Housing Space in England at the Neighbourhood-Level, 1971 to 2017

Christopher D. Lloyd1 · James Gleeson2

Received: 25 June 2021 / Accepted: 11 May 2022 / Published online: 13 June 2022 © The Author(s) 2022

Abstract
While most discussions of housing in the UK tend to focus on national or regional scales, the level of diversity within regions means that measuring trends at neighbourhood level is vital for a more complete understanding of how housing markets and housing conditions are changing. Using small area data also enables identification of hot spots of changing housing demand as well as charting changes in the composition of housing stock in neighbourhoods. This paper makes use of a new dataset, developed as a part of the PopChange project, which enables analysis of population and housing change using Census data for neighbourhoods across England since 1971. The data reveal considerable neighbourhood-level diversity in trends throughout this period. Notable trends identified include a marked increase in overcrowding in outer London over the period 1971–2011, a decrease in the number of rooms per person across much of the wider south east between 2001 and 2011, and large increases in average household size in parts of London, Birmingham, Bradford, and Oldham. Administrative data for 2015 and 2017 allow a post 2011 Census perspective on the number of dwellings per person. When measured in terms of dwellings per person, housing space increased at regional level over the period everywhere except London, but there is considerable variation and all regions contain neighbourhoods with declining numbers of dwellings per person.

Keywords Housing · Overcrowding · Dwellings

Christopher D. Lloyd
c.lloyd@qub.ac.uk
James Gleeson
James.Gleeson@london.gov.uk

1 Geography, School of Natural and Built Environment, Queen’s University Belfast, Elmwood Avenue, Belfast BT7 1NN, UK
2 Greater London Authority, City Hall, The Queen’s Walk, London SE1 2A, UK
Introduction

An ongoing housing crisis in the UK, caused by a combination of factors including a major shortage of housing in many areas and declining social housing, has been widely discussed in public\(^1\) and policy arenas (see DCLG, 2017). Public concern over housing as one of the most important issues facing the country is at its highest level since the 1970s (Ipsos MORI, 2018). Several studies have assessed changes in the availability of housing, housing types, and housing spaces. But, as yet, there have been no locally-detailed analyses of such changes. A detailed understanding of trajectories of change in housing is vital to guide and assess housing policy, and this paper provides an evidence base – specifically on housing space – to support development of this understanding.

Estimates for the number of new homes demanded in England vary widely, and Wilson and Barton (2018) cite a range between 240,000 and 340,000 new homes per year, with an approximate increase of 222,000 in the total housing stock in 2017/18 (for the same period a figure of 222,190 is cited by MHCLG, 2019). The considerable geographical variation in housing need is acknowledged by Wilson and Barton (2018), who recognise that the greatest pressures are in London and the south of England, in addition to some local ‘hot-spots’ of demand (Hudson, 2018). However, even within these areas there are considerable differences in housing need (and in overcrowding, as one manifestation of housing need), and also in the rates of change in demand. Fine-scaled differences in housing wealth and patterns of neighbourhood segregation may also contribute to intergenerational inequalities and long-lasting differences in life chances, as explored for example by Galster and Wessel (2019) in Norway and Sharkey (2012) in the US, with a review of evidence in the UK provided by Tunstall et al. (2013).

An understanding of the changing distribution of housing relative to population is obviously a central concern of housing policy. Within this, overcrowding has been a persistent concern. Previous research has suggested that overcrowding is associated with negative outcomes in terms of, for example, health or educational attainment (see, for example, Dorling et al., 2005; Office of the Deputy Prime Minister, 2004, and see Tunstall, 2015 for a short review); Shelter (2005) detail several impacts linked to overcrowding including strained family relationships, problems related to child development and education, and poor health (including anxiety and stress). However, there is currently little understanding of which neighbourhoods have seen growth, decline or persistence in overcrowding rates beyond the most recent Census. This paper uncovers neighbourhood-level trends in overcrowding and other measures of housing space, namely the number of dwellings per person, average household size, and the number of rooms per person.

