the quality of life indicators considered in this study the type of measure of need used can make a considerable difference.

**Table 38: Total variation in quality of life indicator models attributable to PCTs and small areas (Model 3B - controlling for domain specific need variables)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3545 | - |
| imd_score_kids | 0.0051 | - |
| imd_score_elderly | 0.0036 | - |
| wa_tot_ben | 14.4622 | 0.2645 |
| wa_jsa | 1.3434 | 0.5313 |
| sec_school_absence | 2.6217 | 0.1998 |
| ks4_mean_points_score | 28.4195 | 0.1541 |
| combi_air_qual_ind | 0.0463 | 0.1849 |
| area_green | 48.7366 | 3.0587 |
| smr_lsoa_01 | 0.1918 | 0.3905 |
| pphhlds_limlong_ill | 25.3552 | 0.1505 |
| perc_rough | 0.0008 | 16.9134 |
| phhlds_noheating | 50.0019 | 0.8397 |
| perc_commute_wrk | 8.0051 | 0.4941 |
| perc_privtrans_wrk | 21.7868 | 0.1822 |
| perc_pubtrans_wrk | 11.9617 | 0.5059 |
| perc_footbike_wrk | 11.4307 | 0.5786 |
| turnout | 76.8473 | 0.2623 |
| le_all | 3.9212 | 0.0252 |
| concept_teen | 212.8532 | 0.5258 |

Table 39 reports the estimated coefficients of the seven domain specific deprivation indices for each quality of life indicator. Estimates in bold italic indicate a 5 percent statistical significance for these figures. Most coefficients show the expected sign; for example one would expect the percentage of teenage conceptions at small area to be positively associated with deprivation in terms of income, education, environment and crime. A counter-intuitive result found in our analysis is that for election turnout, which shows a positive and high association with the IMD index of deprivation for employment and barriers. Elsewhere in this report (see Section 5.2.1.4) we have attempted to provide a possible explanation for this relationship. Another counter-intuitive result is given by the positive coefficient of employment deprivation for the average point score for KS4 examinations (ks4_mean_point_score). This is again consistent with previous model results and might indicate that we have some residual collinearity in this particular model.

**Table 39: The beta coefficients for domain specific need variables for models attributable to PCTs and small areas (Model 3B – controlling for domain specific need variables)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***0.7389*** | 0.0831 | 0.1819 | 0.1304 | ***0.3374*** | 0.0097 | ***0.0014*** | 0.0003 | -0.0078 | 0.0033 | ***0.0128*** | 0.0002 | | |
| imd_score_kids | | | ***0.9882*** | 0.0133 | ***0.0439*** | 0.0013 | ***0.0033*** | 0.0000 | ***0.0010*** | 0.0000 | ***0.0002*** | 0.0000 | ***0.0108*** | 0.0007 |
| imd_score_elderly | | | ***0.2688*** | 0.0107 | ***0.0758*** | 0.0010 | ***0.0005*** | 0.0000 | ***0.0005*** | 0.0000 | ***0.0009*** | 0.0000 | -0.0001 | 0.0006 |
| wa_tot_ben | | | | | ***6.7056*** | 0.0516 | ***0.2214*** | 0.0017 | ***0.0305*** | 0.0023 | -0.0114 | 0.0017 | ***0.3997*** | 0.0373 |
| wa_jsa | | | | | ***0.9779*** | 0.0159 | ***0.0224*** | 0.0005 | ***0.0077*** | 0.0007 | ***0.0132*** | 0.0005 | ***0.1813*** | 0.0115 |
| sec_school_absence | ***1.5300*** | 0.1959 | -0.2873 | 0.3532 | ***0.5689*** | 0.0267 | | | -0.0020 | 0.0009 | ***0.0028*** | 0.0007 | ***0.2556*** | 0.0150 |
| ks4_mean_points_score | -39.7404 | 0.7367 | ***25.0873*** | 1.3298 | -3.9289 | 0.1001 | | | ***0.0171*** | 0.0035 | -0.0072 | 0.0026 | -0.5681 | 0.0564 |
| combi_air_qual_ind | ***0.1118*** | 0.0199 | -0.3060 | 0.0313 | ***0.0598*** | 0.0024 | -0.0004 | 0.0001 | -0.0036 | 0.0001 | | | ***0.0439*** | 0.0013 |
| area_green | 2.0374 | 1.0408 | ***11.1375*** | 1.6354 | -2.4563 | 0.1233 | -0.0113 | 0.0039 | ***0.4663*** | 0.0043 | | | -0.2645 | 0.0667 |
| smr_lsoa_01 | ***1.3318*** | 0.0692 | ***0.2874*** | 0.1006 | | | -0.0016 | 0.0003 | 0.0004 | 0.0003 | ***0.0012*** | 0.0002 | ***0.0350*** | 0.0045 |
| pphhlds_limlong_ill | -5.3736 | 0.7743 | ***67.4974*** | 1.1297 | | | ***0.1247*** | 0.0029 | -0.0627 | 0.0032 | -0.0548 | 0.0024 | -0.4022 | 0.0511 |
| perc_rough | -0.0273 | 0.0043 | ***0.0648*** | 0.0069 | ***0.0020*** | 0.0005 | -0.0001 | 0.0000 | ***0.000039*** | 0.0000 | | | ***0.0014*** | 0.0003 |
| phhlds_noheating | ***2.9944*** | 0.9655 | -6.2238 | 1.5157 | ***1.5470*** | 0.1147 | ***0.0695*** | 0.0036 | -0.0118 | 0.0040 | | | ***1.3100*** | 0.0620 |
| perc_commute_wrk | ***1.7738*** | 0.3491 | 0.7144 | 0.5468 | -1.1289 | 0.0417 | -0.0526 | 0.0013 | ***0.0434*** | 0.0014 | 0.0010 | 0.0011 | -0.1332 | 0.0233 |
| perc_privtrans_wrk | -23.1028 | 0.6826 | -22.6882 | 1.0702 | -0.6070 | 0.0813 | -0.0308 | 0.0025 | ***0.0570*** | 0.0028 | -0.1198 | 0.0021 | -0.2730 | 0.0455 |
| perc_pubtrans_wrk | -9.9598 | 0.4325 | ***3.6980*** | 0.6774 | ***0.3263*** | 0.0517 | ***0.0100*** | 0.0016 | -0.0238 | 0.0019 | ***0.0478*** | 0.0013 | ***0.4052*** | 0.0289 |
| perc_footbike_wrk | -4.3510 | 0.4671 | -8.1834 | 0.7319 | ***2.2431*** | 0.0557 | -0.0160 | 0.0017 | -0.0899 | 0.0019 | ***0.0840*** | 0.0014 | ***0.4309*** | 0.0312 |
| turnout | 5.1037 | 2.6724 | ***28.0395*** | 3.9900 | -2.7038 | 0.2787 | -0.1562 | 0.0100 | ***0.1178*** | 0.0085 | 0.0103 | 0.0079 | -1.4757 | 0.1564 |
| le_all | -2.8391 | 0.7096 | -8.6555 | 0.9440 | | | -0.0150 | 0.0026 | ***0.0051*** | 0.0021 | -0.0151 | 0.0021 | -0.5542 | 0.0390 |
| concept_teen | ***17.7050*** | 4.4354 | -3.1884 | 6.1214 | | | ***0.2636*** | 0.0163 | 0.0299 | 0.0189 | ***0.0306*** | 0.0137 | ***2.5702*** | 0.2856 |

*5.2.3.4. Model 3C and Model 3D - model with PCT performance indicators with and without domain specific need variables*

In this section we present results for the two-level random effects model with PCT performance indicators with and without domain specific needs variables. Estimates of residual variance for all quality of life indictors and at both levels are significant at the 5 percent level. The only exception is the indicator percentage of people living rough (perc_rough) which is not significant for the PCT level. For the majority of quality of life indicators, the greatest residual variation occurs at LSOA / ward level. However, for the indicators combined air quality (combi_air_qual_ind) and election turnout (turnout) the proportion of residual variance attributable at PCT level is greater than 50 percent. Further, for two quality of life indicators, the percentage of people commuting to work over 20 km (perc_commute_wrk) and the percentage of people commuting to work by public transport (perc_pubtrans_wrk), the proportion of residual variance attributable to PCTs is respectively equal to about 40 and 45 percent (see Table 40 and Figure 16).

**Table 40: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to PCTs and small areas (Model 3C – controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | β | SE | $\sigma_{u0}$ | SE | $\sigma_e$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.0891 | 0.1007 | 0.0915 | 0.0110 | 0.2403 | 0.0029 | 0.2757 | 0.7243 |
| imd_score_kids | 0.0919 | 0.0103 | 0.0009 | 0.0001 | 0.0042 | 0.0001 | 0.1764 | 0.8236 |
| imd_score_elderly | 0.1562 | 0.0106 | 0.0010 | 0.0001 | 0.0028 | 0.0000 | 0.2663 | 0.7337 |
| wa_tot_ben | 11.4387 | 0.6171 | 3.4465 | 0.4157 | 10.6105 | 0.1264 | 0.2452 | 0.7548 |
| wa_jsa | 2.2685 | 0.1616 | 0.2280 | 0.0280 | 1.0036 | 0.0120 | 0.1851 | 0.8149 |
| sec_school_absence | 7.7271 | 0.3165 | 0.9268 | 0.1108 | 1.7641 | 0.0211 | 0.3444 | 0.6556 |
| ks4_mean_points_score | 39.4173 | 0.6736 | 3.6043 | 0.4541 | 24.2909 | 0.2894 | 0.1292 | 0.8708 |
| combi_air_qual_ind | 1.6888 | 0.0485 | 0.0231 | 0.0027 | 0.0129 | 0.0002 | 0.6416 | 0.3584 |
| area_green | -17.7225 | 1.1526 | 12.2064 | 1.4673 | 29.7246 | 0.3540 | 0.2911 | 0.7089 |
| smr_lsoa_01 | 0.8186 | 0.0262 | 0.0023 | 0.0005 | 0.1881 | 0.0022 | 0.0120 | 0.9880 |
| pphhlds_limlong_ill | 26.5890 | 0.6066 | 3.0182 | 0.3795 | 21.6734 | 0.2581 | 0.1222 | 0.8778 |
| perc_rough | 0.0013 | 0.0016 | 0.0000 | 0.0000 | 0.0009 | 0.0000 | 0.0010 | 0.9990 |
| phhlds_noheating | 7.4847 | 1.2141 | 13.7888 | 1.6485 | 25.6770 | 0.3058 | 0.3494 | 0.6506 |
| perc_commute_wrk | 2.6958 | 0.5835 | 3.2006 | 0.3810 | 4.7631 | 0.0567 | 0.4019 | 0.5981 |
| perc_privtrans_wrk | 25.6829 | 0.7604 | 5.1140 | 0.6206 | 16.4199 | 0.1955 | 0.2375 | 0.7625 |
| perc_pubtrans_wrk | 19.5730 | 0.7069 | 4.7459 | 0.5629 | 5.8152 | 0.0692 | 0.4494 | 0.5506 |
| perc_footbike_wrk | 5.5259 | 0.6101 | 3.4048 | 0.4063 | 7.6046 | 0.0906 | 0.3093 | 0.6907 |
| turnout | 24.9485 | 2.1948 | 39.3043 | 4.9737 | 38.7660 | 1.0497 | 0.5034 | 0.4966 |
| le_all | 80.4009 | 0.2162 | 0.0669 | 0.0260 | 3.6898 | 0.0903 | 0.0178 | 0.9822 |
| concept_teen | 24.0692 | 2.8706 | 58.9332 | 7.8266 | 107.7912 | 3.2827 | 0.3535 | 0.6465 |

Comparing the results obtained in this model specification with those with domain specific need indicators only, the introduction of performance indicators for PCTs has a mixed effect, with the majority of quality of life indicators displaying lower residual variances at PCT level. The mixed effect of PCT performance indicators on the proportion of residual variances may be an indication – especially for the one where this value is high – that some influence may be exerted at this particular level.

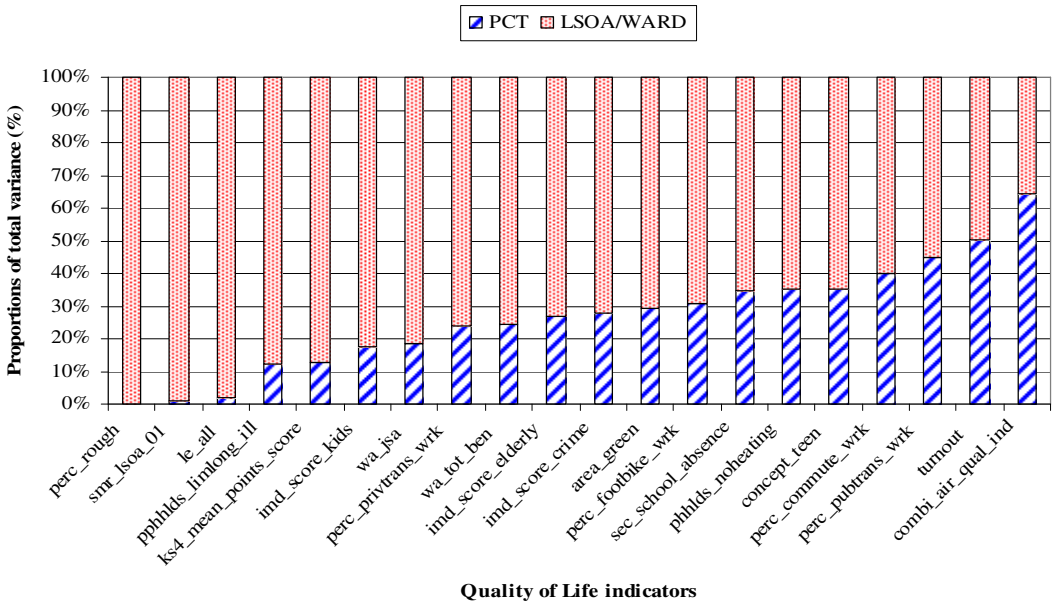



**Figure 16: Proportion of variation in quality of life indicators attributable to PCTs and small areas (intra-class correlation coefficients) (Model 3C – controlling for domain specific need variables and PCT performance indicators)**

In terms of coefficients of variation, these are in general lower, but of comparable size, to those obtained in Model 3B (Table 41).

**Table 41: Total variation in quality of life indicator models attributable to PCTs and small areas (Model 3C – controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | Total variation | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3318 | - |
| imd_score_kids | 0.0051 | - |
| imd_score_elderly | 0.0038 | - |
| wa_tot_ben | 14.0570 | 0.2607 |
| wa_jsa | 1.2315 | 0.5087 |
| sec_school_absence | 2.6908 | 0.2024 |
| ks4_mean_points_score | 27.8952 | 0.1527 |
| combi_air_qual_ind | 0.0360 | 0.1630 |
| area_green | 41.9310 | 2.8372 |
| smr_lsoa_01 | 0.1904 | 0.3890 |
| pphhlds_limlong_ill | 24.6916 | 0.1486 |
| perc_rough | 0.0009 | 18.6912 |
| phhlds_noheating | 39.4659 | 0.7460 |
| perc_commute_wrk | 7.9637 | 0.4929 |
| perc_privtrans_wrk | 21.5339 | 0.1812 |
| perc_pubtrans_wrk | 10.5611 | 0.4753 |
| perc_footbike_wrk | 11.0094 | 0.5679 |
| turnout | 78.0703 | 0.2644 |
| le_all | 3.7567 | 0.0247 |
| concept_teen | 166.7244 | 0.4654 |

Table 42 shows the estimated coefficients of the seven domain specific IMD indices of deprivation. Estimates in bold italic are statistically significant at the 5 percent level. These are similar to the results obtained in Model 3B.

**Table 42: The beta coefficients for domain specific need variables for models attributable to PCTs and small areas (Model 3C – controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***1.1159*** | 0.1246 | -0.1300 | 0.1998 | ***0.3326*** | 0.0151 | ***0.0016*** | 0.0005 | -0.0075 | 0.0005 | ***0.0150*** | 0.0004 | | |
| imd_score_kids | | | ***0.9917*** | 0.0207 | ***0.0451*** | 0.0020 | ***0.0032*** | 0.0001 | ***0.0011*** | 0.0001 | 0.0001 | 0.0001 | ***0.0147*** | 0.0011 |
| imd_score_elderly | | | ***0.2595*** | 0.0169 | ***0.0795*** | 0.0016 | ***0.0003*** | 0.0000 | ***0.0004*** | 0.0001 | ***0.0009*** | 0.0000 | -0.0004 | 0.0009 |
| wa_tot_ben | | | | | ***6.8151*** | 0.0796 | ***0.2142*** | 0.0025 | ***0.0312*** | 0.0033 | -0.0214 | 0.0027 | ***0.4896*** | 0.0554 |
| wa_jsa | | | | | ***0.9625*** | 0.0244 | ***0.0235*** | 0.0008 | ***0.0076*** | 0.0010 | ***0.0126*** | 0.0008 | ***0.1822*** | 0.0169 |
| sec_school_absence | ***1.7659*** | 0.2998 | -0.0477 | 0.5477 | ***0.4969*** | 0.0415 | | | -0.0025 | 0.0014 | 0.0002 | 0.0011 | ***0.2718*** | 0.0228 |
| ks4_mean_points_score | -39.4198 | 1.0955 | ***25.9178*** | 2.0024 | -4.5090 | 0.1510 | | | ***0.0172*** | 0.0050 | 0.0017 | 0.0040 | -0.4197 | 0.0837 |
| combi_air_qual_ind | ***0.1462*** | 0.0290 | -0.4314 | 0.0464 | ***0.0703*** | 0.0035 | -0.0005 | 0.0001 | -0.0035 | 0.0001 | | | ***0.0476*** | 0.0019 |
| area_green | 0.4674 | 1.3890 | ***12.6101*** | 2.2228 | -2.5632 | 0.1689 | -0.0130 | 0.0005 | ***0.4660*** | 0.0056 | | | -0.0597 | 0.0886 |
| smr_lsoa_01 | ***1.3972*** | 0.1027 | ***0.3641*** | 0.1538 | | | -0.0024 | 0.0004 | 0.0006 | 0.0004 | ***0.0014*** | 0.0003 | ***0.0286*** | 0.0067 |
| pphhlds_limlong_ill | -7.1774 | 1.1659 | ***70.3156*** | 1.7385 | | | ***0.1216*** | 0.0044 | -0.0563 | 0.0048 | -0.0608 | 0.0038 | -0.3384 | 0.0775 |
| perc_rough | -0.0180 | 0.0068 | ***0.0504*** | 0.0113 | ***0.0020*** | 0.0007 | -0.0001 | 0.0000 | 0.000008 | 0.000027 | | | ***0.0016*** | 0.0004 |
| phhlds_noheating | -6.0169 | 1.2925 | 0.2935 | 2.0675 | ***1.9214*** | 0.1574 | ***0.0482*** | 0.0048 | -0.0145 | 0.0053 | | | ***1.4715*** | 0.0824 |
| perc_commute_wrk | ***1.1091*** | 0.5575 | 1.6234 | 0.8909 | -1.1877 | 0.0686 | -0.0510 | 0.0021 | ***0.0428*** | 0.0023 | ***0.0056*** | 0.0018 | -0.0862 | 0.0374 |
| perc_privtrans_wrk | -24.6900 | 1.0317 | -19.9893 | 1.6505 | -1.0537 | 0.1264 | -0.0114 | 0.0038 | ***0.0646*** | 0.0042 | -0.1142 | 0.0033 | -0.2557 | 0.0692 |
| perc_pubtrans_wrk | -8.7501 | 0.6164 | 1.7796 | 0.9847 | ***0.5044*** | 0.0759 | ***0.0045*** | 0.0023 | -0.0258 | 0.0025 | ***0.0405*** | 0.0020 | ***0.3224*** | 0.0413 |
| perc_footbike_wrk | -3.1456 | 0.7034 | -9.6556 | 1.1246 | ***2.2142*** | 0.0864 | -0.0167 | 0.0026 | -0.0978 | 0.0029 | ***0.0926*** | 0.0023 | ***0.4873*** | 0.0472 |
| turnout | 6.2013 | 4.0733 | ***28.8488*** | 6.1061 | -3.5014 | 0.4278 | -0.1635 | 0.0148 | ***0.1330*** | 0.0128 | 0.0235 | 0.0123 | -1.6021 | 0.2363 |
| le_all | -3.4194 | 1.0366 | -8.8144 | 1.4234 | | | -0.0115 | 0.0038 | 0.0026 | 0.0031 | -0.0177 | 0.0032 | -0.4793 | 0.0574 |
| concept_teen | ***22.3131*** | 6.7936 | -12.3027 | 9.2767 | | | ***0.3021*** | 0.0243 | 0.0050 | 0.0287 | 0.0252 | 0.0216 | ***2.8974*** | 0.4363 |

Estimated coefficients for PCT performance indicators are shown in Table 43, figures in bold italic are statistically significant at the 5 percent level. Only star rating (star_rating) and current distance from target in percentage terms (curr_dft_percent) seem to have a positive association with some of the quality of life indicators. A not so straight-forward positive association is found in our model between PCT star rating and the percentage of households with limiting long-standing illness (phhlds_limlong_ill). On the one hand one would expect this association to be negative, assuming that less well-performing PCTs should have a higher percentage of households with limiting longstanding illness. However, if one considers that GPs and by reflection PCTs are assessed also in terms of the number of tests they perform on their patients on a number of key diseases (e.g. diabetes) and also good record keeping of patients on their list with these diseases, then this positive relationship may be explained by greater attention to case finding.

**Table 43: The beta coefficients for PCT performance indicators for models attributable to PCTs and small areas (Model 3C – controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | β-finman | SE | β-star_rating | SE | β-curr_dft_percent | SE |
|---|---|---|---|---|---|---|
| imd_score_crime | -0.0127 | 0.0560 | -0.0769 | 0.0324 | -0.0169 | 0.0103 |
| imd_score_kids | 0.0059 | 0.0056 | -0.0034 | 0.0033 | 0.0005 | 0.0010 |
| imd_score_elderly | 0.0096 | 0.0059 | -0.0144 | 0.0034 | -0.0005 | 0.0011 |
| wa_tot_ben | 0.1167 | 0.3448 | -0.0069 | 0.1999 | ***0.1542*** | 0.0637 |
| wa_jsa | 0.0766 | 0.0893 | -0.1135 | 0.0520 | -0.0044 | 0.0165 |
| sec_school_absence | -0.1916 | 0.1776 | -0.0360 | 0.1025 | 0.0166 | 0.0328 |
| ks4_mean_points_score | -0.3379 | 0.3595 | 0.1993 | 0.2100 | -0.0542 | 0.0666 |
| combi_air_qual_ind | 0.0120 | 0.0278 | -0.0528 | 0.0158 | -0.0074 | 0.0051 |
| area_green | 1.0443 | 0.6466 | ***0.7940*** | 0.3740 | 0.0845 | 0.1194 |
| smr_lsoa_01 | 0.0042 | 0.0118 | -0.0096 | 0.0071 | -0.0002 | 0.0023 |
| pphhlds_limlong_ill | -0.5112 | 0.3296 | ***0.7661*** | 0.1926 | 0.0053 | 0.0611 |
| perc_rough | 0.0007 | 0.0006 | 0.0001 | 0.0004 | -0.0001 | 0.0001 |
| phhlds_noheating | -0.7366 | 0.6850 | 0.4619 | 0.3950 | -0.2158 | 0.1264 |
| perc_commute_wrk | -0.0061 | 0.3293 | -0.4955 | 0.1894 | ***0.1643*** | 0.0608 |
| perc_privtrans_wrk | 0.1953 | 0.4204 | -0.5011 | 0.2438 | 0.0240 | 0.0777 |
| perc_pubtrans_wrk | -0.1727 | 0.4003 | -0.4088 | 0.2298 | -0.0461 | 0.0739 |
| perc_footbike_wrk | 0.5000 | 0.3411 | 0.3207 | 0.1971 | 0.0397 | 0.0630 |
| turnout | 1.0252 | 1.2500 | ***1.5293*** | 0.7100 | -0.2137 | 0.2268 |
| le_all | 0.0291 | 0.0863 | ***0.2128*** | 0.0534 | 0.0293 | 0.0168 |
| concept_teen | -0.4055 | 1.4810 | -1.4616 | 0.8750 | -0.3091 | 0.2762 |

Tables 44, 45, 46 and Figure 17 show the results obtained from estimating a random-effect multi-level model with only PCT performance indicators. As for Model 1D, our aim was to elicit the true impact that the performance indicators have on the quality of life indicators. The estimation results show that the proportion of residual variance at PCT level is now higher in two thirds of the quality of life indicators, thus meaning that some of the variance at this particular level can be explained simply by the socio-demographic characteristics of the population at small area level. The coefficients of variation (see Table 45) support these findings. An interesting result is the proportion of variance attributable to PCTs for election turnout (turnout), which increases by about 5 percent after needs at small area are taken into account.

All proportions of residual variance are statistically significant at the 5 percent level at both PCT and LSOA/ward level, except for the indicator percentage of people living rough (perc_rough) at PCT level.