Knowledge of local-level changes in housing quality, housing spaces, and tenure should inform policy-making at all levels from national to local government. However, until now England has lacked detailed information on neighbourhood-level

---

\(^1\) See, for example, https://www.telegraph.co.uk/housing-crisis/
changes over a sufficiently long period to discern major trends in the characteristics of housing in local areas. This paper addresses this issue by making use of a new data source, PopChange, which provides counts by population and household categories for small areas from 1971 to 2011, as well as linking to administrative data sources for more recent time points. PopChange (Population Change and Geographic Inequalities in the UK, 1971–2011) is an Economic and Social Research Council (ESRC) funded project which has developed geographically-consistent sets of counts from the Censuses of Britain for 1971, 1981, 1991, 2001 and 2011. These counts are provided for common standard 2011 Census areas (lower layer super output areas; LSOAs) and also 1 km by 1 km grid cells, so that changes through time can be explored. Here, LSOAs in England (with an average population of 1,614 people for LSOAs in England in 2011) are the focus. This paper focuses on changes in housing space in small areas within England between 1971 and 2017 (using administrative data to extend the time series beyond the 2011 Census). Housing space here refers to numbers of dwellings per person, rooms per person, household sizes and overcrowding, rather than housing floor space. Some provisional findings from this work were presented by Lloyd and Gleeson (2020).

The paper makes several key contributions. It takes a focus on the local context and it stresses the need to consider housing trajectories using a novel data source allowing assessment of changes over a period of more than 45 years. By doing this, the paper addresses the problem of how government, and also the voluntary and community sector, can learn from housing histories. Weak ‘institutional memory’ whereby staff churn in government departments contributes to a lack of knowledge of past commissioned research also means that evidence of past policy is often not utilised (Sasse & Haddon, 2018). In the present context, by linking together data on past changes in housing in local areas, crucial context on how housing spaces have changed and how these broad changes may be mirrored elsewhere enables LAs to better understand the challenges faced in particular neighbourhoods, and better design new housing schemes which account for the particular ways in which areas have changed.

In using regularly updateable administrative data sources as well as Census data, the paper offers a means to assess changes in housing demand over small areas for multiple time periods without relying on the Census – although Census data provide vital context. The paper first sets out the data underlying the analyses and the methods used to create a data set which allows for analysis of change through time. Results are then presented on: dwellings per person, overcrowding, average household size, and rooms per person. These analyses are based solely on Census data; the final substantive section considers the use of administrative data for assessing dwellings per person in the post (2011) Census period.

Data and Methods

The analyses in this paper are based on the PopChange LSOA resource linking Census data for 1971, 1981, 1991, 2001, and 2011, plus administrative data for intra-Census years and post-2011 (see Lloyd et al., 2017 which details the creation of
common counts on a 1 km grid rather than LSOAs). The housing variables (and corresponding Census tables) included in the study are detailed in Table 1; the key variables are defined in the relevant sections below. Note the population bases differ between Censuses. The 1971 base is all those present plus visitors; the bases for other years are those usually resident. Usual residence is generally defined as the address in the UK at which a person spends the majority of the time; in most cases this corresponds to a permanent or family home. The specific definition of usual residence varies between Censuses and Lloyd et al. (2017) detail these differences.

In addition to housing data, the Index of Multiple Deprivation (IMD) for 2015 (Smith et al., 2015), is utilised to provide context for changes in housing space. Mid-year population estimates (MYEs\(^2\); supplied by the Office for National Statistics (ONS)) for 2015 (to match the 2015 IMD – although note that the 2015 IMD is derived using data for multiple time periods as far back as the 2011 Census) and 2017 (the most recent data at the time of writing), and dwellings counts for the same years\(^3\) (Valuation Office Agency (VOA) data), are used to assess changes in dwellings per person beyond the most recent Census.

The links from 1971, 1981 and 1991 to 2011 LSOAs were undertaken using an overlay procedure whereby:

- The source zones (e.g., 1991 EDs) were overlaid in a GIS package with the target zones (2011 LSOAs).

Table 1 Housing variables, corresponding Census tables, and measures of household space. HH is households. Note that, for 1971, HH data were supplied as rates (per 1000; SAS18) and these were converted to counts using total HH counts (from SAS19)

| Year   | 1971 | 1981 | 1991 | 2001 | 2011 |
|--------|------|------|------|------|------|
| Usual residents (total and in HH) | SAS01 | SAS01 | SAS01 | KS001 | KS101 |
| Number of dwellings | N/A | N/A | SAS61 | UV055 | KS401 |
| Average household size | SAS01, SAS18 | SAS01, SAS10 | SAS01, SAS20 | KS001, KS018 | KS101 |
| Average number of rooms per person | SAS19 | SAS14 | SAS22 | KS001, KS019 | KS403 |
| Overcrowding | SAS18, SAS19 | SAS10 | SAS23 | CS052 | QS409 |
| Dwellings per person | Number of dwellings / usual residents |
| Overcrowding | Percentage of households with more than one person per room |
| Rooms per person | Average number of rooms per person |
| Average household size | Usual residents in HH / No. households |

\(^2\) https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimates

\(^3\) Table CTSOP1.1: Number of properties by Council Tax band and region, county, local authority district and lower and middle super output area; available from https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2017; note that counts are rounded to the nearest 10 with counts of zero being reported as "0" and counts fewer than 5 reported as negligible and denoted by ".".
Postcode locations for the closest possible year (see Lloyd et al., 2017 for more details) were then linked to the overlay, so that the number of postcodes was determined for each area of intersection between the source and target zones. The areas of the intersecting zone segments and the postcode counts were used to estimate the proportion of the source zone count which should be assigned to each LSOA segment (this is termed areal weighting; see Lloyd, 2014). The LSOA segment boundaries were dissolved and the estimated count for each segment combined to give a final LSOA level count.

The 2001 LSOA counts were assigned to 2011 LSOAs using the lookup table provided by the Office for National Statistics. The lookup was considered suitable since only some 2.5% of the 2001 LSOAs were changed as a result of the 2011 Census and so a more complex postcode-based lookup was unnecessary. The lookup specifies four categories: LSOAs which were the same in 2001 and 2011 (coded ‘U’, for unchanged), merging of two or more 2001 LSOAs resulting in larger LSOAs in 2011 (coded ‘M’), split 2001 LSOAs resulting in smaller LSOAs in 2011 (coded ‘S’), and LSOAs for 2001 and 2011 where the relationship is “irregular and fragmented” (coded ‘X’), and so a simple join is not possible. In this latter case, the centroid of the 2001 LSOA is used to link it to a single 2011 LSOA. Note that some of the largest numerical changes are within 2001 LSOAs which split to form several 2011 LSOAs. In these rare cases it may be difficult to separate genuine population change (2001 LSOAs were split because of population growth) from an incorrect assignment of 2001 counts to 2011 LSOAs. In some instances, smaller zones (Output Areas) can be used to assess the nature of these changes. However, in most cases this is not possible and LSOAs which have been split in this way are indicated in the PopChange resource so that users are aware of the need to interpret their findings with care. To clarify, all LSOAs are included in the PopChange resource but analyses of change using these split LSOAs may, in some cases, not accurately reflect local-level changes.

**Changes in Household Space, 1971–2011**

This paper focuses on four measures of household space:

1. Dwellings per person: total dwellings / total persons (including non-household residents)
2. Overcrowding: percentage of households with more than 1 person per room
3. Rooms per person: total rooms / total persons (including non-household residents)
4. Average household size: mean average number of household residents per household

Dwellings per person is simple to compute given only data on dwellings and people (here total persons) and provides a useful headline figure, especially in relation to assessments of house building / availability.
Overcrowding explicitly relates rooms within a given household to the number of occupants (thus, it can only be calculated if data on individual households and rooms in each household are available). This property means that it has been a key focus of research and also policy, as noted in the introduction.

Rooms per person builds on dwellings per person, but properly reflects (albeit indirectly) dwelling spaces.

Average household size has a rather different focus to the previous three measures as it need not imply limited housing space if many rooms (relative to numbers of occupants) are available. It is an important accompaniment to the other three measures.

Results using each of these measures is assessed in turn, with a focus on trends through time in neighbourhoods across England. Relationships between the measures are discussed later in the paper.