**Table 44: Two-level random-intercept model of the proportion of variation in quality of life indicators attributable to PCTs and small areas (Model 3D –controlling for PCT performance indicators only)**

| Quality of life indicators | β | SE | $\sigma_{u0}$ | SE | $\sigma_e$ | SE | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.5644 | 0.1641 | 0.2633 | 0.0313 | 0.4006 | 0.0048 | 0.3966 | 0.6034 |
| imd_score_kids | 0.3280 | 0.0255 | 0.0063 | 0.0008 | 0.0195 | 0.0002 | 0.2431 | 0.7569 |
| imd_score_elderly | 0.2451 | 0.0176 | 0.0030 | 0.0004 | 0.0069 | 0.0001 | 0.3021 | 0.6979 |
| wa_tot_ben | 17.5762 | 1.3175 | 16.6497 | 2.0216 | 55.0005 | 0.6550 | 0.2324 | 0.7676 |
| wa_jsa | 3.6561 | 0.2564 | 0.6321 | 0.0765 | 1.9378 | 0.0231 | 0.2460 | 0.7540 |
| sec_school_absence | 8.2255 | 0.3558 | 1.2362 | 0.1473 | 2.0459 | 0.0245 | 0.3766 | 0.6234 |
| ks4_mean_points_score | 33.4265 | 0.9467 | 8.4122 | 1.0453 | 47.4063 | 0.5647 | 0.1507 | 0.8493 |
| combi_air_qual_ind | 1.5664 | 0.0566 | 0.0319 | 0.0038 | 0.0165 | 0.0002 | 0.6587 | 0.3413 |
| area_green | -1.1999 | 1.2728 | 15.5884 | 1.8856 | 46.7559 | 0.5568 | 0.2500 | 0.7500 |
| smr_lsoa_01 | 1.2015 | 0.0284 | 0.0062 | 0.0010 | 0.2085 | 0.0025 | 0.0287 | 0.9713 |
| pphhlds_limlong_ill | 31.7060 | 1.1811 | 13.4032 | 1.6228 | 42.0834 | 0.5011 | 0.2416 | 0.7584 |
| perc_rough | 0.0019 | 0.0010 | 0.0000 | 0.0000 | 0.0009 | 0.0000 | 0.0017 | 0.9983 |
| phhlds_noheating | 7.7905 | 1.2580 | 15.4097 | 1.8400 | 29.3303 | 0.3493 | 0.3444 | 0.6556 |
| perc_commute_wrk | 3.5933 | 0.7460 | 5.4701 | 0.6457 | 6.3899 | 0.0761 | 0.4612 | 0.5388 |
| perc_privtrans_wrk | 16.2422 | 1.3112 | 16.6540 | 2.0033 | 39.3263 | 0.4683 | 0.2975 | 0.7025 |
| perc_pubtrans_wrk | 18.5865 | 0.7134 | 4.9957 | 0.5936 | 6.3073 | 0.0751 | 0.4420 | 0.5580 |
| perc_footbike_wrk | 3.5596 | 0.4788 | 2.1622 | 0.2681 | 11.0986 | 0.1322 | 0.1631 | 0.8369 |
| turnout | 29.6744 | 2.1945 | 43.2870 | 5.5496 | 51.1596 | 1.3851 | 0.4583 | 0.5417 |
| le_all | 77.4566 | 0.3477 | 0.9214 | 0.1370 | 4.8305 | 0.1185 | 0.1602 | 0.8398 |
| concept_teen | 37.0468 | 3.3510 | 100.5937 | 13.1408 | 158.6556 | 4.8320 | 0.3880 | 0.6120 |

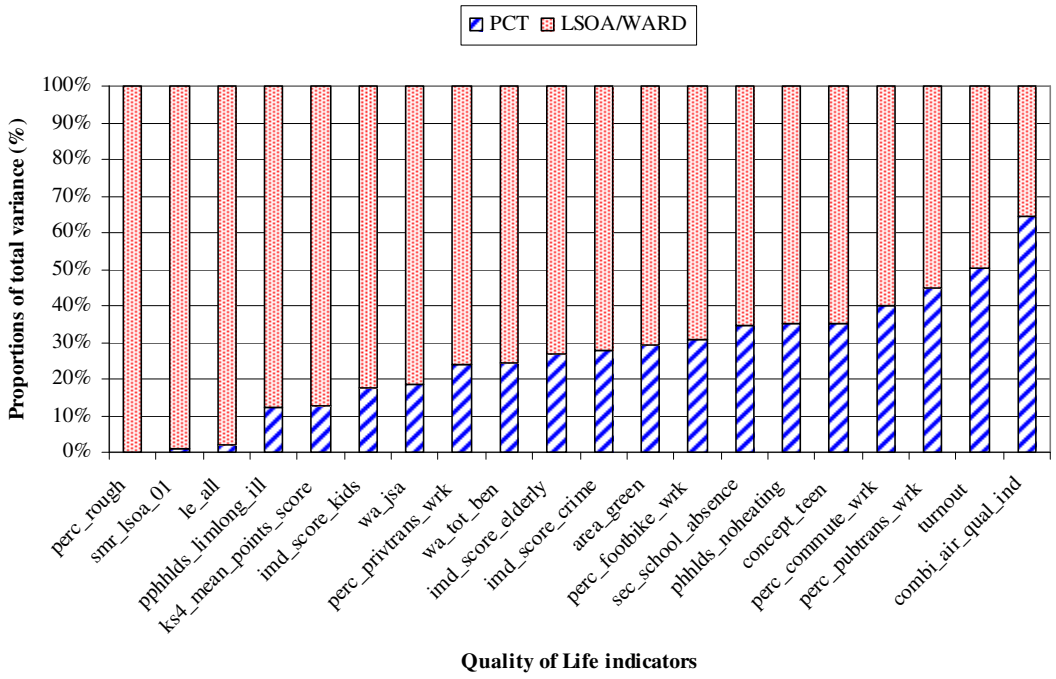



**Figure 17: Proportion of variation in quality of life indicators attributable to PCTs and small areas (intra-class correlation coefficients) (Model 3D –controlling for PCT performance indicators only)**

**Table 45: Total variation in quality of life indicator models attributable to PCTs and small areas (Model 3D –controlling for PCT performance indicators only)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.6639 | - |
| imd_score_kids | 0.0258 | - |
| imd_score_elderly | 0.0099 | - |
| wa_tot_ben | 71.6503 | 0.5887 |
| wa_jsa | 2.5699 | 0.7348 |
| sec_school_absence | 3.2821 | 0.2236 |
| ks4_mean_points_score | 55.8185 | 0.2160 |
| combi_air_qual_ind | 0.0484 | 0.1891 |
| area_green | 62.3442 | 3.4595 |
| smr_lsoa_01 | 0.2147 | 0.4131 |
| pphhlds_limlong_ill | 55.4866 | 0.2227 |
| perc_rough | 0.0009 | 18.7597 |
| phhlds_noheating | 44.7399 | 0.7943 |
| perc_commute_wrk | 11.8600 | 0.6015 |
| perc_privtrans_wrk | 55.9803 | 0.2921 |
| perc_pubtrans_wrk | 11.3029 | 0.4917 |
| perc_footbike_wrk | 13.2607 | 0.6232 |
| turnout | 94.4466 | 0.2908 |
| le_all | 5.7518 | 0.0306 |
| concept_teen | 259.2493 | 0.5803 |

Estimated coefficients for the three PCT performance indicators are shown in Table 46. Estimates in bold italic are statistically significant at the 5 percent level. These are similar to the ones obtained in Model 3C. An interesting result is the positive, but small, association between the average points score at KS4 examinations (ks4_mean_point_score) and the PCT performance indicator current distance from target in percentage terms (curr_dft_percent), which implies that higher educational attainment is associated with overfunding which might allow the PCT to achieve higher performance. Moreover, the same quality of life indicator has a positive association with PCT star ratings.

**Table 46: The beta coefficients for PCT performance indicators for models attributable to PCTs and small areas (Model 3D –controlling for PCT performance indicators only)**

| Quality of life indicators | β-finman | SE | β-star_rating | SE | β-curr_dft_percent | SE |
|---|---|---|---|---|---|---|
| imd_score_crime | -0.0808 | 0.0944 | -0.0738 | 0.0543 | -0.0574 | 0.0174 |
| imd_score_kids | -0.0210 | 0.0147 | -0.0142 | 0.0085 | -0.0076 | 0.0027 |
| imd_score_elderly | -0.0074 | 0.0101 | -0.0147 | 0.0058 | -0.0062 | 0.0019 |
| wa_tot_ben | -1.2766 | 0.7584 | -0.4908 | 0.4399 | -0.3423 | 0.1400 |
| wa_jsa | -0.1598 | 0.1476 | -0.1817 | 0.0855 | -0.0910 | 0.0242 |
| sec_school_absence | -0.2995 | 0.2048 | -0.0607 | 0.1180 | -0.0324 | 0.0378 |
| ks4_mean_points_score | 0.6706 | 0.5456 | ***0.6936*** | 0.3181 | ***0.3133*** | 0.1009 |
| combi_air_qual_ind | 0.0120 | 0.0326 | -0.0187 | 0.0186 | -0.0133 | 0.0060 |
| area_green | 0.4370 | 0.7327 | 0.7666 | 0.4245 | 0.2318 | 0.1353 |
| smr_lsoa_01 | -0.0239 | 0.0166 | -0.0310 | 0.0099 | -0.0093 | 0.0031 |
| pphhlds_limlong_ill | -1.1172 | 0.6799 | 0.5274 | 0.3941 | -0.1750 | 0.1255 |
| perc_rough | 0.0002 | 0.0006 | 0.0001 | 0.0004 | -0.0002 | 0.0001 |
| phhlds_noheating | -1.0812 | 0.7241 | 0.3663 | 0.4176 | -0.4018 | 0.1336 |
| perc_commute_wrk | 0.0783 | 0.4295 | -0.5048 | 0.2464 | ***0.2608*** | 0.0792 |
| perc_privtrans_wrk | 1.0538 | 0.7547 | -0.1425 | 0.4362 | ***0.4138*** | 0.1393 |
| perc_pubtrans_wrk | -0.4945 | 0.4107 | -0.3482 | 0.2358 | -0.0955 | 0.0758 |
| perc_footbike_wrk | 0.3032 | 0.2759 | ***0.3273*** | 0.1607 | -0.1402 | 0.0510 |
| turnout | 1.2439 | 1.3177 | ***1.8797*** | 0.7495 | -0.0114 | 0.2391 |
| le_all | 0.2783 | 0.1957 | ***0.3987*** | 0.1159 | ***0.1229*** | 0.0366 |
| concept_teen | -1.3519 | 1.9183 | -2.5361 | 1.1315 | -0.7782 | 0.3569 |

### *5.2.3.5. Conclusions for model 3*

The main result that emerged from the two-level random effect model defined at LSOA/ward (level 1) and PCTs (level 2) is that the greatest variation in the quality of life indicators exists at small area level. Controlling for socio-demographic characteristics of the population at small area level has the effect, for the majority of quality of life indicators, to reduce total residual variance; thus explaining the great influence exerted by so called 'environmental' factors on our quality of life indicators. In general, the model specification with the overall need variable has the largest impact on reducing the proportion of residual variance attributable to any of the two levels. Further, introducing PCT performance indicators, which are defined at the second level of our analysis, also has the effect of reducing overall residual variance over and above the mere effect of the domain specific need variables.

Results for the regional dummies (results not shown) were once again consistent and very similar in all model specifications 3 (basic, 3A, 3B and 3C) to those found in Models 1 and 2. The estimates are in the majority of models statistically significant at the 5 per cent level. Governmental regions perform better than the region of London (our reference region) for the following quality of life indicators: IMD deprivation index for crime; IMD score on children; IMD score on older people; All people of working age claiming a key benefit (in most models); All people of working age claiming job seeker allowance; Secondary School Absence; Combined Air quality indicator; Area of green space per head; People living rough; Life expectancy at birth; and Teenage conceptions (in most models).

Similarly to the previous two models, Figure 18 shows the distribution of the 20 quality of life indicators ranked by proportion of residual variance at PCT level (from the one with the lowest to the one with the highest variation). In general, the proportion of total residual variance attributed to both PCTs and LSOAs/wards do not change dramatically across the five model specifications, as shown in Figure 18. However, compared to the rankings of the quality of life indicators for the previous two models, there is more variability in the ranks held by any of the 20 quality of life indicators in the hierarchical structure underlying this particular model specification.

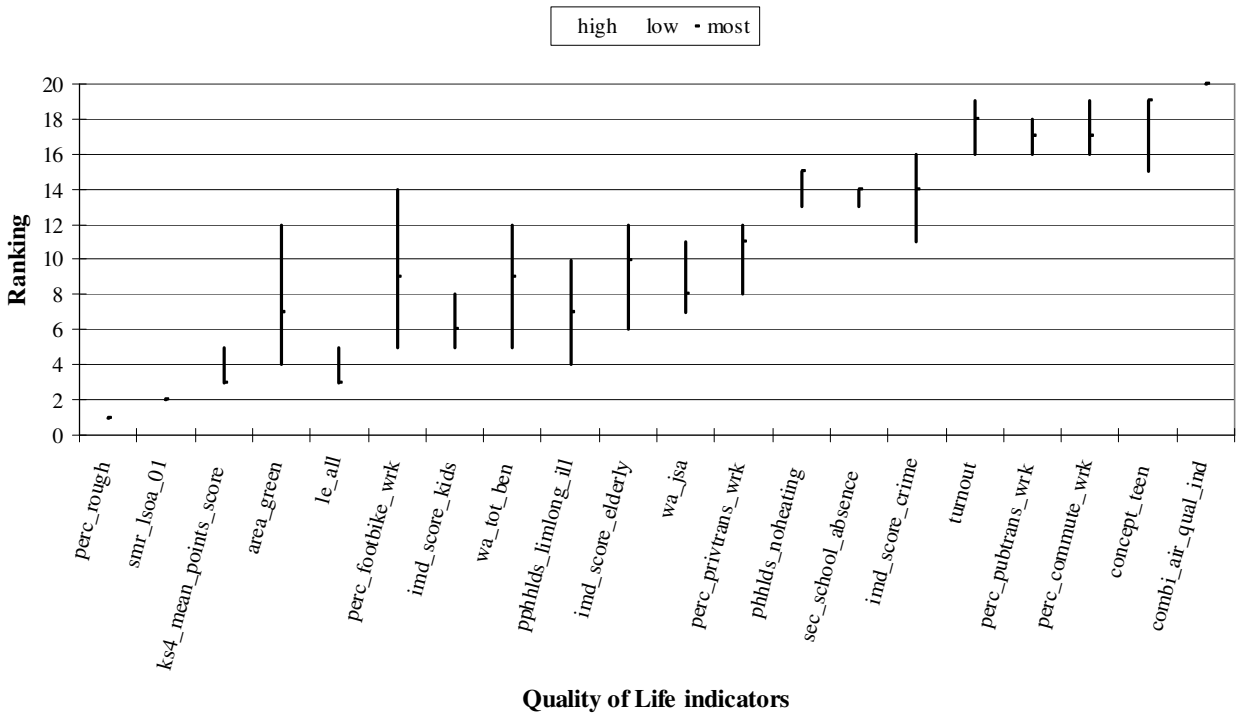



**Figure 18: Changes in rankings of the proportion of variation attributable to higher levels (PCTs) in quality of life indicators (across all variants of Model 3)**

### *5.2.4. Model 4*

The final model is a three-level random-effect model, defined with lower super output areas (LSOAs) or wards as the lowest level in the hierarchical structure (level 1); these are then clustered within Primary Care Trusts (PCTs) (level 2), which in turn are clustered within Strategic Health Authorities (SHAs).

Similarly to models presented in previous Sections, we estimate 20 separate models, one for each quality of life indicator. The first model estimated is one with no explanatory variables, with the aim of eliciting pure level effects. The results for this model specification are discussed in Section 5.2.4.1. We then control for socio-demographic characteristics of the population by introducing 1) the overall score Index of Multiple Deprivation and 2) domain specific indices of deprivation. The former is identified as Model 4A and is discussed in Section 5.2.4.2; the latter is identified as Model 4B and is discussed in Section 5.2.4.3. Alongside the domain specific need variables, we introduce three performance indicators capturing different aspects of performance for Primary Care Trusts. We call this Model 4C and its results are discussed in Section 5.2.4.4. In order to fully investigate the influence that the performance indicators for PCTs exert on the quality of life indicators and the proportion of residual variance attributable to any of the three levels of this model specification, we estimate a model that includes only the PCT performance indicators. This is called Model 4D and its results are also analysed in Section 5.2.4.4. We draw some preliminary conclusions on the overall findings in Model 4 in Section 5.2.4.5.

#### *5.2.4.1. Model 4 – basic specification*

All estimates of residual variance are significant at the 5 percent level for all quality of life indicators and at each level. Two exceptions are: standardised mortality ratio (smr_lsoa_01) and percentage of people living rough (perc_rough) that are not significant at the 5 percent level at SHA level.

**Table 47: Three-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (Model 4 – levels only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{v0}$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_v$ | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.0122 | 0.0708 | 0.1182 | 0.0374 | 0.2152 | 0.0187 | 0.3856 | 0.0030 | 0.1644 | 0.2993 | 0.5362 |
| imd_score_kids | 0.2011 | 0.0117 | 0.0032 | 0.0010 | 0.0058 | 0.0005 | 0.0198 | 0.0002 | 0.1110 | 0.2025 | 0.6865 |
| imd_score_elderly | 0.1618 | 0.0083 | 0.0017 | 0.0005 | 0.0026 | 0.0002 | 0.0070 | 0.0001 | 0.1475 | 0.2289 | 0.6236 |
| wa_tot_ben | 14.4451 | 0.7064 | 12.2442 | 3.7294 | 16.3999 | 1.4464 | 56.7059 | 0.4471 | 0.1435 | 0.1921 | 0.6644 |
| wa_jsa | 2.1979 | 0.1435 | 0.5023 | 0.1532 | 0.7108 | 0.0623 | 1.9864 | 0.0157 | 0.1570 | 0.2222 | 0.6209 |
| sec_school_absence | 8.1103 | 0.1105 | 0.2168 | 0.0913 | 1.2442 | 0.1077 | 2.0483 | 0.0162 | 0.0618 | 0.3545 | 0.5837 |
| ks4_mean_points_score | 34.5278 | 0.2741 | 1.1968 | 0.5608 | 8.7582 | 0.7873 | 47.7221 | 0.3766 | 0.0208 | 0.1518 | 0.8274 |
| combi_air_qual_ind | 1.1639 | 0.0441 | 0.0521 | 0.0145 | 0.0229 | 0.0020 | 0.0171 | 0.0001 | 0.5656 | 0.2485 | 0.1859 |
| area_green | 2.4546 | 0.3767 | 2.7467 | 1.0610 | 11.7734 | 1.0508 | 54.6844 | 0.4311 | 0.0397 | 0.1701 | 0.7902 |
| smr_lsoa_01 | 1.1209 | 0.0167 | 0.0007 | 0.0021 | 0.0077 | 0.0008 | 0.2097 | 0.0017 | 0.0031 | 0.0355 | 0.9614 |
| pphhlds_limlong_ill | 33.4825 | 0.8141 | 17.3104 | 4.9603 | 11.7245 | 1.0363 | 42.9215 | 0.3384 | 0.2406 | 0.1629 | 0.5965 |
| perc_rough | 0.0016 | 0.0003 | 0.0000 | 0.0000 | 0.0016 | 0.0003 | 0.0000 | 0.0000 | 0.0005 | 0.9932 | 0.0063 |
| phhlds_noheating | 8.2056 | 0.7581 | 14.6023 | 4.3025 | 14.0640 | 1.2401 | 37.8359 | 0.2983 | 0.2196 | 0.2115 | 0.5689 |
| perc_commute_wrk | 5.6584 | 0.4657 | 5.6590 | 1.6230 | 3.9746 | 0.3437 | 5.8934 | 0.0465 | 0.3645 | 0.2560 | 0.3796 |
| perc_privtrans_wrk | 25.2409 | 0.9235 | 22.1000 | 6.3692 | 16.9526 | 1.4809 | 41.1230 | 0.3242 | 0.2756 | 0.2114 | 0.5129 |
| perc_pubtrans_wrk | 7.2353 | 1.1367 | 35.6717 | 9.6604 | 4.8048 | 0.4155 | 7.0587 | 0.0556 | 0.7504 | 0.1011 | 0.1485 |
| perc_footbike_wrk | 5.8595 | 0.1979 | 0.8674 | 0.2926 | 2.1649 | 0.1939 | 10.6100 | 0.0836 | 0.0636 | 0.1587 | 0.7777 |
| turnout | 4.2677 | 0.7057 | 9.4767 | 3.7213 | 41.0211 | 3.8025 | 49.0952 | 0.8724 | 0.0952 | 0.4119 | 0.4930 |
| le_all | 78.6100 | 0.2118 | 1.1226 | 0.3355 | 1.0556 | 0.1102 | 5.0010 | 0.0810 | 0.1564 | 0.1470 | 0.6966 |
| concept_teen | 23.9719 | 2.2210 | 124.7873 | 36.8838 | 120.9522 | 11.1283 | 146.4141 | 2.9246 | 0.3182 | 0.3084 | 0.3734 |

$\beta_0$, coefficient intercept; SE, standard error: $\sigma^2_{v0}$, variance of strategic health authority effects; $\sigma^2_{u0}$, variance of primary care trust effects; $\sigma^2_{e0}$,variance of the small area effects; $\rho_v$, proportion of variance attributable to strategic health authorities; $\rho_u$, proportion of variance attributable to primary care trusts and $\rho_e$, proportion of variance attributable to small areas.

For the majority of quality of life indicators, the greatest variations still exist at small area level. However, in a few cases proportions of residual variance are significantly high at both SHA and PCT levels. In particular, the proportions of residual variance attributable to SHAs for the combined air quality indicator (combi_air_qual_ind) and percentage of people commuting to work by public transport (perc_pubtrans_wrk) are equal to respectively over 56 percent and about 75 percent. These figures go up to over 80 percent if the proportion of variance attributable to PCTs is taken into account. The quality of life indicator percentage of people living rough (perc_rough) also shows a considerable proportion of variance at PCT level, equal to over 99 percent. However, once we take

into account socio-demographic characteristics at local level, we find that the proportion of variance attributable to PCTs has almost completely disappeared (see Sections 5.2.4.2 and 5.2.4.3).

Further, it is worth noting that for three quality of life indicators the combined proportion of variance also explains more than 50 percent of total residual variance. These are percentage of people commuting to work for over 20 km (perc_commute_wrk) ($\rho_V$= 0.345 and $\rho_U$=0.2560), election turnout (turnout) ($\rho_V$= 0.0952 and $\rho_U$=0.4119) and the percentage of teenage conceptions (concept_teen) ($\rho_V$= 0.3183. and $\rho_U$= 0.3084).

For a graphical representation see Figure 19.

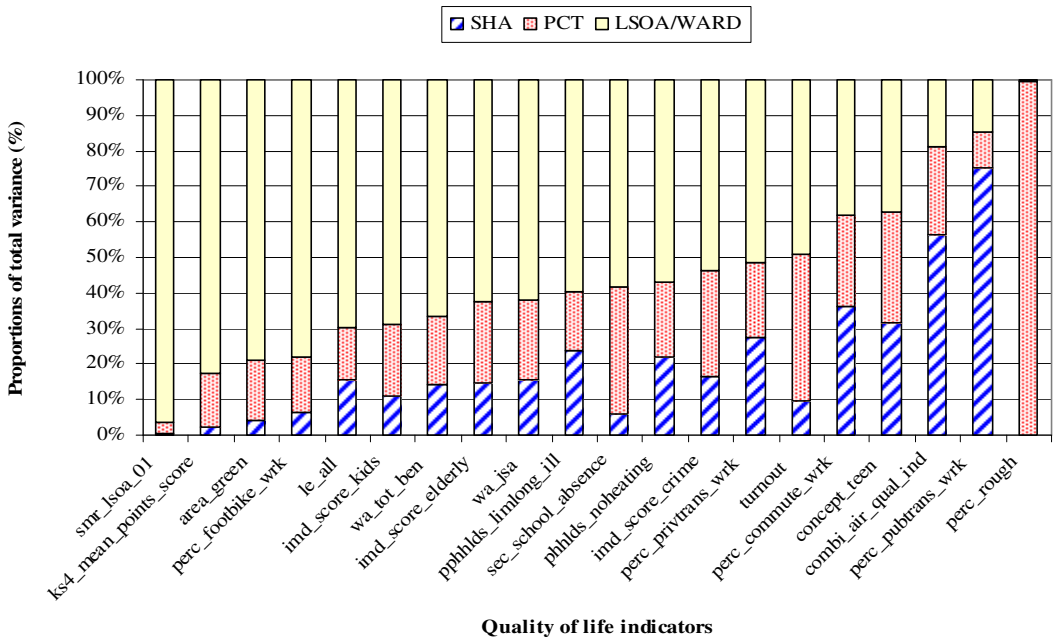



**Figure 19: Proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (intra-class correlation coefficients) (Model 4 – levels only)**

Looking at the total residual variances and their respective coefficients of variation it emerges that some differences exist for the quality of life indicators, with the coefficient of variation varying from 0.0341 for life expectancy at birth (le_all) to 24.9046 for percentage of people living rough (perc_rough).

**Table 48: Total variation in quality of life indicator models attributable to SHAs, PCTs and small areas (Model 4 – levels only)**

| Quality of life indicators | Total variation | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.7191 | - |
| imd_score_kids | 0.0288 | - |
| imd_score_elderly | 0.0112 | - |
| wa_tot_ben | 85.3500 | 0.6425 |
| wa_jsa | 3.1995 | 0.8199 |
| sec_school_absence | 3.5092 | 0.2312 |
| ks4_mean_points_score | 57.6771 | 0.2196 |
| combi_air_qual_ind | 0.0921 | 0.2608 |
| area_green | 69.2044 | 3.6449 |
| smr_lsoa_01 | 0.2181 | 0.4164 |
| pphhlds_limlong_ill | 71.9564 | 0.2536 |
| perc_rough | 0.0017 | 24.9046 |
| phhlds_noheating | 66.5021 | 0.9684 |
| perc_commute_wrk | 15.5270 | 0.6882 |
| perc_privtrans_wrk | 80.1757 | 0.3496 |
| perc_pubtrans_wrk | 47.5351 | 1.0084 |
| perc_footbike_wrk | 13.6423 | 0.6321 |
| turnout | 99.5930 | 0.2986 |
| le_all | 7.1792 | 0.0341 |
| concept_teen | 392.1536 | 0.7137 |

#### *5.2.4.2. Model 4A - overall need variable*

Estimates of residual variance attributable to any of the three levels in Model 4A are all statistically significant at the 5 percent level, with the only exception being the indicator percentage of people living rough (perc_rough), which is not significant at SHA level.

Introducing the overall IMD index of deprivation has a varied effect on the proportion of variance attributable to SHAs and PCTs (Table 49 and Figure 20 for a graphical representation). Regarding SHAs, it has in general the effect of reducing the proportion of variance attributable to SHAs, except for a limited number of quality of life indicators. These are the average points score for KS4 examinations (ks4_mean_points_score), the combined air quality indicator (combi_air_qual_ind), standardised mortality ratio (smr_lsoa_01), percentage of people without central heating (phhlds_noheating), percentage of people commuting to work by private transport (perc_privtrans_wrk), by public transport (perc_pubtrans_wrk) and on foot or by bike (perc_footbike_wrk), and election turnout (turnout). Further, the proportion of residual variance attributable to SHA for the indicators combined air quality and percentage of people commuting to work by public transport is equal to about 58 percent and 75 percent respectively. Thus, it is possible to conclude that SHAs may exert greater influence over these two quality of life indicators.