### Dwellings and People

Dwellings were not counted in the 1981 Census (or the 1971 Census) but were included in the 1991 Census following pressure from central government departments, local and health authorities (Thompson, 1995). Estimating dwellings counts from the available household data was judged to be inadequate and the level of uncertainty was considered too high. Table 2 shows the number of dwellings and persons in each of the nine regions of England in 1991, 2001, and 2011. The total numbers of dwellings and persons for each year for England as a whole are also given. Total persons rather than persons in households are used for consistency with analyses for the post 2011 Census period (see Section 5), for which small area household resident counts are not available. The number of households, rather than individuals, would (if known) better enable assessment of how far there is pent up demand associated with households sharing

| Region                  | Dwellings | Persons |
|-------------------------|-----------|---------|
|                         | 1991      | 2001    | 2011    | 1991      | 2001    | 2011    |
| East                    | 2,092,532 | 2,307,867 | 2,531,907 | 5,051,235 | 5,388,140 | 5,846,965 |
| East Midlands           | 1,633,309 | 1,796,637 | 1,971,514 | 3,951,045 | 4,172,174 | 4,533,222 |
| London                  | 2,911,421 | 3,090,364 | 3,358,163 | 6,672,713 | 7,172,091 | 8,173,941 |
| North East              | 1,072,138 | 1,114,933 | 1,178,269 | 2,542,049 | 2,515,442 | 2,596,886 |
| North West              | 2,792,017 | 2,944,984 | 3,143,898 | 6,723,170 | 6,729,764 | 7,052,177 |
| South East              | 3,097,324 | 3,391,885 | 3,694,388 | 7,485,034 | 8,000,645 | 8,634,750 |
| South West              | 1,967,464 | 2,180,719 | 2,401,289 | 4,605,717 | 4,928,434 | 5,288,935 |
| West Midlands           | 2,078,133 | 2,224,648 | 2,376,728 | 5,146,780 | 5,267,308 | 5,601,847 |
| Yorkshire and The Humber| 2,020,433 | 2,154,706 | 2,319,910 | 4,832,396 | 4,964,833 | 5,283,733 |
| England                 | 19,664,772 | 21,206,743 | 22,976,066 | 47,010,138 | 49,138,831 | 53,012,456 |
dwellings, but would not by itself shed light on problems of constrained household formation. Household formation is affected by the availability of suitable housing, and when housing supply matches demand then household size tends to fall (partly due to people demanding more space per person as incomes rise, and partly due to demographic trends leading to rising numbers of single-person or childless households) (see Bramley et al., 2010).

In England as a whole the number of dwellings grew 8% between 1991 and 2001, while the number of people grew 4.5%—indicating a growing amount of space per person. Between 2001 and 2011 both dwellings and people grew by 8%. London stands out as the only region where growth in people outpaced growth in dwellings in both decades. As will be shown, however, in every other region there were some neighbourhoods where housing growth failed to keep up with growth in the population. The number of dwellings per person in each Census year (derived from Table 2) is shown in the Appendix Table 7. Only in London did the number of dwellings per person decrease over the period 1991 to 2011. It is worth nothing that the coefficient of determination for the total number of persons and total household residents in 2011 is 0.808; there is a relatively small number of LSOAs within which the total number of people is much larger than the number of residents in households (due to student halls of residence and other communal establishments) and so the general geographical trends are robust.

Between 1971 and 2011 there were population decreases in many urban areas of England including Newcastle, Manchester, Liverpool, Birmingham and central London, with increases in the outskirts of London and other areas across, most notably, the south east of England. There is evidence for counter-urbanisation from areas with higher population densities between 1971 and 1981, followed by a gradual increase in urbanisation from 1981 to 2001, and a large increase from 2001 to 2011 (see Lloyd et al., 2017, and also Champion (Ed.) 1989, and Champion, 2008, on more recent trends). Did housing provision keep up with this renewed urban population growth? Fig. 1 shows the ratio of dwellings to persons in (a) 2011 and (b) the change between 2001 and 2011 (in practice, 2011 counts minus 2001 counts to give positive values for increases and negative values for decreases). Note that in the maps blue colour ranges are used for single timepoints and a spectral range for maps of changes and for maps of years with the maximum value of a given measure. In 2011, the numbers of dwellings per person was consistently smaller in urban areas than elsewhere, although in the most expensive parts of central London (largely in the boroughs of Westminster and Kensington and Chelsea) there are relatively large numbers of dwellings per person due to high rates of second home ownership. The largest decreases in dwellings per person between 2001 and 2011 were in outer London and in other urban areas including Birmingham.

Figure 2 shows change in dwellings per person between 2001 and 2011 against initial (2001) population density. In every region, more densely populated neighbourhoods tended to see the smallest increase or the greatest decrease in dwellings per person, consistent with a pattern of housing supply failing to keep up with resurgent population growth in the centres of towns and cities. Figure 2 shows that the relationship between change and initial density was stronger in regions other than London, where typical densities are higher than in other regions and where
neighbourhoods throughout the density distribution tended to see a fall in dwellings per person (although Fig. 1B above shows that there were increases in dwellings per person in a few central London neighbourhoods).

Fig. 1 Dwellings per person: (A) 2011, (B) 2001–2011
Overcrowding declined markedly across England between 1971 and 1981 (see Table 3) before levelling off in most regions and then increasing in London (starting...
in the 1990s) and the wider south east and midlands (in the 2000s), corresponding to evidence for counter-urbanisation from areas with higher population densities between 1971 and 1981, followed by a gradual increase in urbanisation from 1981 to 2001, and a large increase from 2001 to 2011 (see Gleeson, 2015a). The overcrowding rate had been falling continuously since the 1930s (see chart 5.12 in Gleeson, 2015b), and while housing supply in the UK was acknowledged to be relatively unresponsive to demand (see Barker, 2004), population growth from around

![Diagram](https://example.com/diagram.png)

**Fig. 2** Change in dwellings per person by initial density 2001–2011

**Table 3** Percentage of households overcrowded (>1 persons per room), 1971–2011

| Region                  | 1971 | 1981 | 1991 | 2001 | 2011 |
|-------------------------|------|------|------|------|------|
| East                    | 4.31 | 2.30 | 1.49 | 1.22 | 1.44 |
| East Midlands           | 4.99 | 2.84 | 1.58 | 1.21 | 1.33 |
| London                  | 8.43 | 5.28 | 4.12 | 4.97 | 5.84 |
| North East              | 8.44 | 3.95 | 1.60 | 1.20 | 0.99 |
| North West              | 6.31 | 3.63 | 1.93 | 1.45 | 1.35 |
| South East              | 4.39 | 2.39 | 1.67 | 1.31 | 1.57 |
| South West              | 4.44 | 2.23 | 1.44 | 1.00 | 1.13 |
| West Midlands           | 6.76 | 3.98 | 2.37 | 1.81 | 1.87 |
| Yorkshire and The Humber| 5.86 | 3.42 | 1.92 | 1.56 | 1.63 |
| England                 | 6.05 | 3.39 | 2.11 | 1.89 | 2.10 |
the mid-1990’s onwards was generally higher than expected (see OBR, 2017) while housing supply was also hit by the (mostly unanticipated) global financial crisis.

Overcrowding follows similar trends to dwellings per person (Table 2) and changes in the two variables over the period 2001 to 2011 are strongly correlated (the coefficient of determination is 0.82). There are some differences at a regional level – whereas overcrowding in the south east increased between 2001 and 2011, the overall numbers of dwellings per person grew, suggesting a growing inequality of space per person (see Tunstall, 2015).

The region-level summaries again mask considerable variation, and local-level data are essential for understanding the changing spatial distributions of overcrowding. In 2011, overcrowding rates were high in outer London and in Birmingham, as well as in some other urban areas (see Fig. 3A). By far the most marked change between 1971 and 2011 was in outer London where there were large increases (Fig. 3B). Taking the period 2001 to 2011 specifically, large increases in overcrowding are evidenced in London but also in Birmingham (Fig. 3C). An increase in overcrowding in London relative to the rest of the country is observed by Gregory et al., (2001; where overcrowding is defined as > 1.5 persons per room) over a much longer time period — 1901 to 1991. Gregory et al. show that, while overcrowding rates fell sharply between 1901 and 1991, there was an increase in the inequality of overcrowding rates at the national level, and the rank of London’s overcrowding rate among regions rose over time. Figure 3D shows the Census year in which overcrowding was highest in each LSOA – in most areas 1971 saw the highest overcrowding, but a band of LSOAs with their largest values in 2011 is apparent in outer London. At the national level overcrowding fell over the course of the second half of the twentieth century (see also Gleeson, 2015b, Chart 5.12 which demonstrates this trend for areas within London over the period 1931 to 2011), and since the 1990s has only increased in pockets, so given that measurement starts in 1971, that would be expected to be the most common maximum.