The proportion of variance attributable to PCTs decreases in all but one quality of life indicator: percentage of working age population claiming key benefits (wa_tot_ben).

For a number of quality of life indicators such as the combined air quality indicator (combi_air_qual_ind), percentage of people commuting to work over 20 km (perc_commute_wrk), percentage of people commuting by private transport (perc_privtrans_wrk) and by public transport (perc_pubtrans_wrk) and election turnout (turnout), the combined proportions of residual variance attributable to the SHA and PCT levels are greater than 50 percent ($\rho_v + \rho_u > 50$ percent). This is a clear indication that both PSOs at these two levels may exert some influence over these quality of life indicators. Overall however, the greatest variations are still registered at small area level.

Table 49 also shows the estimated coefficients of the overall need indicator for all quality of life indicators. Estimates that are statistically significant at the 5 percent level are shown in bold italic. These show expected associations, although these are negligible in size.

**Table 49: Three-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (Model 4A – controlling for overall need)**

| Quality of life indicators | β | SE | β-overall | SE | $\sigma_{v0}$ | SE | $\sigma_{u0}$ | SE | $\sigma_e$ | SE | $\rho_v$ | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.6983 | 0.0465 | ***0.0315*** | 0.0002 | 0.0504 | 0.0159 | 0.0894 | 0.0078 | 0.2471 | 0.0019 | 0.1303 | 0.2311 | 0.6387 |
| imd_score_kids | -0.0309 | 0.0604 | ***0.0107*** | 0.0000 | 0.0010 | 0.0003 | 0.0004 | 0.0000 | 0.0036 | 0.0000 | 0.1984 | 0.0760 | 0.7256 |
| imd_score_elderly | 0.0410 | 0.0033 | ***0.0055*** | 0.0000 | 0.0002 | 0.0001 | 0.0004 | 0.0000 | 0.0027 | 0.0000 | 0.0736 | 0.1302 | 0.7962 |
| wa_tot_ben | 1.5671 | 0.2105 | ***0.5917*** | 0.0013 | 0.9640 | 0.3259 | 2.4709 | 0.2168 | 7.1805 | 0.0566 | 0.0908 | 0.2328 | 0.6764 |
| wa_jsa | 0.1921 | 0.0776 | ***0.0922*** | 0.0004 | 0.1494 | 0.0443 | 0.1584 | 0.0142 | 0.7892 | 0.0062 | 0.1362 | 0.1444 | 0.7194 |
| sec_school_absence | 7.1236 | 0.0843 | ***0.0457*** | 0.0006 | 0.1098 | 0.0518 | 0.8403 | 0.0731 | 1.7599 | 0.0139 | 0.0405 | 0.3101 | 0.6494 |
| ks4_mean_points_score | 42.9684 | 0.3118 | -0.3875 | 0.0024 | 2.4054 | 0.7029 | 2.1179 | 0.2032 | 26.2050 | 0.2068 | 0.0783 | 0.0689 | 0.8528 |
| combi_air_qual_ind | 1.0992 | 0.0427 | ***0.0030*** | 0.0001 | 0.0490 | 0.0136 | 0.0194 | 0.0017 | 0.0159 | 0.0001 | 0.5809 | 0.2306 | 0.1885 |
| area_green | 3.2172 | 0.3698 | -0.0351 | 0.0034 | 2.5060 | 0.9804 | 11.1790 | 0.9998 | 54.5345 | 0.4300 | 0.0367 | 0.1639 | 0.7994 |
| smr_lsoa_01 | 0.8662 | 0.0089 | ***0.0117*** | 0.0002 | 0.0014 | 0.0005 | 0.0021 | 0.0003 | 0.1890 | 0.0015 | 0.0072 | 0.0107 | 0.9820 |
| pphhlds_limlong_ill | 25.8666 | 0.5707 | ***0.3493*** | 0.0024 | 8.4260 | 2.4042 | 5.7873 | 0.5160 | 25.6781 | 0.2024 | 0.2112 | 0.1451 | 0.6437 |
| perc_rough | 0.0001 | 0.0004 | ***0.0001*** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0021 | 0.0119 | 0.9860 |
| phhlds_noheating | 3.3906 | 0.6941 | ***0.2205*** | 0.0026 | 12.4567 | 3.5702 | 8.8580 | 0.7817 | 31.0529 | 0.2448 | 0.2379 | 0.1692 | 0.5930 |
| perc_commute_wrk | 7.5825 | 0.3833 | -0.0883 | 0.0010 | 3.8239 | 1.0936 | 2.6367 | 0.2287 | 4.8113 | 0.0379 | 0.3392 | 0.2339 | 0.4268 |
| perc_privtrans_wrk | 34.0951 | 0.7255 | -0.4078 | 0.0020 | 14.0235 | 3.8957 | 5.3953 | 0.4755 | 17.7394 | 0.1399 | 0.3774 | 0.1452 | 0.4774 |
| perc_pubtrans_wrk | 7.1833 | 1.1361 | 0.0024 | 0.0012 | 35.6200 | 9.6433 | 4.7693 | 0.4125 | 7.0583 | 0.0556 | 0.7507 | 0.1005 | 0.1488 |
| perc_footbike_wrk | 4.5538 | 0.2548 | ***0.0596*** | 0.0015 | 1.5689 | 0.4786 | 2.0624 | 0.1846 | 10.1002 | 0.0796 | 0.1143 | 0.1502 | 0.7355 |
| turnout | 38.1288 | 0.7492 | -0.1802 | 0.0078 | 10.9118 | 3.9845 | 36.7197 | 3.4122 | 45.4586 | 0.8078 | 0.1172 | 0.3945 | 0.4883 |
| le_all | 80.9293 | 0.1040 | -0.1074 | 0.0019 | 0.2259 | 0.0691 | 0.1430 | 0.0259 | 3.8425 | 0.0621 | 0.0536 | 0.0340 | 0.9124 |
| concept_teen | 12.1288 | 1.8033 | ***0.5210*** | 0.0122 | 80.3302 | 23.7283 | 76.6945 | 7.1511 | 110.1620 | 2.2005 | 0.3007 | 0.2870 | 0.4123 |

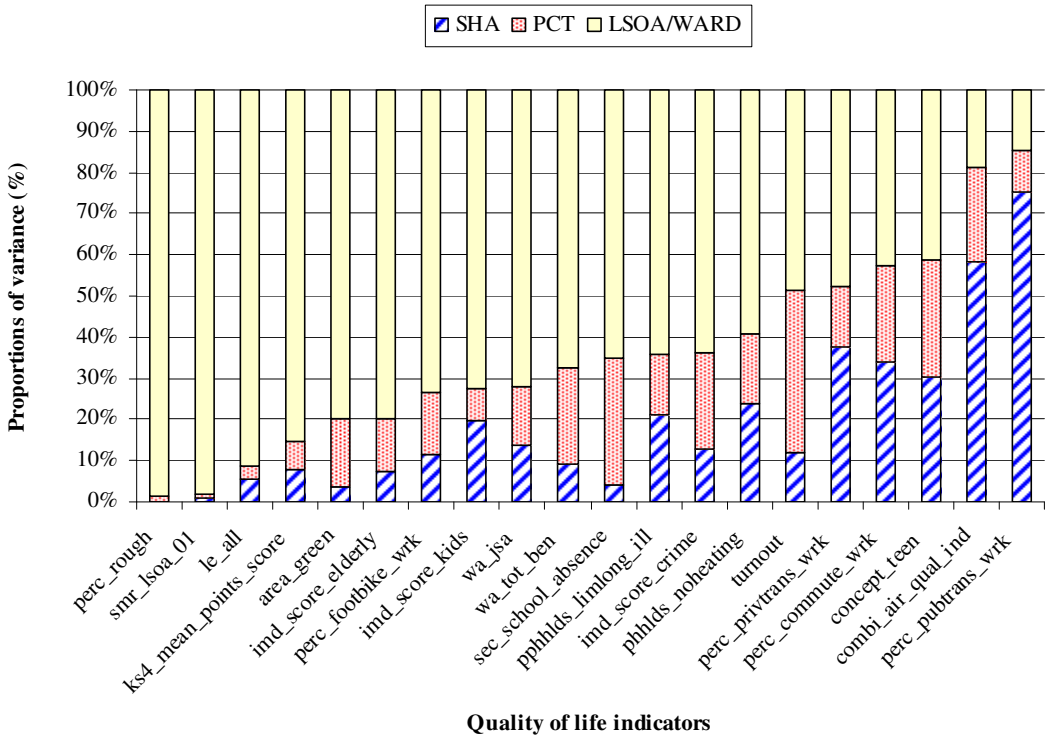



**Figure 20: Proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (intra-class correlation coefficients) (Model 4A – controlling for overall need)**

The introduction of the overall IMD index of deprivation also has an impact on total residual variance and the coefficient of variation, which appear to be reduced after controlling for the socio-demographic characteristics of the population (see Table 50).

**Table 50: Total variation in quality of life indicator models attributable to SHAs, PCTs and small areas (Model 4A – controlling for overall need)**

| Quality of life indicators | Total Variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3870 | - |
| imd_score_kids | 0.0049 | - |
| imd_score_elderly | 0.0034 | - |
| wa_tot_ben | 10.6154 | 0.2266 |
| wa_jsa | 1.0970 | 0.4801 |
| sec_school_absence | 2.7101 | 0.2032 |
| ks4_mean_points_score | 30.7283 | 0.1603 |
| combi_air_qual_ind | 0.0843 | 0.2496 |
| area_green | 68.2194 | 3.6188 |
| smr_lsoa_01 | 0.1924 | 0.3911 |
| pphhlds_limlong_ill | 39.8914 | 0.1888 |
| perc_rough | 0.0008 | 16.9927 |
| phhlds_noheating | 52.3677 | 0.8594 |
| perc_commute_wrk | 11.2718 | 0.5864 |
| perc_privtrans_wrk | 37.1582 | 0.2380 |
| perc_pubtrans_wrk | 47.4476 | 1.0075 |
| perc_footbike_wrk | 13.7314 | 0.6342 |
| turnout | 93.0900 | 0.2887 |
| le_all | 4.2113 | 0.0261 |
| concept_teen | 267.18671 | 0.5891 |

### *5.2.4.3. Model 4B – domain specific need variables*

Controlling for domain specific need variables at small area level has a varied effect on the proportion of residual variance attributable to any of the three levels in this model specification (see Table 51 and Figure 21). Overall, it reduces the proportion of variance at small area level, except for the quality of life indicators percentage of households with one or more limiting longstanding illnesses (pphhlds_limlong_ill) and life expectancy at birth (le_all).

Similarly to the previous two results for Model 4, the quality of life indicators combined air quality and percentage of people commuting to work by public transport show the greatest proportion of variance attributable to SHA level. These organisations may therefore exert some influence over local outcomes for these two quality of life measures. Compared to the previous two models, the proportions of residual variance at SHA level for these two indicators are now greater.

Further, there are a number of quality of life indicators for which the proportions of residual variance for SHAs and PCTs combined are greater than 50 percent. These are percentage of people commuting to work for more than 20 km (perc_commute_wrk) and by private transport (perc_privtrans_wrk), election turnout (turnout) and percentage of teenage pregnancies (concept_teen). These results suggest that both SHAs and PCTs may be able to exert some influence over areas of public interest that are outside the remit of their direct area of control (except for the indicator percentage of teenage conceptions).

**Table 51: Three-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (Model 4B - controlling for domain specific need variables)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{v0}$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_v$ | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.2690 | 0.0525 | 0.0639 | 0.0192 | 0.0778 | 0.0068 | 0.2403 | 0.0019 | 0.1672 | 0.2038 | 0.6290 |
| imd_score_kids | -0.0005 | 0.0101 | 0.0027 | 0.0007 | 0.0008 | 0.0001 | 0.0042 | 0.0000 | 0.3507 | 0.1073 | 0.5420 |
| imd_score_elderly | 0.0936 | 0.0062 | 0.0010 | 0.0003 | 0.0008 | 0.0001 | 0.0027 | 0.0000 | 0.2188 | 0.1729 | 0.6083 |
| wa_tot_ben | 9.1899 | 0.3078 | 2.1693 | 0.6683 | 3.1551 | 0.2785 | 10.9503 | 0.0863 | 0.1333 | 0.1939 | 0.6728 |
| wa_jsa | 1.2607 | 0.1035 | 0.2603 | 0.0763 | 0.2386 | 0.0213 | 1.0387 | 0.0082 | 0.1693 | 0.1552 | 0.6756 |
| sec_school_absence | 7.9226 | 0.0927 | 0.1207 | 0.0547 | 0.8402 | 0.0731 | 1.7454 | 0.0138 | 0.0446 | 0.3105 | 0.6449 |
| ks4_mean_points_score | 37.2153 | 0.3989 | 3.6818 | 1.0550 | 2.3644 | 0.2240 | 25.2922 | 0.1996 | 0.1175 | 0.0754 | 0.8071 |
| combi_air_qual_ind | 1.2717 | 0.0435 | 0.0510 | 0.0141 | 0.0170 | 0.0015 | 0.0138 | 0.0001 | 0.6233 | 0.2078 | 0.1690 |
| area_green | -9.1210 | 0.7817 | 15.5492 | 4.3878 | 8.3587 | 0.7456 | 37.9282 | 0.2990 | 0.2515 | 0.1352 | 0.6134 |
| smr_lsoa_01 | 0.9015 | 0.0136 | 0.0025 | 0.0008 | 0.0024 | 0.0004 | 0.1890 | 0.0015 | 0.0131 | 0.0124 | 0.9745 |
| pphhlds_limlong_ill | 26.9642 | 0.3389 | 2.6366 | 0.7807 | 2.5814 | 0.2391 | 21.4912 | 0.1694 | 0.0987 | 0.0966 | 0.8046 |
| perc_rough | 0.0002 | 0.0008 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0075 | 0.0110 | 0.9815 |
| phhlds_noheating | 7.1843 | 0.7147 | 12.6586 | 3.6550 | 10.1574 | 0.8930 | 32.4464 | 0.2558 | 0.2291 | 0.1838 | 0.5871 |
| perc_commute_wrk | 5.4241 | 0.4303 | 4.8269 | 1.3606 | 2.5480 | 0.2208 | 4.2239 | 0.0333 | 0.4162 | 0.2197 | 0.3642 |
| perc_privtrans_wrk | 32.8324 | 0.7569 | 15.1313 | 4.1883 | 5.3410 | 0.4695 | 16.2257 | 0.1279 | 0.4123 | 0.1455 | 0.4421 |
| perc_pubtrans_wrk | 7.5233 | 1.1426 | 35.9882 | 9.7258 | 4.0791 | 0.3532 | 6.4699 | 0.0510 | 0.7733 | 0.0877 | 0.1390 |
| perc_footbike_wrk | 7.8350 | 0.3968 | 3.9658 | 1.1348 | 2.6684 | 0.2340 | 7.5784 | 0.0597 | 0.2790 | 0.1878 | 0.5332 |
| turnout | 30.8845 | 0.9051 | 14.8006 | 5.0252 | 36.8683 | 3.3952 | 39.4181 | 0.7005 | 0.1625 | 0.4048 | 0.4328 |
| le_all | 80.4496 | 0.1156 | 0.1783 | 0.0552 | 0.1088 | 0.0224 | 3.7782 | 0.0611 | 0.0439 | 0.0268 | 0.9294 |
| concept_teen | 14.1187 | 1.8865 | 81.1930 | 23.9139 | 77.6056 | 7.1799 | 105.3072 | 2.1040 | 0.3074 | 0.2938 | 0.3987 |

The estimates of the proportions of variance at any level are statistically significant at the 5 percent level for all quality of life indicators.

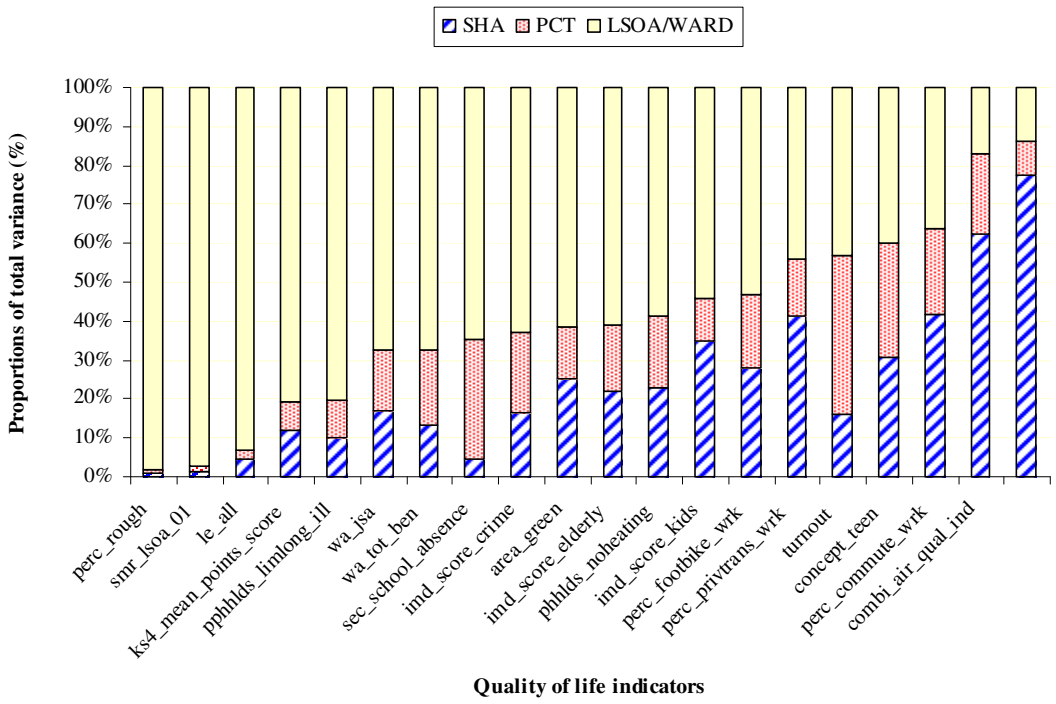



**Figure 21: Proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (intra-class correlation coefficients) (Model 4B - controlling for domain specific need variables)**

Table 52 shows the total residual variance in quality of life indicators and their respective coefficients of variation. Similarly to previous results, the coefficients of variation are very similar in size, except for percentage of people living rough (perc_rough) and area of green space per head (area_green).

**Table 52: Total variation in quality of life indicator models attributable to SHAs, PCTs and small areas (Model 4B - controlling for domain specific need variables)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3820 | - |
| imd_score_kids | 0.0077 | - |
| imd_score_elderly | 0.0044 | - |
| wa_tot_ben | 16.2747 | 0.2806 |
| wa_jsa | 1.5375 | 0.5684 |
| sec_school_absence | 2.7063 | 0.2030 |
| ks4_mean_points_score | 31.3384 | 0.1618 |
| combi_air_qual_ind | 0.0818 | 0.2459 |
| area_green | 61.8361 | 3.4454 |
| smr_lsoa_01 | 0.1940 | 0.3926 |
| pphhlds_limlong_ill | 26.7092 | 0.1545 |
| perc_rough | 0.0008 | 16.9743 |
| phhlds_noheating | 55.2624 | 0.8828 |
| perc_commute_wrk | 11.5988 | 0.5948 |
| perc_privtrans_wrk | 36.6980 | 0.2365 |
| perc_pubtrans_wrk | 46.5372 | 0.9978 |
| perc_footbike_wrk | 14.2126 | 0.6452 |
| turnout | 91.0870 | 0.2856 |
| le_all | 4.0653 | 0.0257 |
| concept_teen | 264.1058 | 0.5857 |

**Table 53: The beta coefficients for domain specific need variables for models attributable to SHAs, PCTs and small areas (Model 4B - controlling for domain specific need variables)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***0.7404*** | 0.0829 | 0.1747 | 0.1302 | ***0.3390*** | 0.0097 | ***0.0014*** | 0.0003 | -0.0078 | 0.0003 | ***0.0129*** | 0.0002 | | |
| imd_score_kids | | | ***0.9868*** | 0.0134 | ***0.0442*** | 0.0013 | ***0.0033*** | 0.0000 | ***0.0010*** | 0.0000 | ***0.0002*** | 0.0000 | ***0.0108*** | 0.0007 |
| imd_score_elderly | | | ***0.2700*** | 0.0107 | ***0.0758*** | 0.0010 | ***0.0005*** | 0.0000 | ***0.0005*** | 0.0000 | ***0.0009*** | 0.0000 | -0.0002 | 0.0006 |
| wa_tot_ben | | | | | ***6.7009*** | 0.0516 | ***0.2214*** | 0.0017 | ***0.0307*** | 0.0023 | -0.0115 | 0.0017 | ***0.4062*** | 0.0373 |
| wa_jsa | | | | | ***0.9776*** | 0.0159 | ***0.0224*** | 0.0005 | ***0.0078*** | 0.0007 | ***0.0132*** | 0.0005 | ***0.1818*** | 0.0115 |
| sec_school_absence | ***1.5219*** | 0.1954 | -0.2926 | 0.3529 | ***0.5715*** | 0.0267 | | | -0.0020 | 0.0009 | ***0.0028*** | 0.0007 | ***0.2559*** | 0.0150 |
| ks4_mean_points_score | -39.7349 | 0.0735 | ***25.1734*** | 1.3282 | -3.9461 | 0.0999 | | | ***0.0168*** | 0.0034 | -0.0071 | 0.0026 | -0.5695 | 0.0565 |
| combi_air_qual_ind | ***0.1066*** | 0.0200 | -0.3049 | 0.0313 | ***0.0609*** | 0.0024 | -0.0004 | 0.0001 | -0.0036 | 0.0001 | | | ***0.0441*** | 0.0013 |
| area_green | 1.9469 | 1.0393 | ***11.2387*** | 1.6344 | -2.4716 | 0.1232 | -0.0108 | 0.0039 | ***0.4664*** | 0.0043 | | | -0.2540 | 0.0668 |
| smr_lsoa_01 | ***1.2876*** | 0.0686 | ***0.3698*** | 0.0997 | | | -0.0015 | 0.0003 | 0.0003 | 0.0003 | ***0.0012*** | 0.0002 | ***0.0338*** | 0.0045 |
| pphhlds_limlong_ill | -5.5593 | 0.7715 | ***67.7082*** | 1.1259 | | | ***0.1250*** | 0.0029 | -0.0631 | 0.0032 | -0.0554 | 0.0024 | -0.3988 | 0.0511 |
| perc_rough | -0.0251 | 0.0043 | ***0.0621*** | 0.0069 | ***0.0017*** | 0.0005 | -0.0001 | 0.0000 | ***0.000046*** | 0.0000 | | | ***0.0015*** | 0.0003 |
| phhlds_noheating | ***3.0131*** | 0.9631 | -6.2577 | 1.5136 | ***1.5415*** | 0.1144 | ***0.0697*** | 0.0036 | -0.0113 | 0.0040 | | | ***1.3217*** | 0.0619 |
| perc_commute_wrk | ***1.8082*** | 0.3491 | 0.7424 | 0.5471 | -1.1429 | 0.0417 | -0.0525 | 0.0013 | ***0.0432*** | 0.0014 | ***0.0040*** | 0.0011 | -0.1367 | 0.0233 |
| perc_privtrans_wrk | -23.2237 | 0.6829 | -22.5223 | 1.0707 | -0.5997 | 0.0815 | -0.0306 | 0.0025 | ***0.0569*** | 0.0028 | -0.1199 | 0.0021 | -0.2832 | 0.0456 |
| perc_pubtrans_wrk | -9.9457 | 0.4322 | ***3.6820*** | 0.6772 | ***0.3317*** | 0.0517 | ***0.0098*** | 0.0016 | ***0.0238*** | 0.0018 | ***0.0479*** | 0.0013 | ***0.4028*** | 0.0289 |
| perc_footbike_wrk | -4.2380 | 0.4667 | -8.3286 | 0.7318 | ***2.2373*** | 0.0557 | -0.0162 | 0.0017 | -0.0895 | 0.0019 | ***0.0841*** | 0.0014 | ***0.4316*** | 0.0312 |
| turnout | 4.6876 | 2.6667 | ***28.9360*** | 3.9856 | -2.7100 | 0.2788 | -0.1559 | 0.0100 | ***0.1168*** | 0.0085 | 0.0099 | 0.0079 | -1.4769 | 0.1568 |
| le_all | -2.5555 | 0.7006 | -9.5060 | 0.9518 | | | -0.0145 | 0.0026 | ***0.0053*** | 0.0021 | -0.0159 | 0.0021 | -0.5376 | 0.0395 |
| concept_teen | ***17.7422*** | 4.4260 | -2.2867 | 6.1076 | | | ***0.2605*** | 0.0163 | 0.0284 | 0.0189 | ***0.0315*** | 0.0138 | ***2.5541*** | 0.2860 |

The estimates of the coefficients of the domain specific need variables are presented in Table 53; figures in bold italic are statistically significant at the 5 percent level. Similarly to results obtained in previous model specifications, the coefficients show the expected associations with quality of life indicators, with the exception of average points score at KS4 examinations. The counter-intuitive association for this quality of life indicator may however be due to the existence of collinearity between the need variables.

*5.2.4.4. Model 4C and Model 4D - model with PCT performance indicators with and without domain specific need variables*

In this section we discuss the results obtained by introducing performance indicators for PCTs alongside the domain specific need variables (Model 4C) and without any further explanatory variables. The estimates of proportion of residual variance attributable to any of the three levels (last three columns in Table 54) are all statistically significant at the 5 percent level, except for authorised and unauthorised absence form secondary school (sec_school_absence) and percentage of people living rough (perc_rough) at SHA and PCT level. It is not possible to establish a tendency in the way the proportions of variance are affected by the introduction of the performance indicators at PCT level. In some cases this has translated in an increase of the proportion of variance at SHA and PCT level, in others a decrease. One result that is worth noting is that for election turnout (turnout) the proportion of residual variance attributable to SHA level has dropped to zero from just over 16 percent in the previous model.