The increasingly strong contrast in overcrowding between urban areas and elsewhere corresponds to an increase in housing space inequalities. One way to represent these inequalities is to use an index of segregation. Here, the index of dissimilarity ($D$; see Lloyd, 2015 for an analysis of multiple demographic and socio-economic variables including housing tenure) is used to measure the geographical ‘spread’ of overcrowded households relative to those which are not overcrowded. The index would take a value of zero if all LSOAs had the same proportions of households in both categories (for example, 80% not overcrowded and 20% overcrowded households in each LSOA – a completely even spread). The maximum possible value is one – this would indicate a case where all LSOAs comprise 100% non-overcrowded households or 100% overcrowded households (a completely uneven spread). Table 4 shows the index value for each Census year. In line with the maps, the figures show a decade-on-decade increase in unevenness, signalling an increased polarisation between areas with high and low rates of overcrowding. Note that the segregation measure requires counts of two groups, such as overcrowded household and non-overcrowded households. Overcrowding is the only measure of household space which can be dichotomised in this way.
The largest increases in overcrowding between 2001 and 2011 tended to be in areas with increases in the proportions of people from Black, Asian and Minority Ethnic (BAME) groups; there is a strong negative correlation between White British % and Overcrowding % in 2011 ($r^2 = 0.71$), and a moderate correlation...
between the changes in these two variables between 2001 and 2011 ($r$ squared = 0.21). BAME groups are more likely to live in the private rented and social rented sectors, which absorbed all of the increase in overcrowding in this period (MHCLG,
2018). For more on this topic, see Finney and Harries (2015), and Johnston et al. (2016), who focus on London.
To more fully understand the determinants of change in overcrowding, a regression model was constructed which seeks to explain changes in overcrowding between 1971 and 2011. The selection of independent variables was guided by the
previous analyses, the literature, and via stepwise selection. The results (Table 5) suggest that overcrowding generally increased when:

- The total population rose
- Places were less overcrowded in 1971
- Average household size rose
- The total number of households fell (likely driven by the greatest increases in the number of households being seen in places that were relatively low density in 1971)
- The private rented sector grew
- The social rented sector shrank
- Unemployment grew
- The White British share of the population was low in 2011.

The overcrowding in 1971 coefficient sign reflects the marked increase of overcrowding in areas which had previously low levels—outer London is the most obvious case. Changes in private renting and social renting are strongly correlated but tests for multicollinearity (including the condition number and variation inflation factors; see Belsley et al., 1980) do not suggest that either variable should be removed from the model.
The analysis in Bramley et al. (2010) demonstrates that higher levels of overall new housing supply and the supply of social housing, in particular, would tend to increase household formation (thereby lowering average household size) and reduce overcrowding (see pp. 10–11). The relatively low levels of housebuilding in England and the shrinkage of the social housing sector (reflected in the model outputs) are therefore part of the explanation for the observed patterns.

The spatial trends in overcrowding between 1971 and 2011 are complex. One way of better understanding the differences and commonalities in trajectories between areas is to employ a classification of these trajectories. The R (programming environment; R Core Team, 2017) package kml (Genolini et al., 2015) implements a version of $k$-means clustering adapted to time-series data such as those analysed here. In this case, the overcrowding percentages for each of the five time points are logged and then the clustering procedure is used to group LSOAs which have similar trajectories. Figure 4 shows median log overcrowding by clusters determined using the kml package. The clusters themselves are mapped in Fig. 5. Most area types correspond to consistently decreasing overcrowding over the period 1971 to 2011. Clusters E and F (concentrated in parts of London and Birmingham, and some other urban areas) show high median levels of overcrowding at all time points. Cluster F (with most notable concentrations in parts of outer London) shows its lowest median levels of overcrowding in 1991, with a subsequent increase. Clusters A (dominating more rural areas across England) and C (found across England, with a particular concentration in the north east) start from relatively high levels and both show considerable decreases over the time period. The map shows clearly that similar overcrowding trajectories are found in different areas of the country, and the distinctions between areas with high or low population densities are obvious.
The trajectory classifications were linked to the Output Area Classification super groups (ONS, 2022) and the two classifications were cross-tabulated (Table 6). This enables a fuller assessment of trajectories for particular types

Fig. 5 Overcrowding trajectory clusters
of areas. Note that the OAC is for one time point (2011) only. There are clear trends for some OAC super groups. For example, over 80% of the OAC super group ‘London Cosmopolitan’ is in clusters E or F (39% and 42% respectively). Clusters E and F have high levels of overcrowding at all time points, with small increases in overcrowding between 2001 and 2011. Some 47% of ‘English and Welsh Countryside’ LSOAs are in cluster A – representing a decrease in overcrowding year-on-year from 1971 to 1991 and relative stability between 2001 and 2011. For ‘Mining Heritage and Manufacturing’, 33% are in cluster A and 29% are in cluster C (with higher levels of overcrowding than in cluster A, but the same general trend over time). In the case of ‘Prosperous England’, 38% are in cluster A while 30% are in cluster B – with the lowest levels of overcrowding at all time points and decreasing levels between 1971 and 1991, and relative consistency between 1991 and 2011.

**Rooms per Person**

The average number of rooms per person is central to the debate over housing space inequality (Tunstall, 2015) and whether there is a shortage of housing or just a poor distribution. Over the period 1911 to 2011, Tunstall notes that the population of England and Wales doubled while the number of rooms tripled, and the rate of ‘low absolute housing consumption (overcrowding)’ reduced from 49 to 4%. However, while inequality in rooms per person, as measured using the Gini coefficient, reduced from the 1920s to the 1980s, it grew again from the 1990s and by 2011 had reached levels not seen for at 50 years. Tunstall offers several possible explanations — increased income inequality, a reduction in social housing, a rise of one person households, and the development of larger homes. While housing stock continued to grow after the 1980s, the space which was available to the least well-housed ten percent of the population did not rise, resulting in an increased unevenness in housing space. Gleeson (2015a) argues that the trends identified by Tunstall can be explained in large part by a growing spatial mismatch between the distribution of population and housing stock in recent decades, as urban population growth outpaced housing supply. In this section we use neighbourhood level data to shed light on this debate.

### Table 6 Overcrowding trajectory clusters by OAC supergroup

| OAC supergroup                          | A  | B  | C  | D  | E  | F  | Sum |
|----------------------------------------|----|----|----|----|----|----|-----|
| Business and Education Centres        | 15.8| 15.3| 22.3| 20.6| 20.1| 5.9| 100 |
| Coast and Heritage                     | 26.7| 33.5| 10.8| 23.1| 5.9 | 0.1| 100 |
| English and Welsh Countryside          | 47.2| 29.8| 11.1| 10.3| 1.6 | 0.0| 100 |
| London Cosmopolitan                   | 1.3 | 0.8 | 7.3 | 9.2 | 39.1| 42.3| 100 |
| Mining Heritage and Manufacturing      | 33.1| 17.4| 29.1| 10.5| 8.0 | 1.9| 100 |
| Prosperous England                    | 38.3| 30.4| 10.2| 16.7| 4.2 | 0.2| 100 |
| Suburban Traits                        | 13.5| 18.0| 11.3| 26.9| 22.5| 7.8| 100 |
The spatial distribution of the number of rooms per person broadly mirrors the map of overcrowding, and for this reason maps of rooms per person are not included here. The number of rooms per person was clearly fewer in LSOAs in urban areas than elsewhere. For the period 1971 to 2011, the number of rooms per person decreased, or increased by only a small amount, in many urban areas. The most obvious trend in the number of rooms per person between 2001 and 2011 is a decrease in London (corresponding to increased overcrowding, as illustrated in Fig. 3C) and the south east. While in most areas the Census year in which the number of rooms per person was smallest in each LSOA was 1971, there are notable exceptions, especially parts of the north of outer London where figures were smallest in 2011, plus a few areas where figures were smallest in 1981. A reduction in the number of rooms per person between 2001 and 2011 in outer London and, to a lesser degree, other urban areas is also observed by Dorling and Thomas (2016). Figure 6 shows change in rooms per person by initial density, 2001–2011. The plot for London indicates that the number of rooms per person fell in most areas while the figure increased in most areas of all other regions, although more densely populated areas saw a decrease in the number of rooms per person.