**Table 54: Three-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (Model 4C - controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{v0}$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_v$ | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.2017 | 0.0843 | 0.0584 | 0.0208 | 0.0674 | 0.0091 | 0.2404 | 0.0029 | 0.1595 | 0.1841 | 0.6564 |
| imd_score_kids | -0.0074 | 0.0122 | 0.0024 | 0.0007 | 0.0007 | 0.0001 | 0.0042 | 0.0001 | 0.3224 | 0.1013 | 0.5763 |
| imd_score_elderly | 0.1054 | 0.0096 | 0.0007 | 0.0003 | 0.0009 | 0.0001 | 0.0028 | 0.0000 | 0.1597 | 0.2079 | 0.6324 |
| wa_tot_ben | 9.1893 | 0.5636 | 2.6283 | 0.9383 | 3.1122 | 0.4195 | 10.6008 | 0.1262 | 0.1608 | 0.1905 | 0.6487 |
| wa_jsa | 1.3173 | 0.1496 | 0.2278 | 0.0759 | 0.1826 | 0.0252 | 1.0034 | 0.0119 | 0.1611 | 0.1292 | 0.7097 |
| sec_school_absence | 8.1042 | 0.2497 | 0.1845 | 0.1041 | 0.9004 | 0.1181 | 1.7646 | 0.0211 | 0.0647 | 0.3160 | 0.6193 |
| ks4_mean_points_score | 36.7769 | 0.6378 | 5.0987 | 1.5751 | 2.3547 | 0.3425 | 24.2823 | 0.2893 | 0.1607 | 0.0742 | 0.7651 |
| combi_air_qual_ind | 1.2875 | 0.0501 | 0.0445 | 0.0129 | 0.0126 | 0.0017 | 0.0129 | 0.0002 | 0.6358 | 0.1799 | 0.1843 |
| area_green | -10.6871 | 1.0824 | 12.2607 | 4.0583 | 9.9422 | 1.3366 | 29.7247 | 0.3540 | 0.2361 | 0.1915 | 0.5724 |
| smr_lsoa_01 | 0.9036 | 0.0230 | 0.0020 | 0.0008 | 0.0021 | 0.0005 | 0.1883 | 0.0022 | 0.0106 | 0.0108 | 0.9786 |
| pphhlds_limlong_ill | 26.4885 | 0.5058 | 1.8697 | 0.6812 | 2.2687 | 0.3265 | 21.6675 | 0.2580 | 0.0725 | 0.0879 | 0.8396 |
| perc_rough | 0.0012 | 0.0014 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0009 | 0.0000 | 0.0031 | 0.0016 | 0.9953 |
| phhlds_noheating | 7.9840 | 0.9996 | 7.4820 | 2.7922 | 10.5180 | 1.3993 | 25.6717 | 0.3057 | 0.1713 | 0.2408 | 0.5878 |
| perc_commute_wrk | 5.9979 | 0.5974 | 4.7813 | 1.4807 | 2.5162 | 0.3339 | 4.7644 | 0.0567 | 0.3964 | 0.2086 | 0.3950 |
| perc_privtrans_wrk | 32.8725 | 0.8469 | 9.6247 | 2.9802 | 4.7723 | 0.6454 | 16.4308 | 0.1957 | 0.3122 | 0.1548 | 0.5330 |
| perc_pubtrans_wrk | 7.7184 | 1.0589 | 24.4762 | 6.8084 | 2.9833 | 0.3974 | 5.8150 | 0.0692 | 0.7356 | 0.0897 | 0.1748 |
| perc_footbike_wrk | 6.9784 | 0.5812 | 4.2426 | 1.3364 | 2.4218 | 0.3263 | 7.6067 | 0.0906 | 0.2973 | 0.1697 | 0.5330 |
| turnout | 25.2254 | 1.6880 | 0.0000 | 0.0000 | 44.2431 | 5.5586 | 38.7605 | 1.0496 | 0.0000 | 0.5330 | 0.4670 |
| le_all | 80.2856 | 0.1872 | 0.1563 | 0.0600 | 0.0747 | 0.0303 | 3.6938 | 0.0904 | 0.0398 | 0.0190 | 0.9411 |
| concept_teen | 16.0452 | 2.6528 | 65.0445 | 21.7533 | 48.8610 | 7.3824 | 107.7988 | 3.2830 | 0.2934 | 0.2204 | 0.4862 |

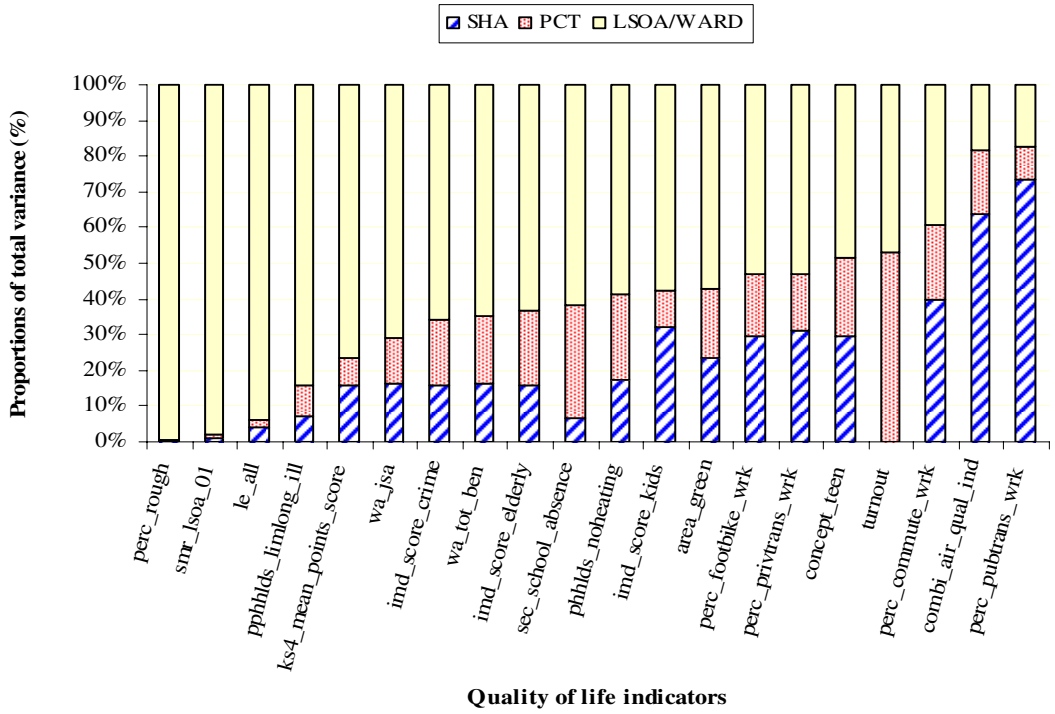



**Figure 22: Proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (intra-class correlation coefficients) (Model 4C - controlling for domain specific need variables and PCT performance indicators)**

For the majority of quality of life indicators, total residual variance and the coefficient of variation have decreased compared to the model specification with only domain specific need variables. These still are fairly similar in size, with the usual exceptions of area of green space per head (area_green) and percentage of people living rough (perc_rough) (Table 55).

**Table 55: Total variation in quality of life indicator models attributable to SHAs, PCTs and small areas (Model 4C - controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.3663 | - |
| imd_score_kids | 0.0073 | - |
| imd_score_elderly | 0.0044 | - |
| wa_tot_ben | 16.3414 | 0.2811 |
| wa_jsa | 1.4137 | 0.5450 |
| sec_school_absence | 2.8494 | 0.2083 |
| ks4_mean_points_score | 31.7356 | 0.1629 |
| combi_air_qual_ind | 0.0700 | 0.2274 |
| area_green | 51.9276 | 3.1573 |
| smr_lsoa_01 | 0.1924 | 0.3910 |
| pphhlds_limlong_ill | 25.8059 | 0.1519 |
| perc_rough | 0.0009 | 18.7308 |
| phhlds_noheating | 43.6718 | 0.7848 |
| perc_commute_wrk | 12.0619 | 0.6066 |
| perc_privtrans_wrk | 30.8277 | 0.2168 |
| perc_pubtrans_wrk | 33.2744 | 0.8437 |
| perc_footbike_wrk | 14.2711 | 0.6465 |
| turnout | 83.0037 | 0.2726 |
| le_all | 3.9249 | 0.0252 |
| concept_teen | 221.7043 | 0.5366 |

**Table 56: The beta coefficients for domain specific need variables for models attributable to SHAs, PCTs and small areas (Model 4C - controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | β-income | SE | β-employ | SE | β-health | SE | β-edu | SE | β-barriers | SE | β-environ | SE | β-crime | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | ***1.1371*** | 0.1244 | -0.1661 | 0.1996 | ***0.3309*** | 0.0151 | ***0.0016*** | 0.0005 | -0.0075 | 0.0005 | ***0.0150*** | 0.0004 | | |
| imd_score_kids | | | ***0.9893*** | 0.0207 | ***0.0455*** | 0.0020 | ***0.0032*** | 0.0001 | ***0.0011*** | 0.0001 | 0.0001 | 0.0001 | ***0.0148*** | 0.0011 |
| imd_score_elderly | | | ***0.2590*** | 0.0169 | ***0.0795*** | 0.0016 | ***0.0003*** | 0.0000 | ***0.0004*** | 0.0001 | ***0.0009*** | 0.0000 | -0.0003 | 0.0009 |
| wa_tot_ben | | | | | ***6.8295*** | 0.0796 | ***0.2139*** | 0.0025 | ***0.0318*** | 0.0033 | -0.0214 | 0.0027 | ***0.4980*** | 0.0554 |
| wa_jsa | | | | | ***0.9662*** | 0.0244 | ***0.0234*** | 0.0008 | ***0.0078*** | 0.0010 | ***0.0127*** | 0.0008 | ***0.1860*** | 0.0170 |
| sec_school_absence | ***1.7527*** | 0.2994 | -0.0382 | 0.5473 | ***0.5000*** | 0.0415 | | | -0.0026 | 0.0014 | 0.0002 | 0.0011 | ***0.2705*** | 0.0228 |
| ks4_mean_points_score | -39.3263 | 1.0922 | ***26.2010*** | 1.9978 | -4.5549 | 0.1507 | | | ***0.0159*** | 0.0050 | 0.0014 | 0.0040 | -0.4360 | 0.0837 |
| combi_air_qual_ind | ***0.1484*** | 0.0290 | -0.4352 | 0.0464 | ***0.0702*** | 0.0035 | -0.0005 | 0.0001 | -0.0035 | 0.0001 | | | ***0.0476*** | 0.0019 |
| area_green | 0.3268 | 1.3887 | ***12.7803*** | 2.2219 | -2.5500 | 0.1691 | -0.0130 | 0.0051 | ***0.4661*** | 0.0056 | | | -0.0647 | 0.0886 |
| smr_lsoa_01 | ***1.3610*** | 0.1018 | ***0.4482*** | 0.1506 | | | -0.0024 | 0.0004 | 0.0005 | 0.0004 | ***0.0013*** | 0.0003 | ***0.0301*** | 0.0068 |
| pphhlds_limlong_ill | -7.2801 | 1.1620 | ***70.3972*** | 1.7297 | | | ***0.1216*** | 0.0043 | -0.0569 | 0.0048 | -0.0611 | 0.0038 | -0.3521 | 0.0775 |
| perc_rough | -0.0151 | 0.0067 | ***0.0462*** | 0.0113 | 0.0012 | 0.0007 | -0.0001 | 0.0000 | 0.000025 | 0.0000 | | | ***0.0018*** | 0.0004 |
| phhlds_noheating | -6.0029 | 1.2911 | 0.2450 | 2.0656 | ***1.9185*** | 0.1573 | ***0.0482*** | 0.0048 | -0.0141 | 0.0053 | | | ***1.4796*** | 0.0824 |
| perc_commute_wrk | 1.0435 | 0.5576 | 1.6723 | 0.8907 | -1.1778 | 0.0687 | -0.0510 | 0.0002 | ***0.0427*** | 0.0023 | ***0.0055*** | 0.0018 | -0.0839 | 0.0374 |
| perc_privtrans_wrk | -24.7562 | 1.0330 | -19.8176 | 1.6515 | -1.0476 | 0.1270 | -0.0113 | 0.0038 | ***0.0640*** | 0.0042 | -0.1143 | 0.0033 | -0.2711 | 0.0693 |
| perc_pubtrans_wrk | -8.7225 | 0.6163 | 1.7130 | 0.9842 | ***0.5004*** | 0.0759 | ***0.0045*** | 0.0023 | -0.0258 | 0.0025 | ***0.0405*** | 0.0020 | ***0.3261*** | 0.0413 |
| perc_footbike_wrk | -3.2096 | 0.7031 | -9.7528 | 1.1240 | ***2.2342*** | 0.0865 | -0.0665 | 0.0026 | -0.0970 | 0.0029 | ***0.0927*** | 0.0023 | ***0.4915*** | 0.0472 |
| turnout | 4.9998 | 4.0379 | ***30.4276*** | 6.0769 | -3.3527 | 4.2458 | -0.1635 | 0.0147 | ***0.1317*** | 0.0128 | 0.0234 | 0.0123 | -1.6205 | 0.2358 |
| le_all | -2.7259 | 1.0369 | -10.0770 | 1.4283 | | | -0.0121 | 0.0038 | 0.0041 | 0.0031 | -0.0171 | 0.0032 | -0.4797 | 0.0588 |
| concept_teen | ***22.9095*** | 6.7858 | -12.4369 | 9.2427 | | | ***0.3008*** | 0.0253 | -0.0023 | 0.0287 | 0.0238 | 0.0216 | ***2.9303*** | 0.4369 |

The coefficient estimates for the domain specific need variables and PCT performance indicators are shown in Tables 56 and 57. Estimates that are statistically significant at the 5 percent level are shown in bold italic. The results have the expected signs and associations across quality of life indicators and the various need variables. The only exception is the indicator average points score for KS4 examinations, which suggests that higher educational attainment is positively related with higher deprivation in terms of unemployment. This counter-intuitive result may be due, as already suggested elsewhere in this report, to unforeseen collinearity between some of the need variables.

**Table 57: The beta coefficients for PCT performance indicators for models attributable to SHAs, PCTs and small areas (Model 4C - controlling for domain specific need variables and PCT performance indicators)**

| Quality of life indicators | β-finman | SE | β-star_rating | SE | β-curr_dft_percent | SE |
|---|---|---|---|---|---|---|
| imd_score_crime | -0.0372 | 0.0558 | -0.0425 | 0.0339 | -0.0158 | 0.0091 |
| imd_score_kids | -0.0051 | 0.0062 | ***0.0095*** | 0.0038 | 0.0000 | 0.0010 |
| imd_score_elderly | 0.0029 | 0.0065 | -0.0052 | 0.0039 | -0.0009 | 0.0011 |
| wa_tot_ben | 0.1827 | 0.3785 | 0.0988 | 0.2295 | 0.1511 | 0.0621 |
| wa_jsa | 0.0548 | 0.0941 | -0.0480 | 0.0573 | ***-0.0027*** | 0.0153 |
| sec_school_absence | -0.1267 | 0.1878 | -0.0039 | 0.1108 | 0.0202 | 0.0327 |
| ks4_mean_points_score | -0.3659 | 0.3521 | 0.2233 | 0.2154 | -0.0956 | 0.0565 |
| combi_air_qual_ind | -0.0167 | 0.0249 | -0.0067 | 0.0152 | -0.0113 | 0.0039 |
| area_green | ***1.5777*** | 0.6864 | 0.1995 | 0.4174 | 0.1798 | 0.1110 |
| smr_lsoa_01 | 0.0093 | 0.0129 | -0.0104 | 0.0080 | ***0.0003*** | 0.0023 |
| pphhlds_limlong_ill | -0.3369 | 0.3315 | 0.3901 | 0.2014 | -0.0056 | 0.0549 |
| perc_rough | ***0.0034*** | 0.0006 | -0.0001 | 0.0004 | -0.0001 | 0.0001 |
| phhlds_noheating | -0.5285 | 0.6871 | 0.1361 | 0.4156 | -0.2271 | 0.1133 |
| perc_commute_wrk | 0.2796 | 0.3488 | -0.3623 | 0.2125 | 0.1371 | 0.0556 |
| perc_privtrans_wrk | 0.0155 | 0.4848 | -0.4657 | 0.2957 | 0.0300 | 0.0774 |
| perc_pubtrans_wrk | -0.6482 | 0.3905 | 0.2052 | 0.2388 | -0.1233 | 0.0609 |
| perc_footbike_wrk | 0.0148 | 0.3434 | ***0.5730*** | 0.2093 | 0.0748 | 0.0550 |
| turnout | 1.0197 | 1.3063 | ***2.3987*** | 0.6856 | -0.2218 | 0.2386 |
| le_all | 0.0675 | 0.1001 | ***0.1557*** | 0.0634 | 0.0321 | 0.0175 |
| concept_teen | -0.8147 | 1.5982 | -0.7087 | 0.9800 | -0.4104 | 0.2613 |

Only a few coefficient estimates for PCT performance indicators are statistically significant at the 5 percent level. Our results do not show any statistically significant associations between any of the health quality of life indicators, except for standardised mortality ratio (smr_lsoa_01) and life expectancy at birth (le_all), which appear to be positively related to the percentage of current distance from target variable and to the star rating of PCTs; thus, indicating that small areas with higher mortality ratios are more often located within worse performing PCTs and that those with higher life expectancy are more often located within better performing PCTs.

A counter-intuitive result is posed by the positive association between the percentage of people living rough (perc_rough) and the PCT financial management performance indicator, possibly suggesting that tighter budgets are associated with more homelessness.

Some other less obvious associations can also be found between quality of life variables the IMD indicator for children (imd_score_kids) and election turnout (turnout) and the star rating for PCTs. Our results suggest that areas with higher scores on children deprivation are associated with PCTs with higher star ratings, although the size of this association is quite small, and higher election turnout is also associated with better performing PCTs.

Further, the quality of life indicator percentage of people of working age claiming job seekers allowance (wa_jsa) and the PCT performance indicator current distance from target in percentage terms (curr_dft_percent) also show a negative association, thus suggesting that areas with higher unemployment figures are to be found within the boundaries of PCTs with smaller distances from target.

**Table 58: Three-level random-intercept model of the proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (Model 4D – controlling for PCT performance indicators only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{v0}$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_v$ | $\rho_u$ | $\rho_e$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.2454 | 0.1315 | 0.1338 | 0.0502 | 0.1918 | 0.0254 | 0.4007 | 0.0048 | 0.1842 | 0.2641 | 0.5517 |
| imd_score_kids | 0.2463 | 0.0219 | 0.0030 | 0.0012 | 0.0057 | 0.0008 | 0.0195 | 0.0002 | 0.1073 | 0.2031 | 0.6895 |
| imd_score_elderly | 0.1911 | 0.0154 | 0.0019 | 0.0007 | 0.0026 | 0.0003 | 0.0069 | 0.0001 | 0.1672 | 0.2251 | 0.6078 |
| wa_tot_ben | 16.6178 | 1.1759 | 10.7753 | 4.0057 | 15.0260 | 2.0256 | 54.9620 | 0.6545 | 0.1334 | 0.1861 | 0.6805 |
| wa_jsa | 2.6689 | 0.2394 | 0.4594 | 0.1695 | 0.6169 | 0.0828 | 1.9369 | 0.0231 | 0.1525 | 0.2047 | 0.6428 |
| sec_school_absence | 8.4379 | 0.2910 | 0.2859 | 0.1547 | 1.2766 | 0.1669 | 2.0454 | 0.0245 | 0.0792 | 0.3538 | 0.5669 |
| ks4_mean_points_score | 33.0299 | 0.7731 | 1.6915 | 1.0115 | 9.0677 | 1.2315 | 47.3882 | 0.5645 | 0.0291 | 0.1559 | 0.8150 |
| combi_air_qual_ind | 1.1914 | 0.0539 | 0.0446 | 0.0134 | 0.0187 | 0.0025 | 0.0165 | 0.0002 | 0.5592 | 0.2339 | 0.2069 |
| area_green | 1.0840 | 0.9828 | 2.6712 | 1.6189 | 15.0444 | 1.9933 | 46.7531 | 0.5567 | 0.0414 | 0.2334 | 0.7252 |
| smr_lsoa_01 | 1.1841 | 0.0277 | 0.0068 | 0.0011 | 0.0059 | 0.0011 | 0.2085 | 0.0025 | 0.0309 | 0.0267 | 0.9424 |
| pphhlds_limlong_ill | 34.5637 | 1.0875 | 13.0830 | 4.3274 | 10.2363 | 1.3931 | 42.0418 | 0.5006 | 0.2002 | 0.1566 | 0.6432 |
| perc_rough | 0.0017 | 0.0008 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0009 | 0.0000 | 0.0006 | 0.0023 | 0.9971 |
| phhlds_noheating | 8.6611 | 1.0541 | 9.1952 | 3.3506 | 11.8325 | 1.5768 | 29.3264 | 0.3492 | 0.1826 | 0.2350 | 0.5824 |
| perc_commute_wrk | 5.8430 | 0.6950 | 5.8924 | 1.8851 | 3.9508 | 0.5233 | 6.3901 | 0.0761 | 0.3630 | 0.2434 | 0.3936 |
| perc_privtrans_wrk | 24.1857 | 1.2274 | 14.5000 | 5.0300 | 14.6151 | 1.9532 | 39.3224 | 0.4683 | 0.2119 | 0.2136 | 0.5746 |
| perc_pubtrans_wrk | 7.0784 | 1.0366 | 23.3347 | 6.5296 | 3.2659 | 0.4348 | 6.3069 | 0.0751 | 0.7091 | 0.0992 | 0.1917 |
| perc_footbike_wrk | 5.2349 | 0.3971 | 1.0680 | 0.4185 | 1.7886 | 0.2480 | 11.1057 | 0.1322 | 0.0765 | 0.1281 | 0.7954 |
| turnout | 29.8003 | 1.5954 | 0.0000 | 0.0000 | 45.2882 | 5.7875 | 51.1599 | 1.3852 | 0.0000 | 0.4696 | 0.5304 |
| le_all | 77.8580 | 0.3378 | 1.1697 | 0.3970 | 0.8488 | 0.1424 | 4.8258 | 0.1184 | 0.1709 | 0.1240 | 0.7051 |
| concept_teen | 28.6615 | 3.2386 | 107.6111 | 36.2687 | 89.9357 | 13.2109 | 158.5011 | 4.8276 | 0.3022 | 0.2526 | 0.4452 |

Tables 58 – 60 and Figure 23 show the results obtained estimating the three-tier model controlling for PCT performance indicators only. Estimates of proportion of residual variance attributable to any of the three levels investigated in Model 4 and for all quality of life indicators are significant at the 5 percent level. A few exceptions are given by the quality of life indicators authorised and unauthorised absence from secondary school (sec_school_absence), average points score at KS4 examinations (ks4_mean_points_score), area of green space per head (area_green) and percentage of people living rough (perc_rough), whose proportion of residual variance attributable to SHAs (all four indicators) and PCT (only for indicator perc_rough) are not significant.

Estimated proportions of residual variance attributable to any of the three levels analysed in this model give very similar results to the basic Model 4 specification. This is an indication that PCT performance indicators alone are not able to explain the variation that exists for each quality of life indicator. In fact, looking at the total residual variance and coefficients of variation, these are not very different to those obtained for the basic Model 4 (see Table 59). Further, these results re-confirm previous findings of our analysis that most of the variation at any of the organisational levels can be explained by differences in the socio-demographic characteristics of the population at small area level.

A graphical representation of the intra-class correlations or proportions of variance attributable to SHAs, PCTs and LSOAs / wards for all quality of life indicators is given in Figure 23.

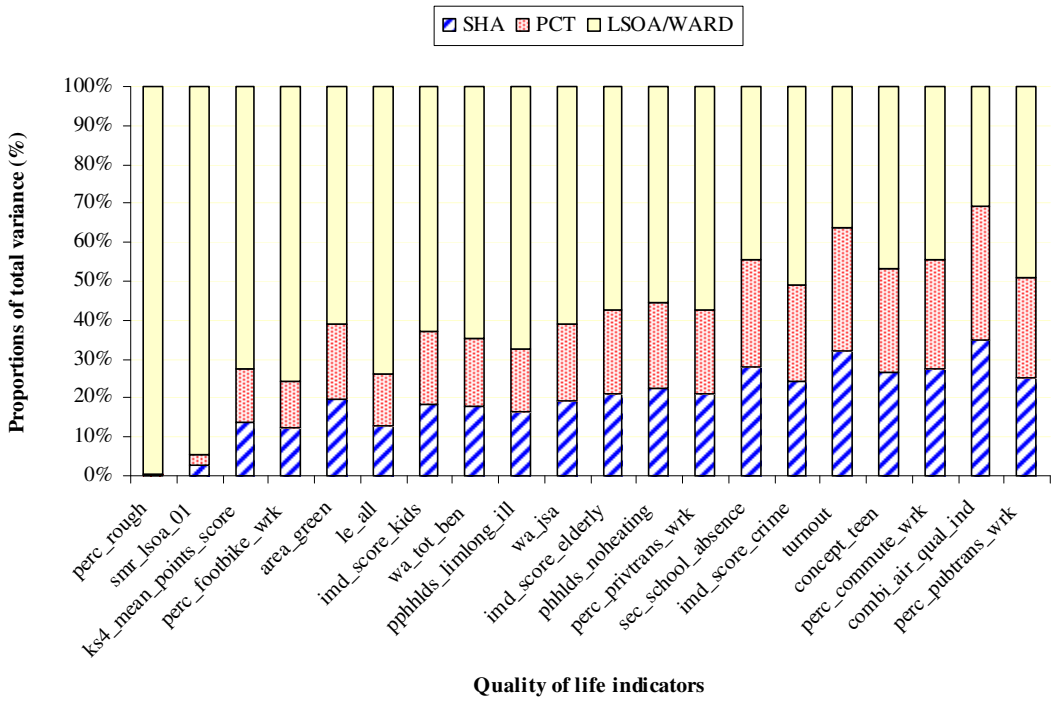



**Figure 23: Proportion of variation in quality of life indicators attributable to SHAs, PCTs and small areas (intra-class correlation coefficients) (Model 4D – controlling for PCT performance indicators only)**

**Table 59: Total variation in quality of life indicator models attributable to SHAs, PCTs and small areas (Model 4D – controlling for PCT performance indicators only)**

| Quality of life indicators | Total variance | Coefficient of variation |
|---|---|---|
| imd_score_crime | 0.7264 | - |
| imd_score_kids | 0.0283 | - |
| imd_score_elderly | 0.0113 | - |
| wa_tot_ben | 80.7632 | 0.6250 |
| wa_jsa | 3.0131 | 0.7956 |
| sec_school_absence | 3.6080 | 0.2344 |
| ks4_mean_points_score | 58.1474 | 0.2204 |
| combi_air_qual_ind | 0.0798 | 0.2428 |
| area_green | 64.4687 | 3.5179 |
| smr_lsoa_01 | 0.2212 | 0.4193 |
| pphhlds_limlong_ill | 65.3611 | 0.2417 |
| perc_rough | 0.0009 | 18.7719 |
| phhlds_noheating | 50.3540 | 0.8427 |
| perc_commute_wrk | 16.2333 | 0.7037 |
| perc_privtrans_wrk | 68.4375 | 0.3230 |
| perc_pubtrans_wrk | 32.9075 | 0.8390 |
| perc_footbike_wrk | 13.9623 | 0.6395 |
| turnout | 96.4481 | 0.2939 |
| le_all | 6.8443 | 0.0333 |
| concept_teen | 356.0479 | 0.6801 |

Table 60 shows the coefficient estimates for the PCT performance indicators obtained in Model 4D. Estimates that are significant at the 5 percent level are shown in bold italic. Compared to Model 4C where PCT performance indicators are accounted for alongside domain specific need variables, we find that the performance indicator financial management does not have any significant association with any of the quality of life indicators. The performance indicator star rating shows similar results to Model 4C, except for the quality of life indicator average points score for KS4 examinations (ks4_mean_points_score) which now is statistically significant at the 5 percent level and shows a positive association with that performance indicator. Our results imply that better educational attainment is related to better performing PCTs in terms of star rating, and worse performing in terms of current distance from target in percentage terms (curr_dft_percent), which implies that higher educational attainment is associated with overfunding which might allow the PCT to achieve higher performance.

**Table 60: The beta coefficients for PCT performance indicators for models attributable to SHAs, PCTs and small areas (Model 4D – controlling for PCT performance indicators only)**

| Quality of life indicators | β-finman | SE | β-star_rating | SE | β-curr_dft_percent | SE |
|---|---|---|---|---|---|---|
| imd_score_crime | -0.0925 | 0.0925 | -0.1053 | 0.0559 | -0.0545 | 0.0153 |
| imd_score_kids | -0.0184 | 0.0159 | -0.0203 | 0.0096 | -0.0074 | 0.0027 |
| imd_score_elderly | -0.0096 | 0.0107 | -0.0152 | 0.0065 | -0.0063 | 0.0018 |
| wa_tot_ben | -0.6627 | 0.8256 | -1.1638 | 0.4998 | -0.3071 | 0.1362 |
| wa_jsa | -0.1161 | 0.1672 | -0.2436 | 0.1012 | -0.0860 | 0.0275 |
| sec_school_absence | -0.2072 | 0.2242 | -0.0657 | 0.1326 | -0.0253 | 0.0389 |
| ks4_mean_points_score | 0.4054 | 0.6017 | ***0.7132*** | 0.3540 | ***0.2997*** | 0.1055 |
| combi_air_qual_ind | -0.0177 | 0.0301 | -0.0200 | 0.0183 | -0.0165 | 0.0018 |
| area_green | 0.3562 | 0.7659 | 0.7594 | 0.4499 | ***0.2657*** | 0.1343 |
| smr_lsoa_01 | -0.0158 | 0.0188 | -0.0348 | 0.0116 | -0.0094 | 0.0031 |
| pphhlds_limlong_ill | -0.2763 | 0.7006 | -0.6794 | 0.4265 | -0.1383 | 0.1132 |
| perc_rough | 0.0000 | 0.0006 | 0.0000 | 0.0004 | -0.0002 | 0.0001 |
| phhlds_noheating | -0.7552 | 0.7317 | -0.2554 | 0.4431 | -0.3980 | 0.1202 |
| perc_commute_wrk | 0.2595 | 0.4329 | -0.0600 | 0.2634 | ***0.2183*** | 0.0694 |
| perc_privtrans_wrk | 0.7031 | 0.8232 | 0.5153 | 0.4997 | ***0.4072*** | 0.1340 |
| perc_pubtrans_wrk | -0.6633 | 0.4078 | 0.1630 | 0.2493 | -0.1731 | 0.0637 |
| perc_footbike_wrk | -0.0370 | 0.2853 | ***0.3664*** | 0.1724 | -0.1184 | 0.0476 |
| turnout | 0.9941 | 1.3291 | ***2.1297*** | 0.6951 | -0.0127 | 0.2429 |
| le_all | 0.1874 | 0.2210 | ***0.4189*** | 0.1363 | ***0.1269*** | 0.0363 |
| concept_teen | -1.0848 | 2.1299 | -2.4192 | 1.3039 | -0.8460 | 0.3481 |

### *5.2.4.5. Conclusions for Model 4*

The main result that emerges for the five permutations of Model 4 analysed in this Section confirms the findings from previous models that the greatest variation exists at small area level. However, we also found important variations (about 50 percent of total residual variance) at both Strategic Health Authorities and Primary Care Trusts for a number of quality of life indicators. Especially large variations exist at SHA level for quality of life indicators combined air quality (combi_air_qual_ind) and percentage of people commuting to work by public transport (perc_pubtrans_wrk), both of which lie outside the remit and area of direct influence of this Public Sector Organisation, thus confirming the potential role that these organisations may play in influencing local outcomes for these two quality of life indicators.

As a summary measure of the relative stability of the 20 quality of life indicators within the various permutations of Model 4, we show the ranking of the indicators in terms of the proportion of variance explained at the higher PSO levels, ranking the indicators from the one with the least variation explained at higher levels (left) to the one with the highest variation explained at higher levels (right).

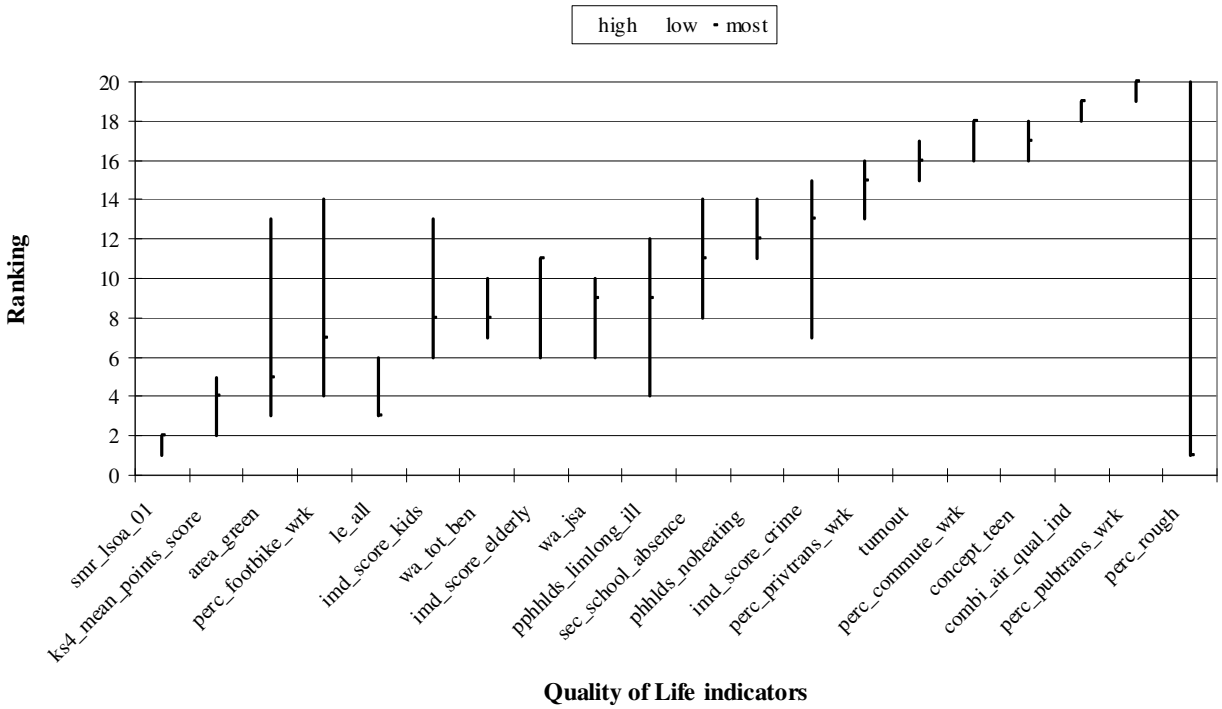



**Figure 24: Changes in rankings of the proportion of variation attributable to higher levels (SHAs and PCTs) in quality of life indicators (across all variants of Model 4)**

This suggests that there is some stability in the rankings of the quality of life variables with respect to the proportion of variation explained at higher levels since the bars are for the most part quite short. However the indicator percentage of people living rough (perc_rough) shows the greatest change in ranking depending on which needs variables and performance indicators are added to the model. This is not surprising given that this variable had the highest overall level of variance. Other variables with a higher coefficient of variation such as area of green space per head (area_green) also tend to show greater variability in rankings.

## 5.3. Seemingly unrelated regression (SUR) model

We estimate a SUR model for all 20 quality of life indicators with domain specific IMD need indicators. As for the multi-level models estimated in previous Sections, we exclude from each equation of the system those regressors that are either directly or indirectly associated with the dependent variables to avoid potential endogeneity bias.

Estimation results are shown in the Table 61. The majority of the coefficient estimates are highly significant (at the 1, 5 and 10 percent level), except for a handful of estimates. These are for quality of life indicators:

- combined air quality (combi_air_qual_ind): coefficient estimate of the regressor 'index of deprivation for health';
- percentage of people living rough (perc_rough): coefficient estimate of the regressor 'index of deprivation for health';
- percentage of population commuting to work by public transport (perc_pubtrans_wrk): coefficient estimate of the regressor 'index of deprivation for health'; and
- percentage of population commuting to work on foot or by bike (perc_footbike_wrk): coefficient estimates of the regressors 'index of deprivation for employment' and 'index of deprivation for education'.

**Table 61: Coefficient estimates for all quality of life indicators (SUR model)**

| Equation | Coefficient | Standard error | z | P>\|z\| | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| **turnout** | | | | | | |
| imd_score_income | -3.1371 | 1.2449 | -2.52 | 0.012 | -5.5770 | -0.6973 |
| imd_score_employ | 18.0553 | 2.1321 | 8.47 | 0 | 13.8763 | 22.2342 |
| imd_score_health | 0.5069 | 0.1390 | 3.65 | 0 | 0.2344 | 0.7794 |
| imd_score_edu | -0.1090 | 0.0048 | -22.9 | 0 | -0.1184 | -0.0997 |
| imd_score_barriers | -0.0711 | 0.0058 | -12.29 | 0 | -0.0824 | -0.0597 |
| imd_score_crime | -1.3990 | 0.0944 | -14.82 | 0 | -1.5840 | -1.2139 |
| imd_score_environ | -0.0701 | 0.0040 | -17.7 | 0 | -0.0779 | -0.0624 |
| _cons | 36.8075 | 0.2331 | 157.93 | 0 | 36.3507 | 37.2643 |
| **imd_score_crime** | | | | | | |
| imd_score_income | 2.4561 | 0.0816 | 30.11 | 0 | 2.2963 | 2.6160 |
| imd_score_employ | -3.0111 | 0.1422 | -21.17 | 0 | -3.2898 | -2.7324 |
| imd_score_health | 0.2792 | 0.0092 | 30.29 | 0 | 0.2612 | 0.2973 |
| imd_score_edu | 0.0016 | 0.0003 | 5.1 | 0 | 0.0010 | 0.0022 |
| imd_score_barriers | -0.0013 | 0.0004 | -3.32 | 0.001 | -0.0020 | -0.0005 |
| imd_score_environ | 0.0213 | 0.0002 | 89.07 | 0 | 0.0209 | 0.0218 |
| _cons | -0.4405 | 0.0154 | -28.56 | 0 | -0.4708 | -0.4103 |
| **imd_score_kids** | | | | | | |
| imd_score_employ | 0.6004 | 0.0155 | 38.69 | 0 | 0.5700 | 0.6308 |
| imd_score_health | 0.0259 | 0.0013 | 19.39 | 0 | 0.0233 | 0.0285 |
| imd_score_edu | 0.0035 | 0.0000 | 84.71 | 0 | 0.0034 | 0.0035 |
| imd_score_barriers | 0.0037 | 0.0001 | 72.27 | 0 | 0.0036 | 0.0038 |
| imd_score_crime | 0.0298 | 0.0009 | 33.27 | 0 | 0.0281 | 0.0316 |
| imd_score_environ | 0.0013 | 0.0000 | 35.87 | 0 | 0.0013 | 0.0014 |
| _cons | -0.0453 | 0.0021 | -21.65 | 0 | -0.0494 | -0.0412 |
| **imd_score_elderly** | | | | | | |
| imd_score_employ | 0.2124 | 0.0120 | 17.74 | 0 | 0.1889 | 0.2359 |
| imd_score_health | 0.0384 | 0.0010 | 37.21 | 0 | 0.0363 | 0.0404 |
| imd_score_edu | 0.0010 | 0.0000 | 32.52 | 0 | 0.0010 | 0.0011 |
| imd_score_barriers | 0.0019 | 0.0000 | 47.35 | 0 | 0.0018 | 0.0020 |
| imd_score_crime | 0.0144 | 0.0007 | 20.63 | 0 | 0.0131 | 0.0158 |
| imd_score_environ | 0.0016 | 0.0000 | 54.88 | 0 | 0.0015 | 0.0017 |
| _cons | 0.0426 | 0.0016 | 26.25 | 0 | 0.0395 | 0.0458 |
| **wa_tot_ben** | | | | | | |
| imd_score_health | 5.6518 | 0.0459 | 123.09 | 0 | 5.5618 | 5.7417 |
| imd_score_edu | 0.2263 | 0.0018 | 123.72 | 0 | 0.2227 | 0.2299 |
| imd_score_barriers | 0.0602 | 0.0025 | 24.04 | 0 | 0.0553 | 0.0651 |
| imd_score_crime | 0.1861 | 0.0445 | 4.19 | 0 | 0.0990 | 0.2733 |
| imd_score_environ | 0.0099 | 0.0019 | 5.32 | 0 | 0.0062 | 0.0135 |
| _cons | 7.8510 | 0.0833 | 94.24 | 0 | 7.6877 | 8.0143 |
| **wa_jsa** | | | | | | |
| imd_score_health | 0.6656 | 0.0145 | 45.85 | 0 | 0.6371 | 0.6940 |
| imd_score_edu | 0.0258 | 0.0006 | 44.24 | 0 | 0.0246 | 0.0269 |
| imd_score_barriers | 0.0299 | 0.0008 | 37.58 | 0 | 0.0284 | 0.0315 |
| imd_score_crime | 0.3071 | 0.0141 | 21.75 | 0 | 0.2794 | 0.3348 |
| imd_score_environ | 0.0225 | 0.0006 | 38.44 | 0 | 0.0213 | 0.0236 |
| _cons | 0.5071 | 0.0265 | 19.15 | 0 | 0.4552 | 0.5590 |

**Table 61: continued**

| Equation | Coefficient | Standard error | z | P>\|z\| | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| **sec_school_absence** | | | | | | |
| imd_score_income | 2.2300 | 0.2129 | 10.48 | 0 | 1.8129 | 2.6472 |
| imd_score_employ | 5.1081 | 0.4102 | 12.45 | 0 | 4.3042 | 5.9121 |
| imd_score_health | 0.0574 | 0.0271 | 2.12 | 0.034 | 0.0043 | 0.1105 |
| imd_score_barriers | -0.0085 | 0.0011 | -7.92 | 0 | -0.0106 | -0.0064 |
| imd_score_crime | 0.4050 | 0.0182 | 22.26 | 0 | 0.3693 | 0.4406 |
| imd_score_environ | 0.0021 | 0.0008 | 2.8 | 0.005 | 0.0006 | 0.0036 |
| _cons | 7.4058 | 0.0428 | 173.01 | 0 | 7.3219 | 7.4897 |
| **ks4_mean_points_score** | | | | | | |
| imd_score_income | -49.0862 | 0.7052 | -69.6 | 0 | -50.4684 | -47.7039 |
| imd_score_employ | 18.2337 | 1.3615 | 13.39 | 0 | 15.5652 | 20.9023 |
| imd_score_health | -1.0482 | 0.0903 | -11.61 | 0 | -1.2252 | -0.8713 |
| imd_score_barriers | 0.0582 | 0.0036 | 16.3 | 0 | 0.0512 | 0.0652 |
| imd_score_crime | -0.7935 | 0.0607 | -13.06 | 0 | -0.9126 | -0.6745 |
| imd_score_environ | 0.0359 | 0.0025 | 14.2 | 0 | 0.0309 | 0.0408 |
| _cons | 37.4374 | 0.1426 | 262.46 | 0 | 37.1578 | 37.7170 |
| **combi_air_qual_ind** | | | | | | |
| imd_score_income | 1.1914 | 0.0318 | 37.41 | 0 | 1.1290 | 1.2538 |
| imd_score_employ | -1.4740 | 0.0555 | -26.54 | 0 | -1.5829 | -1.3652 |
| imd_score_health | 0.0026 | 0.0036 | 0.71 | 0.477 | -0.0045 | 0.0097 |
| imd_score_edu | -0.0032 | 0.0001 | -25.69 | 0 | -0.0034 | -0.0029 |
| imd_score_barriers | 0.0039 | 0.0002 | 25.42 | 0 | 0.0036 | 0.0042 |
| imd_score_crime | 0.1798 | 0.0023 | 77 | 0 | 0.1752 | 0.1843 |
| _cons | 1.1698 | 0.0057 | 206.86 | 0 | 1.1587 | 1.1809 |
| **area_green** | | | | | | |
| imd_score_income | -10.2084 | 0.4742 | -21.53 | 0 | -11.1378 | -9.2790 |
| imd_score_employ | 18.7913 | 0.8290 | 22.67 | 0 | 17.1666 | 20.4160 |
| imd_score_health | -0.8894 | 0.0542 | -16.41 | 0 | -0.9957 | -0.7832 |
| imd_score_edu | 0.0188 | 0.0018 | 10.26 | 0 | 0.0152 | 0.0223 |
| imd_score_barriers | 0.1045 | 0.0022 | 46.46 | 0 | 0.1001 | 0.1089 |
| imd_score_crime | -0.6763 | 0.0345 | -19.63 | 0 | -0.7438 | -0.6088 |
| _cons | -2.0655 | 0.0839 | -24.63 | 0 | -2.2299 | -1.9012 |

**Table 61: continued**

| Equation | Coefficient | Standard error | z | P>\|z\| | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| **smr_lsoa_01** | | | | | | |
| imd_score_income | 0.6435 | 0.0643 | 10 | 0 | 0.5175 | 0.7696 |
| imd_score_employ | 1.4810 | 0.0884 | 16.76 | 0 | 1.3078 | 1.6542 |
| imd_score_edu | -0.0013 | 0.0002 | -5.25 | 0 | -0.0018 | -0.0008 |
| imd_score_barriers | -0.0007 | 0.0003 | -2.25 | 0.024 | -0.0013 | -0.0001 |
| imd_score_crime | 0.0482 | 0.0049 | 9.92 | 0 | 0.0387 | 0.0578 |
| imd_score_environ | 0.0006 | 0.0002 | 2.75 | 0.006 | 0.0002 | 0.0010 |
| _cons | 0.9053 | 0.0097 | 93.25 | 0 | 0.8863 | 0.9243 |
| **pphhlds_limlong_ill** | | | | | | |
| imd_score_income | -12.9535 | 0.7156 | -18.1 | 0 | -14.3561 | -11.5508 |
| imd_score_employ | 86.3092 | 0.9876 | 87.39 | 0 | 84.3734 | 88.2449 |
| imd_score_edu | 0.1267 | 0.0028 | 45.29 | 0 | 0.1212 | 0.1322 |
| imd_score_barriers | -0.0833 | 0.0034 | -24.19 | 0 | -0.0900 | -0.0765 |
| imd_score_crime | -0.3525 | 0.0551 | -6.4 | 0 | -0.4604 | -0.2446 |
| imd_score_environ | -0.0464 | 0.0023 | -19.87 | 0 | -0.0509 | -0.0418 |
| _cons | 26.1107 | 0.1097 | 238.12 | 0 | 25.8958 | 26.3256 |
| **le_all** | | | | | | |
| imd_score_income | 1.7770 | 0.2527 | 7.03 | 0 | 1.2818 | 2.2723 |
| imd_score_employ | -17.3651 | 0.3478 | -49.92 | 0 | -18.0468 | -16.6833 |
| imd_score_edu | -0.0051 | 0.0010 | -5.16 | 0 | -0.0070 | -0.0032 |
| imd_score_barriers | -0.0021 | 0.0012 | -1.78 | 0.076 | -0.0045 | 0.0002 |
| imd_score_crime | -0.7604 | 0.0193 | -39.43 | 0 | -0.7982 | -0.7226 |
| imd_score_environ | -0.0159 | 0.0008 | -19.36 | 0 | -0.0175 | -0.0143 |
| _cons | 80.4554 | 0.0385 | 2091.01 | 0 | 80.3800 | 80.5308 |
| **concept_teen** | | | | | | |
| imd_score_income | 35.1436 | 2.4816 | 14.16 | 0 | 30.2798 | 40.0075 |
| imd_score_employ | -22.0083 | 3.4127 | -6.45 | 0 | -28.6971 | -15.3195 |
| imd_score_edu | 0.3313 | 0.0096 | 34.56 | 0 | 0.3125 | 0.3501 |
| imd_score_barriers | 0.2185 | 0.0118 | 18.51 | 0 | 0.1954 | 0.2416 |
| imd_score_crime | 7.6126 | 0.1884 | 40.4 | 0 | 7.2433 | 7.9819 |
| imd_score_environ | 0.1408 | 0.0079 | 17.81 | 0 | 0.1253 | 0.1563 |
| _cons | 8.7791 | 0.3755 | 23.38 | 0 | 8.0432 | 9.5150 |

**Table 61: continued**

| Equation | Coefficient | Standard error | z | P>\|z\| | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| **perc_rough** | | | | | | |
| imd_score_income | -0.0280 | 0.0036 | -7.72 | 0 | -0.0352 | -0.0209 |
| imd_score_employ | 0.0687 | 0.0064 | 10.8 | 0 | 0.0562 | 0.0812 |
| imd_score_health | -0.0006 | 0.0004 | -1.51 | 0.132 | -0.0014 | 0.0002 |
| imd_score_edu | -0.0001 | 0.0000 | -6.77 | 0 | -0.0001 | -0.0001 |
| imd_score_barriers | 0.0001 | 0.0000 | 6.35 | 0 | 0.0001 | 0.0001 |
| imd_score_crime | 0.0022 | 0.0003 | 8.47 | 0 | 0.0017 | 0.0027 |
| _cons | -0.0023 | 0.0006 | -3.54 | 0 | -0.0035 | -0.0010 |
| **phhlds_noheating** | | | | | | |
| imd_score_income | 30.9609 | 1.1060 | 27.99 | 0 | 28.7932 | 33.1286 |
| imd_score_employ | -25.9124 | 1.9540 | -13.26 | 0 | -29.7422 | -22.0826 |
| imd_score_health | 0.6441 | 0.1286 | 5.01 | 0 | 0.3920 | 0.8962 |
| imd_score_edu | -0.0266 | 0.0043 | -6.17 | 0 | -0.0351 | -0.0182 |
| imd_score_barriers | -0.1377 | 0.0053 | -25.89 | 0 | -0.1481 | -0.1273 |
| imd_score_crime | 4.0414 | 0.0787 | 51.36 | 0 | 3.8872 | 4.1956 |
| _cons | 9.9716 | 0.1987 | 50.18 | 0 | 9.5821 | 10.3611 |
| **perc_commute_wrk** | | | | | | |
| imd_score_income | -5.0219 | 0.4210 | -11.93 | 0 | -5.8471 | -4.1967 |
| imd_score_employ | 7.8487 | 0.7157 | 10.97 | 0 | 6.4459 | 9.2515 |
| imd_score_health | -1.7157 | 0.0460 | -37.3 | 0 | -1.8059 | -1.6256 |
| imd_score_edu | -0.0064 | 0.0016 | -3.99 | 0 | -0.0096 | -0.0033 |
| imd_score_barriers | -0.0161 | 0.0020 | -8.2 | 0 | -0.0199 | -0.0122 |
| imd_score_crime | -0.5844 | 0.0318 | -18.35 | 0 | -0.6468 | -0.5219 |
| imd_score_environ | -0.0277 | 0.0013 | -21.24 | 0 | -0.0303 | -0.0252 |
| _cons | 6.4656 | 0.0779 | 82.97 | 0 | 6.3129 | 6.6184 |
| **perc_privtrans_wrk** | | | | | | |
| imd_score_income | -40.7222 | 0.7619 | -53.45 | 0 | -42.2156 | -39.2288 |
| imd_score_employ | -13.9422 | 1.3049 | -10.68 | 0 | -16.4997 | -11.3847 |
| imd_score_health | 0.7783 | 0.0849 | 9.16 | 0 | 0.6118 | 0.9447 |
| imd_score_edu | 0.0405 | 0.0029 | 13.83 | 0 | 0.0347 | 0.0462 |
| imd_score_barriers | -0.1159 | 0.0036 | -32.64 | 0 | -0.1229 | -0.1089 |
| imd_score_crime | -0.6655 | 0.0578 | -11.52 | 0 | -0.7787 | -0.5523 |
| imd_score_environ | -0.1723 | 0.0024 | -73.28 | 0 | -0.1769 | -0.1677 |
| _cons | 37.9522 | 0.1421 | 267.17 | 0 | 37.6737 | 38.2306 |
| **perc_pubtrans_wrk** | | | | | | |
| imd_score_income | 14.4891 | 0.7718 | 18.77 | 0 | 12.9764 | 16.0017 |
| imd_score_employ | -18.9759 | 1.3373 | -14.19 | 0 | -21.5969 | -16.3549 |
| imd_score_health | -0.0971 | 0.0878 | -1.11 | 0.269 | -0.2692 | 0.0750 |
| imd_score_edu | -0.1131 | 0.0030 | -37.79 | 0 | -0.1189 | -0.1072 |
| imd_score_barriers | 0.2087 | 0.0037 | 57.18 | 0 | 0.2015 | 0.2159 |
| imd_score_crime | 1.8996 | 0.0588 | 32.33 | 0 | 1.7844 | 2.0147 |
| imd_score_environ | 0.1070 | 0.0022 | 49.59 | 0 | 0.1027 | 0.1112 |
| _cons | 3.1860 | 0.1443 | 22.08 | 0 | 2.9032 | 3.4687 |
| **perc_footbike_wrk** | | | | | | |
| imd_score_income | -6.2818 | 0.4918 | -12.77 | 0 | -7.2456 | -5.3180 |
| imd_score_employ | -0.4412 | 0.8372 | -0.53 | 0.598 | -2.0819 | 1.1996 |
| imd_score_health | 0.3618 | 0.0536 | 6.75 | 0 | 0.2567 | 0.4669 |
| imd_score_edu | 0.0017 | 0.0019 | 0.93 | 0.354 | -0.0019 | 0.0054 |
| imd_score_barriers | -0.0419 | 0.0023 | -18.21 | 0 | -0.0464 | -0.0374 |
| imd_score_crime | -0.0924 | 0.0375 | -2.46 | 0.014 | -0.1659 | -0.0188 |
| imd_score_environ | 0.0818 | 0.0016 | 52.44 | 0 | 0.0787 | 0.0848 |
| _cons | 5.8028 | 0.0915 | 63.44 | 0 | 5.6235 | 5.9820 |

Table 62 shows the correlation matrix for the residuals for the SUR model when all 20 quality of life indicators are jointly modelled. There are no strong correlations in the residuals and the highest is between people claiming job seekers allowance (wa_jsa) and people claiming a key benefit (wa_tot_ben) which is positive (0.63); commuting to work by public transport (perc_pubtrans_wrk) and private transport (perc_privtrans_wrk) which is negative (-0.5); IMD score on older people (imd_score_elderly) and IMD score on children (imd_score_kids) which is positive (0.33); and combined air quality indicator (combi_air_qual_ind) and area of green space (area_green) which is negative (-0.32). All of these associations are intuitively plausible. All other correlations were small (below ±0.3).

While the residual correlations did not seem to be very big, the SUR model results did show a significant Breusch-Pagan result which suggests that the quality of life indicators are correlated, and therefore that we should ideally look at these measures in a joint modelling approach such as MVML which we discuss in the following section.

## 5.4. Multi-variate multi-level (MVML) models

Enormous complexity is added when we try to model the 20 quality of life indicators simultaneously. In fact, the large dataset and the complex hierarchy meant that we were unable to model all indicators together even using the most powerful computing capacity available – we had to model first 9 and then 8 QoL indicators at LSOA level. In the first instance we tried to replicate Model 1, the basic model with no additional explanatory variables.

Estimates of proportion of residual variance for the MVML model with 9 quality of life variables are statistically significant at the 5 percent level for all quality of life indicators. As for the ML model, quality of life indicators show the greatest variation at small area level, although for all indicators, except for standardised mortality ratio (smr_lsoa_01) and percentage of people living rough (perc_rough), the proportion of residual variance attributable to the Local Authorities are quite substantial, which suggests that Local Authorities may have a role in influencing these aspects of quality of life.

**Table 62: Correlation Matrix of residuals for all quality of life indicators (SUR model)**

| | turnout | imd_score_ crime | imd_score_ kids | imd_score_ elderly | wa_tot_ben | wa_jsa | sec_school_ absence | ks4_mean _points_score | combi_air_ qual_ind | area_green |
|---|---|---|---|---|---|---|---|---|---|---|
| **turnout** | 1 | | | | | | | | | |
| **imd_score_crime** | 0 | 1 | | | | | | | | |
| **imd_score_kids** | -0.0513 | -0.1125 | 1 | | | | | | | |
| **imd_score_elderly** | -0.0143 | -0.0879 | 0.3332 | 1 | | | | | | |
| **wa_tot_ben** | -0.0124 | -0.0317 | 0.2722 | 0.1034 | 1 | | | | | |
| **wa_jsa** | -0.0204 | -0.0378 | 0.237 | 0.2781 | 0.6264 | 1 | | | | |
| **sec_school_absence** | -0.0382 | -0.0128 | -0.0681 | -0.0665 | -0.1347 | -0.0722 | 1 | | | |
| **ks4_mean_points_score** | 0.0579 | 0.0214 | 0.0436 | 0.1494 | 0.1412 | 0.1399 | -0.1799 | 1 | | |
| **combi_air_qual_ind** | -0.086 | -0.0766 | -0.0029 | 0.0646 | -0.0291 | 0.1214 | 0.0402 | 0.0122 | 1 | |
| **area_green** | 0.1034 | -0.0023 | -0.0371 | -0.0161 | -0.0188 | -0.0693 | -0.0174 | 0.0082 | -0.3223 | 1 |
| **smr_lsoa_01** | -0.0159 | -0.0455 | -0.046 | 0.1327 | -0.1173 | -0.0602 | -0.0101 | 0.0181 | -0.0226 | 0.0416 |
| **pphhlds_limlong_ill** | 0.142 | -0.0535 | -0.0524 | 0.0036 | -0.0265 | -0.2158 | -0.0569 | 0.06 | -0.109 | 0.0953 |
| **le_all** | 0.143 | 0.0713 | -0.0084 | -0.0936 | 0.2072 | 0.0597 | -0.0475 | -0.0142 | -0.0657 | 0.0006 |
| **concept_teen** | -0.1352 | -0.016 | -0.0702 | 0.0164 | -0.0312 | 0.1381 | 0.0846 | 0.0703 | 0.1797 | -0.0996 |
| **perc_rough** | -0.0252 | -0.0108 | 0.0237 | 0.0146 | -0.0149 | -0.0011 | 0.0043 | -0.0209 | 0.0124 | -0.0145 |
| **phhlds_noheating** | -0.0038 | -0.2829 | -0.1646 | -0.1349 | -0.056 | -0.0853 | 0.0582 | -0.0481 | -0.0406 | 0.0524 |
| **perc_commute_wrk** | -0.0989 | 0 | 0.0118 | 0.0422 | -0.0317 | -0.0175 | -0.0244 | -0.0322 | -0.2422 | 0.1477 |
| **perc_privtrans_wrk** | -0.1046 | 0 | -0.0881 | -0.0378 | -0.0211 | -0.0289 | 0.0078 | 0.0083 | -0.22 | 0.1368 |
| **perc_pubtrans_wrk** | -0.02 | 0 | 0.1371 | 0.0256 | 0.0227 | 0.1099 | 0.0369 | -0.0373 | 0.4879 | -0.2663 |
| **perc_footbike_wrk** | -0.0623 | 0 | 0.1058 | 0.0351 | -0.0401 | -0.0056 | 0.0201 | -0.1406 | -0.1145 | -0.0517 |

**Table 62: continued**

| | smr_lsoa_01 | pphhlds_limlong_ill | le_all | concept_teen | perc_rough | phhlds_noheating | perc_commute_wrk | perc_privtrans_wrk | perc_pubtrans_wrk | perc_footbike_wrk |
|---|---|---|---|---|---|---|---|---|---|---|
| **smr_lsoa_01** | 1 | | | | | | | | | |
| **pphhlds_limlong_ill** | -0.0339 | 1 | | | | | | | | |
| **le_all** | -0.2345 | 0.0452 | 1 | | | | | | | |
| **concept_teen** | -0.0184 | -0.017 | -0.2391 | 1 | | | | | | |
| **perc_rough** | 0.0158 | -0.0539 | -0.0102 | -0.0408 | 1 | | | | | |
| **phhlds_noheating** | -0.032 | 0.0032 | 0.0538 | 0.0471 | 0.0058 | 1 | | | | |
| **perc_commute_wrk** | 0.0933 | -0.2412 | -0.0925 | -0.1272 | 0.0312 | 0.0288 | 1 | | | |
| **perc_privtrans_wrk** | 0.0243 | -0.2137 | -0.0381 | 0.094 | -0.0343 | 0.1673 | 0.2585 | 1 | | |
| **perc_pubtrans_wrk** | -0.0309 | -0.192 | 0.007 | 0.0941 | -0.0188 | -0.1602 | -0.2235 | -0.5099 | 1 | |
| **perc_footbike_wrk** | 0.0274 | -0.2078 | -0.0616 | -0.2321 | 0.1058 | -0.0607 | 0.1493 | -0.24 | -0.1924 | 1 |

Note: Breusch-Pagan test of independence: $\chi^2(190) = 77336.619$, Pr = 0.0000

**Table 63: MVML model of the proportion of variation in 9 quality of life indicators attributable to LAs and small areas (Model 1 – levels only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|---|---|---|---|
| imd_score_crime | 0.3396 | 0.0918 | 0.2742 | 0.0210 | 0.3702 | 0.0029 | 0.4255 | 0.5745 |
| imd_score_kids | 0.2800 | 0.0123 | 0.0048 | 0.0004 | 0.0203 | 0.0002 | 0.1908 | 0.8092 |
| imd_score_elderly | 0.2078 | 0.0079 | 0.0020 | 0.0002 | 0.0074 | 0.0001 | 0.2131 | 0.7869 |
| wa_jsa | 3.0410 | 0.1318 | 0.5519 | 0.0438 | 2.1068 | 0.0166 | 0.2076 | 0.7924 |
| sec_school_absence | 8.1269 | 0.1911 | 1.1819 | 0.0912 | 2.0461 | 0.0162 | 0.3661 | 0.6339 |
| area_green | 0.1672 | 0.9369 | 28.4055 | 2.1937 | 51.0454 | 0.4028 | 0.3575 | 0.6425 |
| smr_lsoa_01 | 1.1171 | 0.0161 | 0.0069 | 0.0007 | 0.2106 | 0.0017 | 0.0319 | 0.9681 |
| perc_rough | 0.0035 | 0.0008 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0175 | 0.9825 |
| perc_commute_wrk | 3.0259 | 0.4145 | 5.6028 | 0.4278 | 5.6220 | 0.0444 | 0.4991 | 0.5009 |

The estimates of local authority effects as calculated in the MVML model are, however, very similar to those obtained with the ML modelling estimations (see Table 64).

**Table 64: Intra-class correlation coefficients for ML and MVML model with 9 quality of life indicators (Model 1 – levels only)**

| Quality of life indicators | $\rho_{u\text{-ML}}$ | $\rho_{e\text{-ML}}$ | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|
| imd_score_crime | 0.4234 | 0.5766 | 0.4255 | 0.5745 |
| imd_score_kids | 0.1891 | 0.8109 | 0.1908 | 0.8092 |
| imd_score_elderly | 0.2108 | 0.7892 | 0.2131 | 0.7869 |
| wa_jsa | 0.2052 | 0.7948 | 0.2076 | 0.7924 |
| sec_school_absence | 0.3651 | 0.6349 | 0.3661 | 0.6339 |
| area_green | 0.3592 | 0.6408 | 0.3575 | 0.6425 |
| smr_lsoa_01 | 0.0174 | 0.9826 | 0.0319 | 0.9681 |
| perc_rough | 0.0173 | 0.9827 | 0.0175 | 0.9825 |
| perc_commute_wrk | 0.4986 | 0.5014 | 0.4991 | 0.5009 |

Figure 25 shows a graphical representation of the intra-class correlation coefficients. Quality of life indicators are ranked from those with the smallest variation (left) to those with the highest variation (right) at LA level.

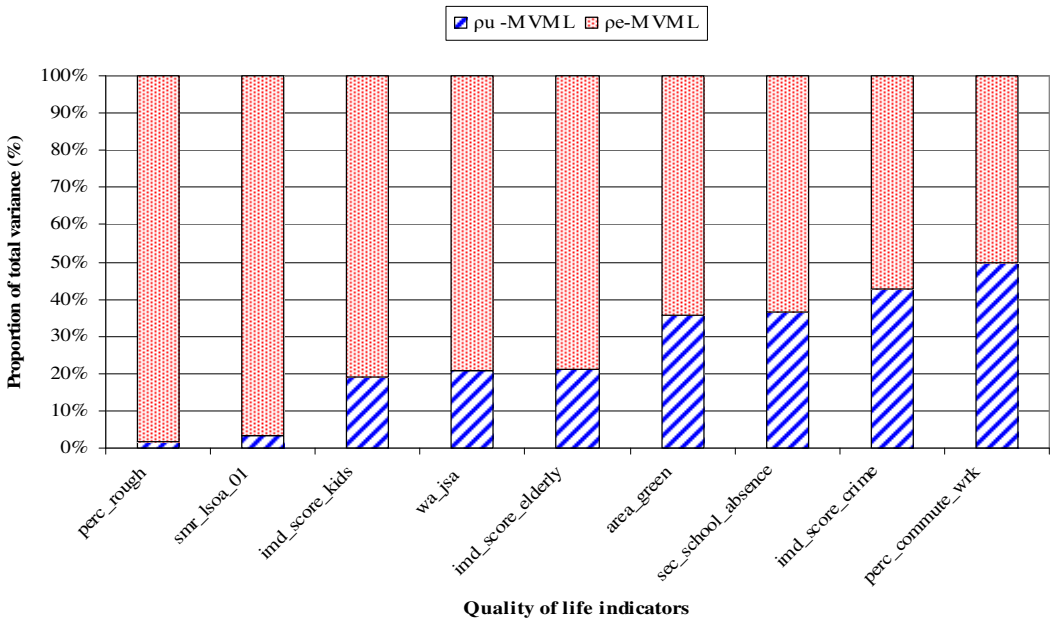



**Figure 25: Proportion of variation in 9 quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1 – levels only)**

**Table 65: Total variation in 9 quality of life indicators attributable to LAs and small areas (Model 1 – levels only) – ML and MVML results**

| Quality of life indicators | ML model | | MVML model | |
|---|---|---|---|---|
| | *Total variance* | *Coefficient of Variation* | *Total variance* | *Coefficient of Variation* |
| imd_score_crime | 0.6420 | - | 0.6444 | - |
| imd_score_kids | 0.0250 | - | 0.0251 | - |
| imd_score_elderly | 0.0094 | - | 0.0094 | - |
| wa_jsa | 2.6511 | 0.7463 | 2.6586 | 0.7474 |
| sec_school_absence | 3.2229 | 0.2215 | 3.2280 | 0.2217 |
| area_green | 79.6484 | 3.9102 | 79.4508 | 3.9054 |
| smr_lsoa_01 | 0.2144 | 0.4128 | 0.2175 | 0.4158 |
| perc_rough | 0.0008 | 17.0145 | 0.0008 | 17.0159 |
| perc_commute_wrk | 11.2138 | 0.5849 | 11.2248 | 0.5851 |

Total residual variance and coefficients of variation in both the ML and MVML models are very similar, as reported in Table 65.

The second basic model which was run contained 8 quality of life indicators and no control variables. Estimates of proportion of residual variance are statistically significant at the 5 percent level for all quality of life indicators at both LA and small area level (see the last two columns in Table 66). These are greatest at LSOA level, with the exclusion of the indicator combined air quality (combi_air_qual_ind) for which the greatest variation occurs at Local Authority level.

**Table 66: MVML model of the proportion of variation in 8 quality of life indicators attributable to LAs and small areas (Model 1 – levels only)**

| Quality of life indicators | $\beta_0$ | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|---|---|---|---|
| wa_tot_ben | 14.9156 | 0.6941 | 15.3227 | 1.2161 | 58.3070 | 0.4600 | 0.2081 | 0.7919 |
| ks4_mean_points_score | 34.2448 | 0.4907 | 7.4897 | 0.6149 | 48.3170 | 0.3815 | 0.1342 | 0.8658 |
| combi_air_qual_ind | 1.5792 | 0.0333 | 0.0365 | 0.0028 | 0.0169 | 0.0001 | 0.6829 | 0.3171 |
| pphhlds_limlong_ill | 29.7205 | 0.6848 | 15.0125 | 1.1777 | 43.5146 | 0.3433 | 0.2565 | 0.7435 |
| phhlds_noheating | 7.6114 | 0.6786 | 14.7799 | 1.1547 | 38.5750 | 0.3044 | 0.2770 | 0.7230 |
| perc_privtrans_wrk | 15.7033 | 0.6968 | 15.5813 | 1.2183 | 41.6670 | 0.3287 | 0.2722 | 0.7278 |
| perc_pubtrans_wrk | 19.5166 | 0.4146 | 5.5953 | 0.4287 | 6.9130 | 0.0545 | 0.4473 | 0.5527 |
| perc_footbike_wrk | 5.6329 | 0.3417 | 3.7439 | 0.2930 | 10.2397 | 0.0808 | 0.2677 | 0.7323 |

The proportions of residual variance for both the ML and MVML models with 8 quality of life indicators and no control variables are very similar (see Table 67).

**Table 67: Intra-class correlation coefficients for ML and MVML model with 8 quality of life indicators (Model 1 – levels only)**

| Quality of life indicators | $\rho_{u\text{-ML}}$ | $\rho_{e\text{-ML}}$ | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|
| wa_tot_ben | 0.2063 | 0.7937 | 0.2081 | 0.7919 |
| ks4_mean_points_score | 0.1341 | 0.8659 | 0.1342 | 0.8658 |
| combi_air_qual_ind | 0.6815 | 0.3185 | 0.6829 | 0.3171 |
| pphhlds_limlong_ill | 0.2551 | 0.7449 | 0.2565 | 0.7435 |
| phhlds_noheating | 0.2764 | 0.7236 | 0.2770 | 0.7230 |
| perc_privtrans_wrk | 0.2723 | 0.7277 | 0.2722 | 0.7278 |
| perc_pubtrans_wrk | 0.4458 | 0.5542 | 0.4473 | 0.5527 |
| perc_footbike_wrk | 0.2664 | 0.7336 | 0.2677 | 0.7323 |

A graphical representation of the proportion of residual variance at both LA and LSOA level is shown in Figure 26.

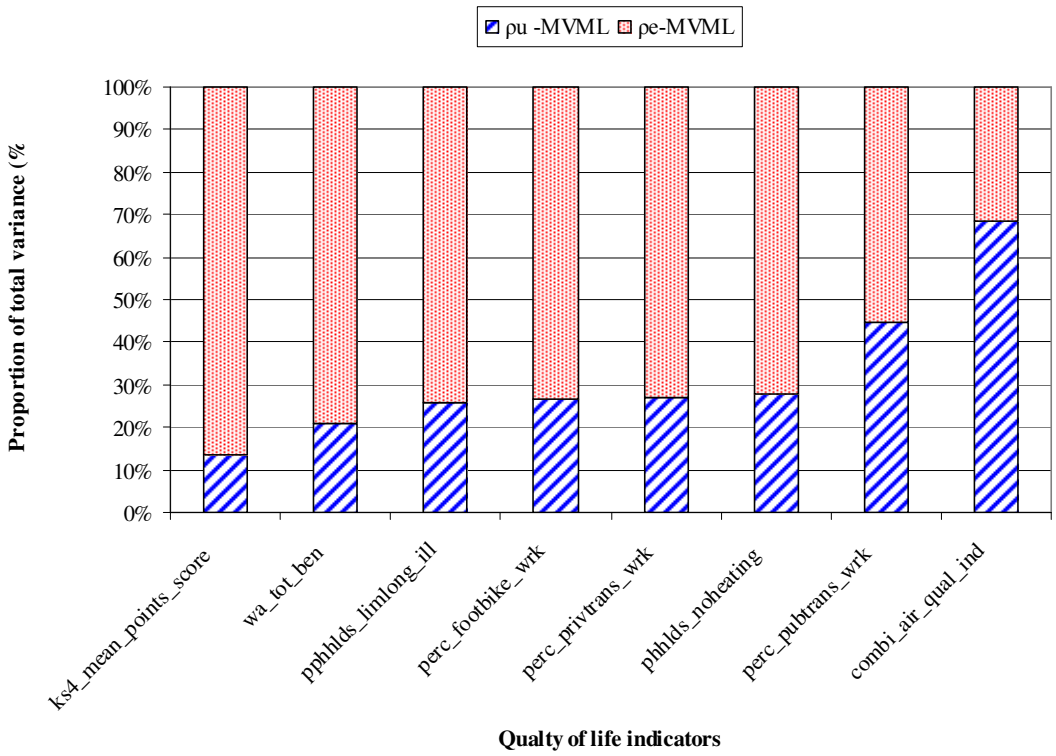



**Figure 26: Proportion of variation in 8 quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1 – levels only)**

Total residual variances and relative coefficients of variation for all quality of life indicators for both ML and MVML model formulations are shown in Table 68. These are very similar in size.

**Table 68: Total variation in 8 quality of life indicators attributable to LAs and small areas (Model 1 – levels only) – ML and MVML results**

| Quality of life indicators | ML model | | MVML model | |
|---|---|---|---|---|
| | *Total variance* | *Coefficient of Variation* | *Total variance* | *Coefficient of Variation* |
| wa_tot_ben | 73.4660 | 0.5961 | 73.6297 | 0.5967 |
| ks4_mean_points_score | 55.7682 | 0.2159 | 55.8067 | 0.2160 |
| combi_air_qual_ind | 0.0532 | 0.1982 | 0.0534 | 0.1986 |
| pphhlds_limlong_ill | 58.4155 | 0.2285 | 58.5271 | 0.2287 |
| phhlds_noheating | 53.3101 | 0.8671 | 53.3550 | 0.8674 |
| perc_privtrans_wrk | 57.2599 | 0.2954 | 57.2483 | 0.2954 |
| perc_pubtrans_wrk | 12.4746 | 0.5166 | 12.5083 | 0.5173 |
| perc_footbike_wrk | 13.9594 | 0.6394 | 13.9836 | 0.6400 |

We then control for socio-demographic characteristics by means of the IMD overall need variable. Results for the MVML models with 9 quality of life indicators are shown in Table 69, which shows also the coefficient estimates of the overall need variable for each quality of life indicator.

Estimates of the proportion of residual variance are statistically significant at the 5 percent level for all quality of life indicators. Controlling for need has the overall effect of reducing the proportion of residual variance attributable to the LA level, which suggests that local needs account for some of the variation that exists at LA level. Nonetheless, for four quality of life indicators, the IMD deprivation

score on crime (imd_score_crime), authorised and unauthorised absence from secondary school (sec_school_absence), area of green space per head (area_green) and percentage of people commuting to work for over 20 km (perc_commute_wrk), over 30 percent of total variance can be attributed to Local Authorities, which may be able to exert some influence over these aspects of quality of life. Regarding the coefficient estimates of the overall need variable, these show the expected signs (values in bold italic are statistically significant at the 5 percent level). Compared to the results obtained in the ML model framework, the MVML estimates are slightly higher (see Table 70).

**Table 69: MVML model of the proportion of variation in 9 quality of life indicators attributable to LAs and small areas (Model 1A – controlling for overall need)**

| Quality of life indicators | $\beta_0$ | SE | β-overall need | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| imd_score_crime | -0.4210 | 0.0665 | ***0.0303*** | 0.0002 | 0.1423 | 0.0110 | 0.2373 | 0.0019 | 0.3750 | 0.6250 |
| imd_score_kids | 0.0127 | 0.0036 | ***0.0106*** | 0.0000 | 0.0004 | 0.0000 | 0.0036 | 0.0000 | 0.0989 | 0.9011 |
| imd_score_elderly | 0.0663 | 0.0034 | ***0.0056*** | 0.0000 | 0.0004 | 0.0000 | 0.0027 | 0.0000 | 0.1133 | 0.8867 |
| wa_jsa | 0.6796 | 0.0680 | ***0.0938*** | 0.0004 | 0.1412 | 0.0115 | 0.8200 | 0.0065 | 0.1469 | 0.8531 |
| sec_school_absence | 6.9400 | 0.1664 | ***0.0473*** | 0.0006 | 0.8862 | 0.0686 | 1.7188 | 0.0136 | 0.3402 | 0.6598 |
| area_green | 0.6622 | 0.9310 | -0.0201 | 0.0033 | 27.8169 | 2.1494 | 50.9853 | 0.4023 | 0.3530 | 0.6470 |
| smr_lsoa_01 | 0.8182 | 0.0120 | ***0.0119*** | 0.0002 | 0.0027 | 0.0004 | 0.1888 | 0.0015 | 0.0139 | 0.9861 |
| perc_rough | 0.0014 | 0.0008 | ***0.0001*** | 0.0000 | 0.0000 | 0.0000 | 0.0008 | 0.0000 | 0.0169 | 0.9831 |
| perc_commute_wrk | 5.1627 | 0.3561 | -0.0852 | 0.0010 | 4.1120 | 0.3145 | 4.5605 | 0.0360 | 0.4741 | 0.5259 |

**Table 70: Intra-class correlation coefficients for ML and MVML model with 9 quality of life indicators (Model 1 – controlling for overall need)**

| Quality of life indicators | $\rho_{u\text{-ML}}$ | $\rho_{e\text{-ML}}$ | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|
| imd_score_crime | 0.3717 | 0.6283 | 0.3750 | 0.6250 |
| imd_score_kids | 0.0971 | 0.9029 | 0.0989 | 0.9011 |
| imd_score_elderly | 0.1125 | 0.8875 | 0.1133 | 0.8867 |
| wa_jsa | 0.1451 | 0.8549 | 0.1469 | 0.8531 |
| sec_school_absence | 0.3395 | 0.6605 | 0.3402 | 0.6598 |
| area_green | 0.3541 | 0.6459 | 0.3530 | 0.6470 |
| smr_lsoa_01 | 0.0129 | 0.9871 | 0.0139 | 0.9861 |
| perc_rough | 0.0158 | 0.9842 | 0.0169 | 0.9831 |
| perc_commute_wrk | 0.4731 | 0.5269 | 0.4741 | 0.5259 |

Table 71 reports total residual variance and the coefficients of variation for both ML and MVML models controlling for overall need at local level. Focussing first on the MVML values and comparing them with the same results obtained in the basic model specification, it emerges that the introduction of the need adjuster has the effect of depressing overall residual variance and their relative coefficients of variation.

Further, the estimates obtained with the MVML formulation are of comparable size with those obtained with the ML one; an indication that the MVML model formulation has had very little effect.

**Table 71: Total variation in 9 quality of life indicators attributable to LAs and small areas (Model 1A – controlling for overall need) –ML and MVML results**

| Quality of life indicators | ML model | | MVML model | |
|---|---|---|---|---|
| | *Total variance* | *Coefficient of Variation* | *Total variance* | *Coefficient of Variation* |
| imd_score_crime | 0.3777 | - | 0.3796 | - |
| imd_score_kids | 0.0039 | - | 0.0040 | - |
| imd_score_elderly | 0.0031 | - | 0.0031 | - |
| wa_jsa | 0.9592 | 0.4489 | 0.9612 | 0.4494 |
| sec_school_absence | 2.6023 | 0.1991 | 2.6050 | 0.1992 |
| area_green | 78.9287 | 3.8925 | 78.8022 | 3.8894 |
| smr_lsoa_01 | 0.1913 | 0.3900 | 0.1915 | 0.3901 |
| perc_rough | 0.0008 | 16.9914 | 0.0008 | 16.9976 |
| perc_commute_wrk | 8.6549 | 0.5138 | 8.6726 | 0.5143 |

Figure 27 gives a graphical representation of the proportion of residual variance at LA and LSOA levels.

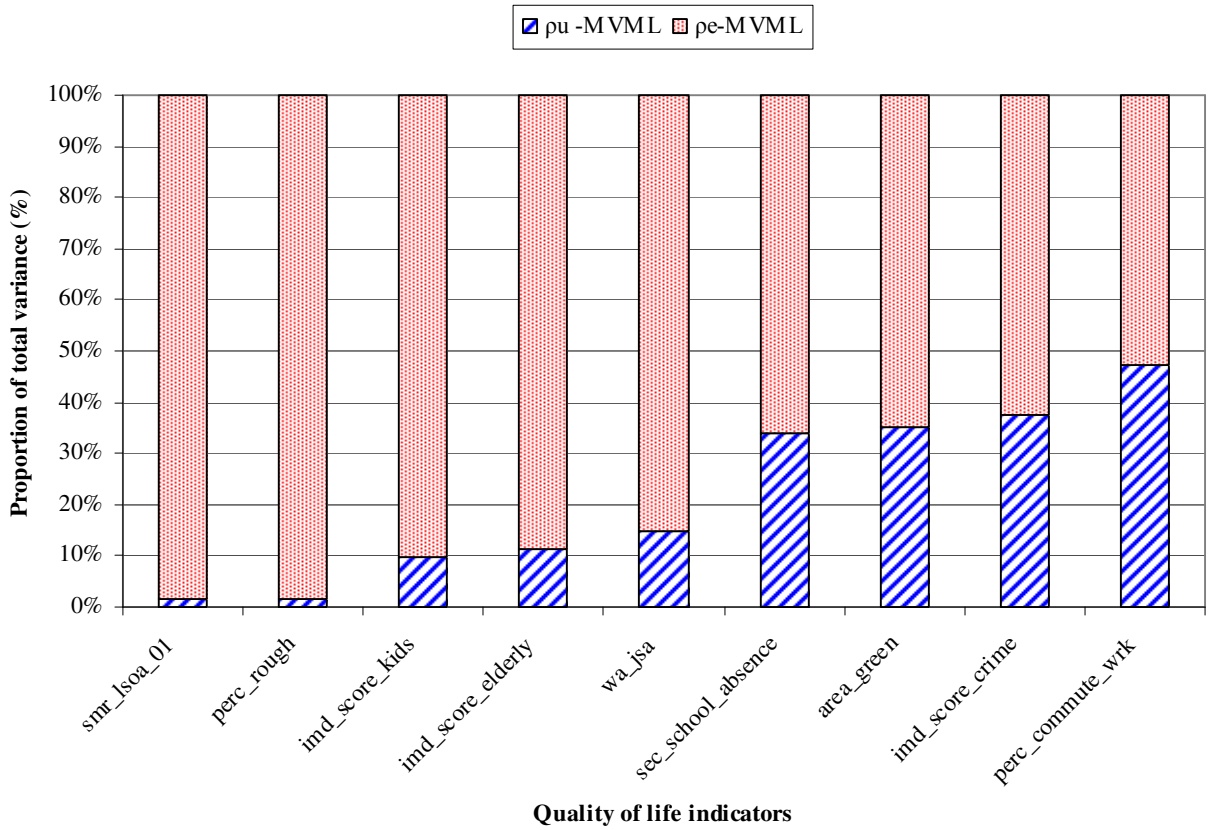



**Figure 27: Proportion of variation in 9 quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1A – controlling for overall need)**

**Table 72: MVML model of the proportion of variation in 8 quality of life indicators attributable to LAs and small areas (Model 1A – controlling for overall need)**

| Quality of life indicators | $\beta_0$ | SE | β-overall need | SE | $\sigma^2_{u0}$ | SE | $\sigma^2_{e0}$ | SE | $\rho_{u\text{-MVML}}$ | $\rho_{e\text{-MVML}}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| wa_tot_ben | 0.0321 | 0.2485 | ***0.5893*** | 0.0012 | 1.9325 | 0.1533 | 7.2389 | 0.0571 | 0.2107 | 0.7893 |
| ks4_mean_points_score | 44.0295 | 0.2852 | -0.3859 | 0.0023 | 2.3287 | 0.2026 | 26.3510 | 0.2081 | 0.0812 | 0.9188 |
| combi_air_qual_ind | 1.4992 | 0.0317 | ***0.0032*** | 0.0001 | 0.0330 | 0.0025 | 0.0155 | 0.0001 | 0.6806 | 0.3194 |
| pphhlds_limlong_ill | 20.9024 | 0.4610 | ***0.3496*** | 0.0023 | 6.6397 | 0.5276 | 25.7696 | 0.2033 | 0.2049 | 0.7951 |
| phhlds_noheating | 1.9331 | 0.5876 | ***0.2258*** | 0.0026 | 10.9241 | 0.8562 | 31.1846 | 0.2460 | 0.2594 | 0.7406 |
| perc_privtrans_wrk | 25.9527 | 0.4505 | -0.4060 | 0.0019 | 6.4371 | 0.5035 | 17.5503 | 0.1385 | 0.2684 | 0.7316 |
| perc_pubtrans_wrk | 19.5038 | 0.4155 | 0.0006 | 0.0012 | 5.5887 | 0.4281 | 6.9130 | 0.0545 | 0.4470 | 0.5530 |
| perc_footbike_wrk | 4.2217 | 0.3447 | ***0.0555*** | 0.0014 | 3.7729 | 0.2945 | 9.7899 | 0.0772 | 0.2782 | 0.7218 |

We conclude with the results for the MVML model with 8 quality of life indicators and the single overall need indicator. These are shown in Table 72. Estimates of the proportion of residual variance are statistically significant at the 5 percent level for all quality of life indicators. Compared to the estimates obtained in the basic MVML model with 8 quality of life indicators the effect of controlling for need at small area is in general that of decreasing the proportion of residual variance attributable to Local Authorities, except for two indicators percentage of working age population on key benefits (wa_tot_ben) and percentage of people commuting to work on foot or by bike (perc_footbike_wrk) for which we observe a slight increase. The greatest variations still exist at small area level, except for the combined air quality indicator (combi_air_qual_ind).

Coefficient estimates of the overall need variable for each quality of life indicator are also shown in Table 72. Figures in bold italic indicate estimates that are statistically significant at the 5 percent level. All show the expected signs.

Table 73 reports the proportion of residual variance for both ML and MVML formulations, with the latter method exerting very little effect.

**Table 73: Total variation in 8 quality of life indicators attributable to LAs and small areas (Model 1A – controlling for overall need)**

| Quality of life indicators | $\rho_{u\text{-}ML}$ | $\rho_{e\text{-}ML}$ | $\rho_{u\text{-}MVML}$ | $\rho_{e\text{-}MVML}$ |
|---|---|---|---|---|
| wa_tot_ben | 0.2102 | 0.7898 | 0.2107 | 0.7893 |
| ks4_mean_points_score | 0.0809 | 0.9191 | 0.0812 | 0.9188 |
| combi_air_qual_ind | 0.6800 | 0.3200 | 0.6806 | 0.3194 |
| pphhlds_limlong_ill | 0.2038 | 0.7962 | 0.2049 | 0.7951 |
| phhlds_noheating | 0.2576 | 0.7424 | 0.2594 | 0.7406 |
| perc_privtrans_wrk | 0.2688 | 0.7312 | 0.2684 | 0.7316 |
| perc_pubtrans_wrk | 0.4453 | 0.5547 | 0.4470 | 0.5530 |
| perc_footbike_wrk | 0.2806 | 0.7194 | 0.2782 | 0.7218 |

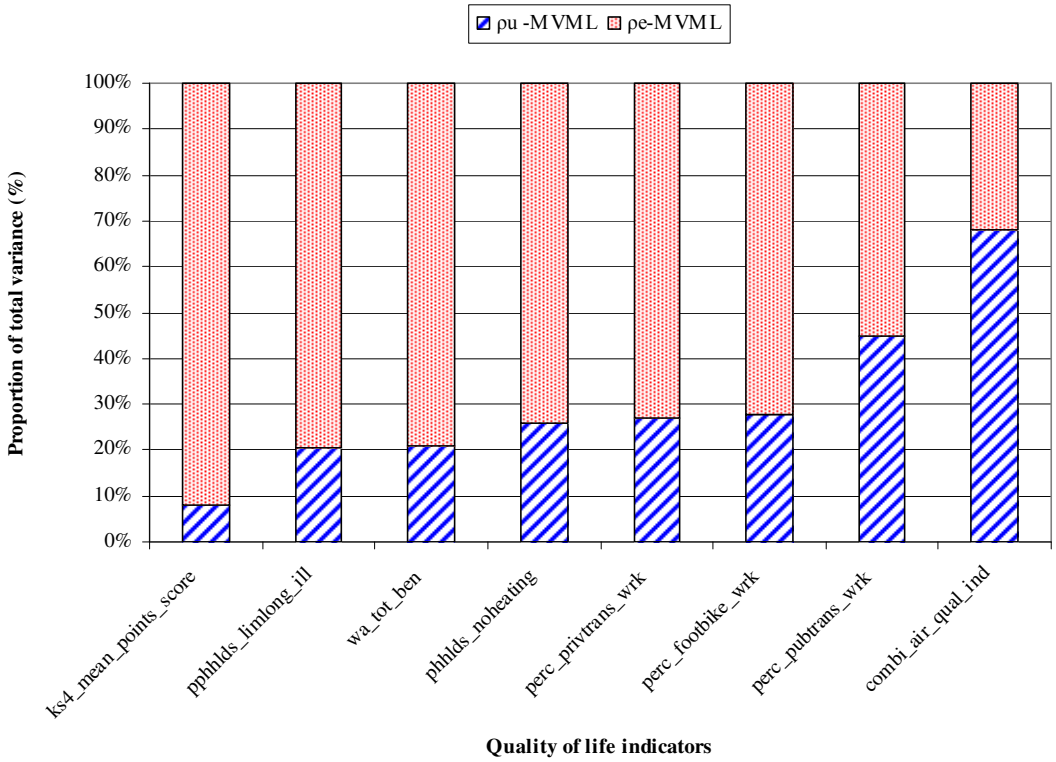



**Figure 28: Proportion of variation in 8 quality of life indicators attributable to LAs and small areas (intra-class correlation coefficients) (Model 1A – controlling for overall need)**

**Table 74: Total variation in 8 quality of life indicators attributable to LAs and small areas (Model 1A – controlling for overall need) –ML and MVML results**

| Quality of life indicators | ML model | | MVML model | |
|---|---|---|---|---|
| | *Total variance* | *Coefficient of Variation* | *Total variance* | *Coefficient of Variation* |
| wa_tot_ben | 9.1647 | 0.2105 | 9.1714 | 0.2106 |
| ks4_mean_points_score | 28.6601 | 0.1548 | 28.6797 | 0.1548 |
| combi_air_qual_ind | 0.0484 | 0.1890 | 0.0485 | 0.1892 |
| pphhlds_limlong_ill | 32.3647 | 0.1701 | 32.4093 | 0.1702 |
| phhlds_noheating | 42.0072 | 0.7697 | 42.1087 | 0.7706 |
| perc_privtrans_wrk | 23.9997 | 0.1913 | 23.9874 | 0.1912 |
| perc_pubtrans_wrk | 12.4623 | 0.5163 | 12.5017 | 0.5171 |
| perc_footbike_wrk | 13.6060 | 0.6313 | 13.5628 | 0.6303 |

The estimates of the proportion of variation explained at each level in the MVML model are remarkably consistent with those from the individual ML models.

We were unable to run any further models using MVML – the system would simply crash. However our results show that it is possible to obtain suitable estimates of the proportion of variation at different hierarchical levels, using just ML models. We obtain extremely consistent estimates of the proportion of variation between the MVML and ML approaches, underlining our justification for this approach. This is an important finding as it significantly reduces the computational complexity of examining these relationships.

## 6. Discussion

The objectives of this study were to develop statistical models to explain the link between PSOs and quality of life indicators in order to:

1. examine the degree of variation in quality of life indicators associated with different PSOs;
2. explore the extent to which factors beyond the control of PSOs influence their outcomes;
3. explore the correlation in quality of life indicators across PSOs; and
4. examine the level in the organisational hierarchy which exerts the most influence on local outcomes.

We set out to address these questions through a series of quantitative analyses of quality of life data in England at a small area level. In addition, we undertook a comprehensive literature review tailored to the main themes of our project.

Our study focused on three main areas in the review: quality of life; social capital; and the policy context.

First, we noted that quality of life can be interpreted very broadly at both the individual and the community level and we explored the way in which it is linked to concepts of happiness and subjective well-being. In exploring the determinants of happiness or well-being it is clear that many aspects of the broader social and environmental context in which people live, are key factors in their well-being.

Second, we considered the concept of social capital which broadly concerns the networks of relationships and bonds formed at individual or community level that may be important influences on the quality of life and well-being of citizens. There has been increasing emphasis in public policy making on the role of social capital and the responsibility of organisations and agencies to work together to address the needs of local communities in terms of creating the conditions to enhance social capital. Social capital was considered in order to explore further the importance of factors related to the networks, values and norms that are embedded in the social associations that people encounter in their everyday life and that may contribute to their well-being.

Third, we went on to consider the policy agenda which has placed a heavy emphasis on the responsibility of PSOs, working together, for the well-being of citizens, especially focusing on the community and neighbourhood level where social capital may have a major role to play. Over the last decade with the advent of the modernisation agenda, there has been increasing emphasis on the need for partnerships between organisations and for policy to be developed and implemented across the traditional sector boundaries. In particular, local authorities have been charged with promoting the well-being of their area and this explicitly entails working with other agencies (in strategic partnerships) - even where boundaries are not coterminous - in order to develop sustainable community strategies that address the full range of quality of life issues. Partnerships between organisations have been seen as a major tool for delivering change at local level and have been formalised in many sectors. The increasing emphasis on notions of ‘community’ and ‘neighbourhood’ as levels at which community cohesion and social capital are fostered, implies that it is useful to look beyond the usual regional, local authority or health area level to smaller geographical areas.

A number of themes emerged from the literature review which helped inform the quantitative analysis we undertook:

- The quality of life indicators we included in our analysis attempt as far as possible to reflect broad aspects of the quality of life of citizens.
- The models we used are structured to capture the degree to which PSOs may influence aspects of quality of life outside their main domain of influence.
- The analysis included consideration of the level at which influence on quality of life and well-being of citizens may occur. In particular it goes beyond the traditional organisational boundaries to consider the importance of lower levels which may more closely reflect communities or neighbourhoods.

Our descriptive analyses (correlations and factor analysis) were useful to explore objective 3 of the study, namely exploring the correlation in quality of life indicators. The results suggested overall some

significant correlations between some of the quality of life variables. For example, variables measuring various domains of income deprivation were highly correlated. Similarly variables picking up measures of environmental deprivation were highly correlated. The SUR model results also showed a significant Breusch-Pagan result which suggests, as we expected, that the quality of life indicators are correlated, and therefore that we should ideally look at these measures in a joint modelling approach such as MVML.

However, when we tried to replicate all the permutations of Model 1 for the MVML approach, the enormity of the dataset meant that running 17 quality of life indicators at LSOA level simultaneously was impossible. We therefore had to run two subsets of 9 and 8 indicators respectively. In addition, we could only run the basic model and variant A (with the overall IMD index); any additional adjusters caused the system to crash.

In short, the estimates of the proportion of variation explained at each level in the MVML model were remarkably consistent with those from the individual ML models. This gave us reassurance that whilst the SUR model had suggested we should ideally model the quality of life indicators as a system of equations given the correlations between the different measures, the simpler and computationally more amenable approach of modelling each quality of life indicator using an individual ML, would provide similar and consistent answers.

We therefore focused our efforts on using the ML modelling approach to address our remaining three objectives, namely examining the degree of variation in quality of life indicators associated with different PSOs, exploring the extent to which factors beyond the control of PSOs influence their outcomes, and examining the level in the organisational hierarchy which exerts the most influence on local quality of life indicators.

A trend which emerges across all 4 models is that the greatest variation in our quality of life indicators tends to exist at small area level. In order to test whether this is a statistical phenomenon rather than a real result, we constructed a number of artificial PSOs by randomly assigning LSOAs to higher level organisations. The intention is to demonstrate the extent to which the effects we find are created by the purposive definition of PSOs, and are not manufactured artificially by random variation in the data[4]. We therefore created a series of 304 artificial PCTs nested within 28 artificial SHAs by assigning LSOAs entirely randomly to the PCTs, which are in turn assigned randomly to SHAs.

Table 75 reports for each of the 17 indicators available at the LSOA level the proportion of variance attributable to the artificial PCT and SHA levels. This is analogous to the Tables reported earlier for the genuine PCTs and SHAs. As expected, there is negligible variation detected at the PCT or SHA level. This confirms the finding that a large proportion of the variation in many of the indicators is closely associated with the administrative agencies in place at the time of the study. In other words, when we use our genuine PSO boundaries in the models, they are associated with genuine variation at their levels, and not just the result of random variation. We can therefore reasonably assert that these PSOs should be able to exert some influence over the quality of life indicators at these higher levels.

[4] This exercise was suggested by Matt Sutton and Hugh Gravelle at the HESG conference in Aberdeen to find evidence on how to interpret the variation that exists at the lowest level in our model.

**Table 75: Proportion of variation in quality of life indicators attributable to hypothetical SHAs and hypothetical PCTs and small areas (basic model specification – levels only)**

| Quality of life indicators | sha level | pct level | ward / lsoa level | Tot($\rho_v$,$\rho_u$,$\rho_e$) |
|---|---|---|---|---|
| imd_score_crime | 0.0000 | 0.0001 | 0.9999 | 0.3695 |
| imd_score_kids | 0.0000 | 0.0000 | 1.0000 | 0.0047 |
| imd_score_elderly | 0.0005 | 0.0005 | 0.9990 | 0.0033 |
| wa_tot_ben | 0.0000 | 0.0004 | 0.9996 | 10.0832 |
| wa_jsa | 0.0000 | 0.0000 | 1.0000 | 1.1081 |
| sec_school_absence | 0.0001 | 0.0007 | 0.9991 | 2.6333 |
| ks4_mean_points_score | 0.0001 | 0.0000 | 0.9999 | 30.0246 |
| combi_air_qual_ind | 0.0000 | 0.0001 | 0.9999 | 0.0737 |
| area_green | 0.0001 | 0.0000 | 0.9999 | 165.7396 |
| smr_lsoa_01 | 0.0000 | 0.0002 | 0.9998 | 0.1922 |
| pphhlds_limlong_ill | 0.0001 | 0.0000 | 0.9998 | 38.5029 |
| perc_rough | 0.0000 | 0.0000 | 1.0000 | 0.0008 |
| phhlds_noheating | 0.0004 | 0.0003 | 0.9993 | 51.7348 |
| perc_commute_wrk | 0.0000 | 0.0000 | 1.0000 | 10.3175 |
| perc_privtrans_wrk | 0.0001 | 0.0005 | 0.9994 | 35.3233 |
| perc_pubtrans_wrk | 0.0002 | 0.0001 | 0.9997 | 40.9266 |
| perc_footbike_wrk | 0.0000 | 0.0000 | 1.0000 | 13.4100 |

We plot the proportion of variation at each level in Figure 29 and it supports the assertion that the levels matter. Most of the variation in this hypothetical exercise is at the small area level.

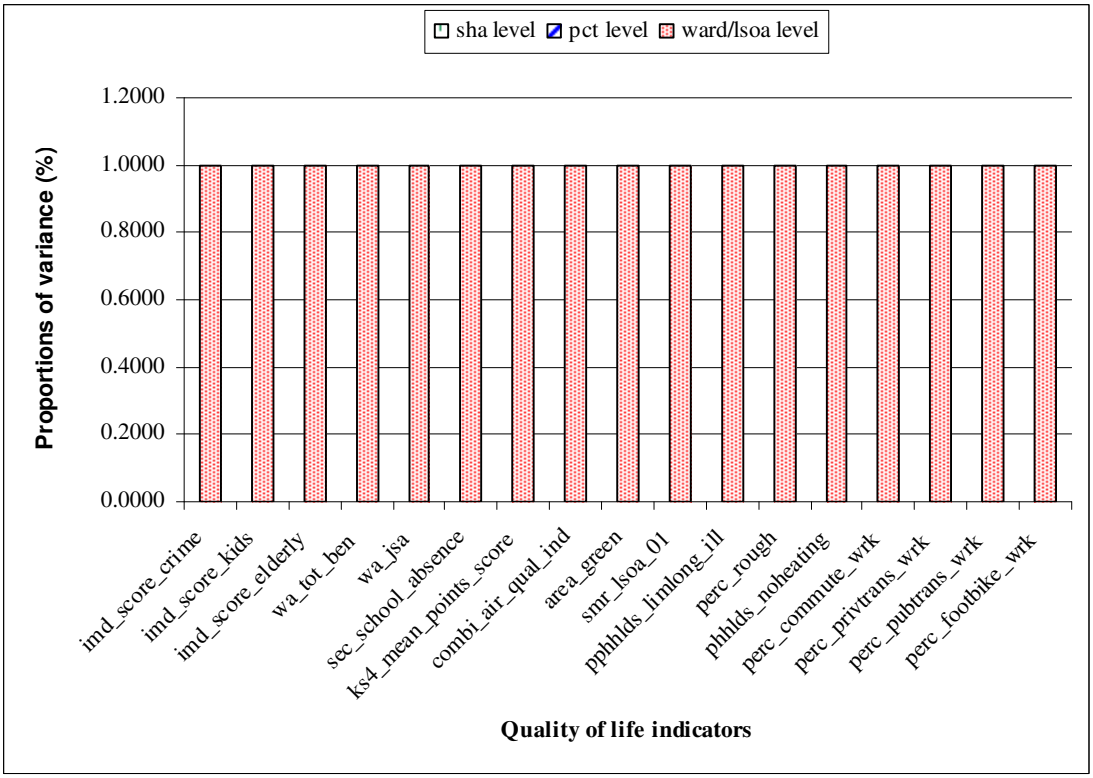



**Figure 29: Proportion of variation in quality of life indicators attributable to hypothetical SHAs and hypothetical PCTs and small areas (basic model specification – levels only)**

The introduction of more explanatory variables in the model specifications has the effect, in general, of reducing the total variance for most quality of life indicators. As we move in each case from our basic model to the additional explanatory variables in variants A, B, C and D respectively of the models, the coefficient of variation decreases suggesting that introducing more needs and performance adjusters, tends to reduce the amount of total variation in the models. This is to be expected since we are explaining more of the overall variation in each of the models as we add additional explanatory variables.

However across almost all model specifications, the proportion of total variance attributable to any of the hierarchical levels is hardly changed and remains robust. Thus the proportion of variation explained by the different levels in the hierarchy tends to be relatively stable.

When we examined the changes in rankings of quality of life indicators across the different model specifications, they remained remarkably stable with generally not very large changes in rankings. Quality of life indicators towards the origin of the axes have a large variation at small area level. These tended to be variables such as the standardised mortality ratio (smr_lsoa_01), educational attainment (ks4_mean_points_score) and the percentage of individuals living rough (perc_rough). This suggests that a lot of the variation at small area level for variables such as people living rough (perc_rough) may be very localised and area specific, whereas for variables such as air quality (combi_air_qual_ind), election turnout (turnout) and transport (perc_commute_wrk; perc_pubtrans_wrk), the majority of the variation is attributable to higher level PSOs suggesting they may have a greater role to play in influencing outcomes on these variables. We summarise the 6 QoL indicators which tend to consistently fall to the left and right respectively of the rankings across all 4 models. Those marked with a tick are in the top or bottom 6 rankings consistently.

**Table 76: Summary of variability in rankings across models and proportion of variation explained**

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| **Most variation at small area level** | | | | |
| smr_lsoa_01 | ✓ | ✓ | ✓ | ✓ |
| ks4_mean_points_score | ✓ | ✓ | ✓ | ✓ |
| perc_rough | ✓ | ✓ | ✓ | ✓ * |
| imd_score_kids | ✓ | ✓ | ✓ | ✓ * |
| le_all | ✓ | × * | ✓ | ✓ |
| area_green | × | ✓ | ✓ * | ✓ * |
| **Most variation at PSO level** | | | | |
| perc_pubtrans_wrk | ✓ | ✓ | ✓ | ✓ |
| perc_commute_wrk | ✓ | ✓ | ✓ | ✓ |
| turnout | ✓ | × | ✓ | ✓ |
| combi_air_qual_ind | ✓ | ✓ | ✓ | ✓ |
| concept_teen | ✓ | ✓ | ✓ | ✓ |
| imd_score_crime | ✓ | ✓ | ✓ * | ✓ |

* These QoL indicators show some variability in rankings within this model.

As mentioned, there was relative stability in the rankings of the quality of life variables with respect to the proportion of variation explained at higher levels since the bars were for the most part quite short. However for a few indicators, there was variation in terms of ranking, for example: the percentage of people living rough (perc_rough) in Model 4 showed a lot of variability. This is not surprising given that perc_rough had a high overall level of variance. Other variables with a higher coefficient of variation such as area of green space per head (area_green) also tend to show greater variability in rankings. These have been marked with an asterisk in Table 76.

Nevertheless, the results suggest that variables further to the right of the spectrum are more amenable to intervention from higher levels than variables clustered to the left, This reaffirms that PSOs can likely have greater influence over variables such as teenage conception, election turnout, air quality and transport, than over mortality or life expectancy.

What influence can PSOs have at small area level then? As explained earlier, LSOAs have been constructed specifically to take into account not only mutual proximity and population size but also ‘social homogeneity’. It can be argued therefore that the variation at small area level is not just a statistical result or random variation, but represents some genuine variation which may be amenable

to influence at a small area level (such as communities or neighbourhoods). However, the relative size of the variation given by the coefficient of variation on a variable such as life expectancy (le_all) was consistently very small compared to percentage of people living rough (perc_rough) and area of green space per head (area_green) which have high levels of total variance. This suggests that in order to reduce overall variation between small areas, the latter variables might be more amenable to intervention.

Finally, the results also suggest that in principle LAs and PCTs may have some influence over indicators outside of their traditional remit and that perhaps from a policy point of view one might look at a performance management system which took account of these cross-over influences, though designing performance metrics that cross organisational boundaries are notoriously difficult. There may also be scope for partnership working where organisations might both have some influence over a QoL outcome. A less direct link might also be that achievement on one QoL outcome might benefit other QoL indicators in other areas (if they are positively correlated).

For example, a recent health committee inquiry into health inequalities noted the important links between the built environment, physical activity and health. The need to consider the impact on health of planning decisions that affect the potential for walking and cycling to work, as well as the association between higher green space and lower health inequalities were highlighted (House of Commons Health Committee, 2009).

There are several examples of partnership working in this area - the Forestry Commission for England (FCE), a government department responsible for forestry in England, is currently in partnership with various PCTs running joint projects to improve the heath and well-being of individuals (O'Brien, 2005). In 2005, the FCE signed a Health Concordat with the Countryside Agency, English Nature, Sport England and the Association of National Park Authorities to set out the campaigns and events that the agencies will undertake to promote health and well-being. The partnerships between these agencies and the health sector are also seen to contribute to the National Service Frameworks (NSFs) for coronary heart disease, mental health, older people, diabetes and children.

Our SUR model and correlations did uncover associations between various QoL indicators which would suggest that attainment on one QoL would likely be associated with attainment on another, for example between people claiming job seekers allowance (wa_jsa) and people claiming a key benefit (wa_tot_ben), and the IMD deprivation score on older people (imd_score_elderly) and children (imd_score_kids). Thus agencies and PSOs working to improve QoL in one area may likely find positive spin-off effects as other areas of QoL improve and there may be occasions for partnership working to exploit these opportunities.

# 7. Conclusions

We draw two sets of conclusions. First, from a methodological perspective, our work provides new evidence on the complex interactions between PSOs and the potential influence they may have on the quality of life of citizens at a local level. This is the first study of its kind to provide evidence on the sources of variation in quality of life indicators at small area level and to use advanced methods to disentangle this variation. We provide insights into whether the three approaches SUR, ML and MVML are suitable methods to examine the complex interplay between different hierarchical levels that are commonplace in all public services.

Second, from a policy perspective we have demonstrated that it is important to consider the influence of PSOs on quality of life in areas that fall outside their traditional domains. Moreover, our results give a flavour of the relative influence that health care and local government organisations may have on measures that span health, education, environment, safety, housing and others. We also illustrated the potential significance of considering the small area level in public policy making. The existence of substantial variation in quality of life measures at this level suggests that PSOs with responsibilities at higher level should be aware of the variation that exists at this level within their area and the differential impact their policies may have locally. As we outlined earlier, government policy highlights the importance of local communities and neighbourhoods and although there are no obvious PSOs that have responsibility for quality of life at small area level, the thrust of policy has been to encourage PSOs to become more responsive to local needs and to devolve to communities a greater role in decision-making, including the handling of resources at neighbourhood group and community level (Dept for Communities and Local Government, 2008). Also, as the literature suggests, fostering social capital can enhance the quality of life of citizens and protect them from social exclusion. Neighbourhood and community networks and relationships appear to play an important role in the creation and maintenance of social capital. Our results therefore suggest that policy attention to the local level may well be a fruitful approach if the aim is to enhance the overall well-being of citizens.

Finally, this project also provides a good basis from which further research can be developed. First, there is scope to consider different variables, both in terms of quality of life indicators and explanatory variables and also to explore the use of panel data (although there may be some computational challenges). Second, modelling of the error term at the lowest level into a deterministic and a random component would further explore the nature of the variation at small area level, although this would require information at smaller levels such as postcode.

## 8. Appendix A: Literature search

Three electronic databases (EconLIT, Social Policy & Practice, and International Bibliography of Social Sciences) were searched to identify potentially relevant papers. A total of 733 unique records were identified after de-duplication using bibliographic software. The records were sifted by two researchers and relevant papers were selected. The search strategies used are listed below.

**Econlit (via Silverplatter)**
**244 records identified**

**Search strategy**
#1 public sector in ti,de
#2 local government in ti,de
#3 central government in ti,de
#4 local authorit* in ti,de
#5 public services in ti,de
#6 service delivery in ti,de
#7 public policy in ti,de
#8 public choice in ti,de
#9 centralization in ti,de
#10 centralisation in ti,de
#11 decentralization in ti,de
#12 decentralisation in ti,de
#13 municipality in ti,de
#14 (public services in ti,de) or (local authorit* in ti,de) or (municipality in ti,de) or (central government in ti,de) or (decentralisation in ti,de) or (local government in ti,de) or (decentralization in ti,de) or (public sector in ti,de) or (centralisation in ti,de) or (centralization in ti,de) or (public choice in ti,de) or (public policy in ti,de) or (service delivery in ti,de)
#15 quality-of-life in ti,de
#16 qol in ti
#17 (wellbeing or well-being) in ti,de
#18 (well adj being) in ti,de
#19 social capital in ti,de
#20 community cohesion in ti,de
#21 (community cohesion in ti,de) or (social capital in ti,de) or ((well adj being) in ti,de) or ((wellbeing or well-being) in ti,de) or (qol in ti) or (quality-of-life in ti,de)
#22 ((community cohesion in ti,de) or (social capital in ti,de) or ((well adj being) in ti,de) or ((wellbeing or well-being) in ti,de) or (qol in ti) or (quality-of-life in ti,de)) and ((public services in ti,de) or (local authorit* in ti,de) or (municipality in ti,de) or (central government in ti,de) or (decentralisation in ti,de) or (local government in ti,de) or (decentralization in ti,de) or (public sector in ti,de) or (centralisation in ti,de) or (centralization in ti,de) or (public choice in ti,de) or (public policy in ti,de) or (service delivery in ti,de))

**Social Policy & Practice (via Silverplatter)**
**395 records identified**

**Search strategy**
#1 (public sector) in de
#2 (local government) in de
#3 (central government) in de
#4 (local authorit*) in ti,ab
#5 (public services) in ti,ab
#6 (service delivery) in ti,ab
#7 ((public services) in ti,ab) or ((local authorit*) in ti,ab) or ((central government) in de) or ((local government) in de) or ((public sector) in de) or ((service delivery) in ti,ab)
#8 (performance or indicator* or measure* or benchmark* or target* or (best value)) in ti,ab
#9 (performance indicators) in de
#10 (performance measurement) in de
#11 ((performance measurement) in de) or ((performance indicators) in de) or ((performance or indicator* or measure* or benchmark* or target* or (best value)) in ti,ab)

#12 quality-of-life in de
#13 qol in ti,ab
#14 (wellbeing or well-being) in ti,ab
#15 (well next being) in ti,ab
#16 ((well next being) in ti,ab) or ((wellbeing or well-being) in ti,ab) or (qol in ti,ab) or (quality-of-life in de)
#17 (((performance measurement) in de) or ((performance indicators) in de) or ((performance or indicator* or measure* or benchmark* or target* or (best value)) in ti,ab)) and (((public services) in ti,ab) or ((local authorit*) in ti,ab) or ((central government) in de) or ((local government) in de) or ((public sector) in de) or ((service delivery) in ti,ab)) and (((well next being) in ti,ab) or ((wellbeing or well-being) in ti,ab) or (qol in ti,ab) or (quality-of-life in de))

**International Bibliography of Social Sciences (via Silverplatter)**
**205 records identified**

**Search strategy**
#1 public sector in ti,de
#2 local government in ti,de
#3 central government in ti,de
#4 local authorit* in ti,de
#5 public services in ti,de
#6 service delivery in ti,de
#7 public policy in ti,de
#8 public choice in ti,de
#9 centralization in ti,de
#10 centralisation in ti,de
#11 decentralization in ti,de
#12 decentralisation in ti,de
#13 municipality in ti,de
#14 (public services in ti,de) or (local authorit* in ti,de) or (municipality in ti,de) or (central government in ti,de) or (decentralisation in ti,de) or (local government in ti,de) or (decentralization in ti,de) or (public sector in ti,de) or (centralisation in ti,de) or (centralization in ti,de) or (public choice in ti,de) or (public policy in ti,de) or (service delivery in ti,de)
#15 quality-of-life in ti,de
#16 qol in ti
#17 (wellbeing or well-being) in ti,de
#18 (well adj being) in ti,de
#19 social capital in ti,de
#20 community cohesion in ti,de
#21 (community cohesion in ti,de) or (social capital in ti,de) or ((well adj being) in ti,de) or ((wellbeing or well-being) in ti,de) or (qol in ti) or (quality-of-life in ti,de)
#22 ((community cohesion in ti,de) or (social capital in ti,de) or ((well adj being) in ti,de) or ((wellbeing or well-being) in ti,de) or (qol in ti) or (quality-of-life in ti,de)) and ((public services in ti,de) or (local authorit* in ti,de) or (municipality in ti,de) or (central government in ti,de) or (decentralisation in ti,de) or (local government in ti,de) or (decentralization in ti,de) or (public sector in ti,de) or (centralisation in ti,de) or (centralization in ti,de) or (public choice in ti,de) or (public policy in ti,de) or (service delivery in ti,de))

# 9. Appendix B: Description and generation of quality of life indicators

We describe the 20 quality of life indicators by source of data. A brief overview of the data source used is also provided.

## 9.1. British local election database

The British Local Election Database (1889-2003) taken from the UK Data Archive (Rallings *et al*, 2006) provides information on local election results in England. It contains information on, for example, election turnout (see below), the percentage of votes gained by each political party that put forward candidates at each of the council elections, and the total number of votes cast in each election. The information is provided at electoral ward level, although it can be grouped together up to county council level.

**1. Election turnout**

This indicator relates to the turnout at the latest local election in England. There are five different council types in England at which council elections take place. A summary of the five types of council, along with years at which each election took place is presented in the table below:

**Table 77: Summary of years at which local elections held in England, by council type**

| Type of election | Years of elections |
|---|---|
| County Council | 1997, 2001 |
| District Council | 1995, 1996, 1997, 1998, 1999, 2000, 2002 and 2003 |
| London Borough Council | 1998, 2002 |
| Metropolitan Borough Council | 1995, 1996, 1998, 1999, 2000, 2002 and 2003 |
| Unitary Authority Council | 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002 and 2003 |

For each type of council, we kept the election turnout results for the latest available election year.

## 9.2. Index of multiple deprivation 2004

The Index of Multiple Deprivation 2004 (IMD) measures multiple deprivation at small area level. It is based on the idea that individuals living in a specific area may experience one or more forms of deprivation. Seven dimensions of deprivation are identified and the assumption is made that these dimensions can be measured separately.

The domains of deprivation and their purpose is shown in the following table.

**Table 78: The English Indices of Deprivation 2004 and their respective purposes**

| Deprivation domain | Purpose |
|---|---|
| Income deprivation | To capture proportion of the population experiencing income deprivation |
| Employment deprivation | To measure employment deprivation conceptualised as involuntary exclusion of the working age population from the labour market |
| Health deprivation and disability | To identify areas with relatively high rates of people who die prematurely or whose quality of life is impaired by poor health or who are disabled |
| Education, skills and training deprivation | To capture the extent of deprivation in education, skills and training in a local area. The domain is divided into two, with the intent of depicting both the 'flow' and 'stock' of educational disadvantage within an area. Ten first sub-domain relates to the lack of attainment (among children and young people flow), and the second relates to the lack |

| | |
|---|---|
| | of qualifications in terms of skills in the working age population (stock). |
| Barriers to housing and services | To measure barriers to housing and to key local services. The indicators falls into two sub-domains: 'geographical barriers' and 'wider barriers' which includes issues relating to access to housing such as affordability. |
| Living environment deprivation | To measure deprivation in the living environment, and it comprises of two sub-domains: one measuring the 'indoors' living environment to capture the quality of housing, and one measuring the 'outdoors' living environment containing two measures about air quality and road traffic accidents. |
| Crime | To measure the rate of recorded crime for four major crime themes: burglary, theft, criminal damage and violence. These represent the occurrence of personal and material victimisation at a small area level. |

Source: The English Indices of Deprivation 2004 (revised) (ODPM, 2004a)

Each domain is composed of a number of different indicators, which are chosen according to a set of criteria. These are that (a) the indicators are 'domain specific'; (b) they are appropriate for the measurement of that particular form of deprivation; (c) are measuring conditions that are experienced by a wide majority of individuals, not just a few; (d) are up-to-date and (e) easily up-dated on a regular basis; (f) statistically robust; and (g) consistently available for the whole of England at small area level.

For each index a single summary measure is produced from the different indicators that make up a single domain. This measure is expressed in units that are meaningful and hence easily interpreted, for example the proportion of individuals experiencing a form of deprivation. For two domains (Income and Employment), all the indicators that make up the domain are simply summed together, as they are expressed in the same metric. To obtain the area rate, the former needs to be divided by the population at risk in that particular area. In some of the other domains, a single measure is produced by applying maximum likelihood factor analysis. This technique is used to produce weights "for combining indicators into a single score" (ODPM, 2004a). The domains or sub-domains where this technique has been applied are: Health deprivation and Disability; Children/Young People sub-domain; Education, skills and training deprivation; and the Crime Domain.

Hence, each of 32,482 LSOAs in England is assigned a score for every domain of deprivation. According to the score received, LSOAs are assigned a rank, where 1 is the most deprived area and 32,482 the least deprived area.

Further, an overall IMD is assigned to each LSOA, which is calculated as the weighted[5] area level aggregation of the seven specific dimensions of deprivation listed above.

In this paper we use three different indices of multiple deprivation as measures of quality of life at small area level. These are the index of multiple deprivation for crime, income deprivation affecting children (IDACI) and income deprivation affecting older people (IODAOPI).

## 2. Index of Multiple Deprivation for crime

The Crime domain registers the incidence of recorded crime in terms of "the occurrence of personal and material victimisation at small area level, [and] regardless of the presence or absence of other types of deprivation (such as income deprivation) in the area". Data/indicators of crime for four different types of crime are collected under this domain and combined together. These are burglary, theft, criminal damage and violence. A total of thirty-three different categories of recorded crime are collected from each of the thirty-nine regional police forces in England.

[5] Domain weights for the overall IMD 2004 are as follows: Income deprivation, 22.5 %; employment deprivation, 22.5 %; health deprivation and disability, 13.5 %; education, skills and training deprivation, 13.5%; barriers to housing and services, 9.3 %; crime, 9.3 %; and living environment deprivation, 9.3 %.

**3. Income Deprivation Affecting Children (IDACI)**

This is a sub-set of the Index of Income Deprivation domain and consists of, for each SOA, the percentage of children under the age of 16 who live in families that receive either income support (IS) or an income based job-seekers allowance (JSA-IB), and in families who receive working families tax credit (WFTC) or disabled person tax credit (DPTC) and whose equivalised income is below 60 percent of median before housing costs.

**4. Income Deprivation Affecting Older People (IDAOPI)**

This is also a sub-set of the Income Deprivation Domain and it consists of the percentage of population in an SOA who are sixty years old and over and who are either on income support (IS) or receive an income based job-seekers allowance (JSA-IB).

## 9.3. 2001 Census

A census is a survey of all people and households in the country. It provides essential information from national to neighbourhood level for government, business, and the community. The most recent census was held in 2001.

The information is obtained by every single individual living in England and Wales at the date of the Census. Hence, it includes also foreigners who permanently reside in a third country other than the UK. Every individual is under the obligation to complete the census form, being otherwise liable for prosecution.

The following table provides a summary of the main topics covered by the 2001 Census.

**Table 79: Topics in 2001 Census, by direct questions and from the responses of two or more questions**

| **Topics covered by direct questions** | |
|---|---|
| • **People** | |
| | Number |
| *Demographic and social information about everybody* | |
| | Age (calculated from date of birth)<br>Birthplace (country)<br>Carers, unpaid<br>Ethnic group<br>Health, general<br>Illness, limiting long term<br>Marital status<br>Migrants (different address one year before)<br>Religion<br>School children and students<br>Welsh language (Wales only) |
| *Employment and qualifications of people aged 16-74* | |
| | Academic qualifications<br>Professional qualifications<br>Working/not working (in week before Census)<br>Hours worked<br>Means of travel to work |
| • **Households** | |
| | Number |
| • **Housing** | |
| | Accommodation type<br>Bath/shower/WC, exclusive use<br>Cars and vans, availability and number<br>Central heating |

| | |
|---|---|
| | Floor level, lowest |
| | Rooms, number |
| | Tenure |
| • **Additional information collected in communal establishments** | |
| | Number and type of establishment |
| **Topics derived from the responses to two or more questions** | |
| • **People** | |
| | Dependent children |
| | Living arrangements |
| *Aged 16-74* | |
| | Distances travelled to work |
| | Economic activity |
| | Industries of employment |
| | Occupations |
| | Socio economic classification |
| | Social grade |
| • **Households** | |
| | by characteristics of reference person in household |
| | Composition |
| | Family composition |
| | Lone parents |
| | Moving groups (of migrants) |
| | Pensioner households |
| | Size, number of residents |
| | Students away during term time |
| | Types |
| • **Families (within households)** | |
| | by characteristics of reference person in household |
| | Composition |
| | Types |
| • **Housing** | |
| | Dwellings |
| | Household spaces |
| | Occupied/second home/vacant dwelling indicator |
| | Overcrowding (occupancy ratings/persons per room) |
| | Shared |
| | Student accommodation |
| | Under occupancy (occupancy rating) |

Source: ONS, http://www.statistics.gov.uk/census2001/topics.asp, last accessed 31st March 2008

The 2001 Census results are used as a source of information for several quality of life indicators. They are available at a number of geographical/administrative levels. The lowest area output area at which they are available is the Lower Layer Super Output Area or LSOA. All data were collected and collated at LSOA. Information on the different levels is retained, from governmental regions down to postcode level.

In most cases, the information provided in the 2001 Census needed to be aggregated, calculated and/or transformed in order to obtain an indicator of quality of life similar to the one published by the Audit Commission.

The quality of life indicators extracted from the 2001 Census were the following:

**5. Households with one or more limiting longstanding illnesses**

Each individual is asked to respond (self assessment question) "whether or not [he/she] has a limiting long-term illness, health problem or disability which limits their daily activities or the work they can do,

including problems that are due to old age (ONS, 2004)". This information is aggregated up to the household level to produce a variable that returns the percentage of households in a given LSOA with one or more longstanding illnesses.

No data manipulation was necessary for this quality of life indicator.

**6. People living rough (percentage)**

The 2001 Census provides information on the number of individuals in each LSOA that are living rough. In order to obtain our quality of life measure, we have divided the total number of people living rough by the total number of people living in each LSOA.

**7. Households (occupied) without central heating (percentage)**

The 2001 Census results comprise the total number of households without central heating. In order to obtain the quality of life indicator, we divided the previous variable by the total number of all occupied spaces, by LSOA.

**8. Population travelling over 20km to work (percentage)**

The 2001 Census provides information on the total number of people commuting to work from 20km to less than 30km, from 30km to less than 40km, from 40km to less than 60km and from 60km and over. All these numbers were aggregated and then divided by the total number of people to create the quality of life measure.

**9-11. Population travelling to work by private vehicle (percentage), population travelling to work by public transport (percentage) and population travelling to work by bike or foot (percentage)**

Individuals were asked to state the type of transport used to commute to work. Individuals' answers were collected in the following categories:

1. Underground; metro; light rail; tram
2. Train
3. Bus; minibus or coach
4. Driving a car or van
5. Motorcycle; scooter or moped
6. Bicycle
7. On foot

These were aggregated into the following categories: private vehicle (4 + 5); public transport (1 + 2 + 3) and by bike or foot (6 + 7). The total number of individuals using the three types of transport was then divided by the total number of individuals to obtain percentages at LSOA level.

## 9.4. Neighbourhood statistics

The Neighbourhood Statistics Website is a free access online data resource. It contains datasets that describe the characteristics of a neighbourhood, with a particular focus on deprivation. The website includes results from the 2001 Census (ONS, 2007d).

It provides information on the following topics:

- 2001 Census: Census Area and Key Statistics
- Access to Services
- Community Well-Being/Social Environment
- Crime and Safety
- Economic Deprivation
- Education, Skills and Training
- Health and Care

- Housing
- Indices of Deprivation and Classification
- People and Society: 'Income and Lifestyles' and 'Population and Migration'
- Physical Environment
- Work Deprivation

The following variables were taken from the Neighbourhood Statistics website (ONS, 2007c):

**12 – 13. All people of working age claiming a key benefit and all people of working age claiming job seekers' allowance**

The above quality of life indicators are both collected in the Benefit Data Indicators: Working Age Client group database. These data show the percentage of people claiming key benefits as a proportion of the working age population. The data are provided for LSOAs, LAs, GORs, and are broken down by:

- statistical group (their main reason for interacting with the benefit system),
- gender, and
- 3 bands of age (16-24, 25-49 and 50-59/64 (59 for Females, 64 for Males))

Data used in this project refer to August 2004, which was the latest available year at the time the database was created. The data available were classified as 'experimental statistics' at the time the data was accessed (August 2007). Since then more recent data has become available.

**14 - 15. Secondary school absence indicator and National Curriculum assessments: average point score for Key Stage 4**

These quality of life indicators are developed from indicators used to generate the Index of Multiple Deprivation 2004.

Data on secondary school absence is provided by the Department for Education and Skills (DfES) and it covers two academic years 2002/2003 and 2003/2004. Data from both years were used to produce estimates of the average proportion of sessions missed through absence. The secondary school absence indicator relates to both authorised and unauthorised absences of pupils in maintained schools. The first refer to absences that have been approved by a teacher, or other authorised person from the school; unauthorised absences refer to absences taken without appropriate permission, including also unexplained or unjustified absences.

Data was collected through telephone calls to schools' attendance registrars at the beginning of the morning session and during the afternoon session. Pupils are classified as 'present', 'absent' or 'attending an approved educational activity'. This information was used to calculate an average for each school, which was then attributed to each pupil in the school. Subsequently, these rates were attached to each pupils' postcode using the Pupil Level Annual School Census (PLASC). As each area can include more than one secondary school, an average area rate of all the schools serving the area was produced (ONS, 2007c).

Data on the combined National Curriculum Assessment indicator average points score for Key Stage 4 is taken from the amended data cycle of the National Pupil Database (NPD) and are supplied by the Department for Education and Skills (DfES). The results are for the academic year 2002/03, covering the period between the 1st of September 2002 and the 31st of August 2003. The Pupil Level Annual Schools Census allows one to link pupils' results to their residential postcodes through the Unique Pupil Number. Pupils' residential postcodes are then used to construct this indicator at Lower Super Output Area or LSOA level.

To calculate the average point score at LSOA level, first the average point score for each pupil is calculated by summing up the point scores for their 8 best grades. Then, the average point scores for all eligible pupils in the LSOA are summed and divided by the total number of eligible pupils in the LSOA. If no pupils eligible for the test are resident in the LSOA, then a missing value is returned. A value of '0' is possible and means that there were pupils eligible at LSOA level to take the test but no score was obtained, either because pupils were absent or their tests missing or scripts ineligible.

**16. – 17. Combined air quality indicator and Area of green space**

The combined air quality indicator represents an update to indicators used in the creation of the English IMD 2004.

Data are taken from the National Atmospheric Emissions Inventory (NAEI) measures of emissions for benzene, nitrogen dioxide, sulphur dioxide and particulates. Data are for 2003. The NAEI collects and maintains estimates of emissions for small areas (modelled to 1 km grid squares) in the UK. Data for the four mentioned pollutants were then allocated to LSOAs by members of the Geography Department at Staffordshire University. The annual mean levels for these pollutants in each LSOA are divided by the standard value for that pollutant and then all four values added up to determine an overall air quality score for the LSOA.

A higher value of the score implies poorer overall air quality.

The quality of life indicator 'area of green space' is an experimental statistic and data are obtained through the Generalised Land Use Database (GLUD) for 2005. Data are presented in thousands of square metres to 2 decimal places for nine simple land categories (domestic buildings; non-domestic buildings; roads; paths; rail; domestic gardens; greenspace; water; other land uses (largely hardstanding); and unclassified. A '0' entry is shown where there is no area of a given land type, whilst a dash (-) is entered when the area is les than 5 square metres. We use the category 'greenspace' as a measure of quality of life. A higher value implies higher quality of life.

## 9.5. Other data sources

We also used data from a number of other sources such as the Public Health Observatory for standardised mortality ratio and the Office for National Statistics for both life expectancy at birth and teenage conceptions.

**18. Life expectancy at birth**

Data on life expectancy at birth at ward level were released for the first time in 2006 by the Office for National Statistics as experimental statistics. These were calculated using abridged life tables (developed by Chiang (1984)) where deaths and populations are aggregated into age groups.

Life expectancy at birth for a ward in 1999-2003 is an estimate of the average number of years a newborn baby is expected to survive if he or she would experience the age-specific mortality rate of that particular ward for that time period throughout his or her life. The indicator reflects mortality amongst those living in the area, rather than those that were born in the area. Thus, it is not the number of years a baby born in a certain ward in 1999-2003 would live because death rates in a certain area may change over time and because many of those born in a certain ward may live elsewhere for some part of their lives.

**19. Teenage conceptions**

Teenage conceptions data at ward level were made available to us by the Office for National Statistics. It covers the period 2002-2004, with data being aggregated across these years because of small numbers at ward level, which may have resulted with the identification of the person.

The data relate to conceptions by residents of England under the age of 18 that terminated with either a maternity at which one or more live or still birth occurred or that received a legal abortion under the 1976 Act. Hence, it does not include conceptions that were terminated because of a spontaneous miscarriage or illegal abortion.

The figures relate to the area of the woman's place of usual residence when the maternity or abortion took place. No information is available on the area of usual residence at the time of conception.

## 20. Standardised mortality ratio

Data was obtained through the Public Health Observatory and refers to age-sex standardised mortality ratios at Lower Super Output Area for England. We use the standardised mortality ratios for 2001.

An indirect standardization method is used to calculate the standardized mortality ratios using death rates for England. English death rates for each age group up to age 85 are used to determine the expected number of deaths in a particular area given the size and age structure of its population. This figure is then compared with the actual number of 'observed' deaths which did take place.

An SMR can therefore be defined as the ratio of the observed number of deaths in an area to the number expected if the ward had the same age-specific rates as the whole of England.

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