**Household Size**

Households are, on average, larger in urban areas (particularly London, Birmingham, and Manchester) than elsewhere (Fig. 7A). Between 1971 and 2011, the average household size increased by more than one person in many parts of London (especially in parts of the east of London) and other urban areas including Birmingham,
Bradford, and Oldham (Fig. 7B). This broad spatial pattern is also found between 2001 and 2011 specifically, as shown in Fig. 7C. Note that the maximum increase of 2.66 in Fig. 7C corresponds to a zero household count in 1971 (in this case, the household size was recorded as zero in 1971 and 2.66 in 2011); the maximum
increase where there were households in 1971 and 2011 is 2.40. Average household sizes were at their largest in most LSOAs in 1971 or 1981, but in some parts of London and other urban areas average household sizes were largest in 2011. As was shown previously, overcrowding is largest in areas with large BAME populations,
and the same is true of areas with large average household sizes. Catney and Simpson (2014) show that high average numbers of adults per household for South Asian groups persisted over the period 1991–2001. Over this time period economic
circumstances improved for these groups, suggesting that preferences, rather than economic situations, drive household sizes. This is supported by the decline in overcrowding which was more marked for the Pakistani and Bangladeshi groups than
for other groups. If there was an economic driver for large average household sizes, reduced overcrowding would be expected to be associated with a decline in average household sizes (in terms of adult sharing). Rather, reduced overcrowding in these groups is associated with a decline in fertility. In contrast, in London there is evidence that large household sizes are at least in part an involuntary consequence of the housing shortage. For example, Bentley and McCallum (2019) find that increases in household size and in young adults living with parents at regional level are linked to house price growth, suggesting a causal relationship between housing supply shortfalls and larger household sizes.

Figure 8 shows change in average household size by initial density, 1971–2011. Across England as a whole, the average household size fell between 1971 and 2011, but least of all in places with higher population densities in 1971; at regional levels the East and North East buck this trend, with similar declines in average household sizes throughout the density distribution.

Focusing on the latter half of this period and plotting the change in average household size between 1991 and 2011 by initial (1991) density (Fig. 9) shows some trends in common with change between 1971 and 2011 (Fig. 8). However, this time there is a positive relationship between initial density and change in average household size in every region, and most neighbourhoods in London see rising average household sizes.
Correlations Between Measures of Housing Space

The measures used in this study are distinct but inter-related: the degree of similarity can be measured using the Spearman’s rank correlation coefficient (indicated by $r_s$). Values close to -1 or 1 suggest that the two measures contain the same information (they are strongly related), while values close to zero indicate that the measures contain distinct information. There is a strong relationship (with a correlation coefficient ($r_s$) of -0.83) between overcrowding and rooms per person, and weaker correlations between overcrowding and average household size ($r_s=0.21$), and average household size and rooms per person ($r_s=0.30$). When the number of rooms per person in a household falls below 1 (or equivalently, persons per room rises above 1) it is considered overcrowded. An area with a highly unequal distribution of housing may therefore have an overcrowding problem even if its values on the other measures are not unusual.

Dwellings and People, 1991–2017

In this final analysis section, Census data on people and dwellings (utilising Census data for 1991, the earliest for which relevant data are available), 2001, and 2011) are complemented by administrative data for 2015 and 2017, building on Sect. 3.1. The other measures of housing space cannot be captured using freely-available...
administrative data, and so this element necessarily focuses on numbers of dwellings and people. This component of the analysis is particularly relevant in the context of changes to Census questions between 2011 and 2021, with no question on total

**Fig. 10** Dwellings per person: (A) 2017, (B) 2011–2017, (C) Census or administrative data year with the fewest dwellings per person
numbers of rooms in the 2021 Census (just the number of bedrooms in England), and the planned use of VOA data by the ONS to derive statistics on numbers of rooms. Given this, and the likelihood that the 2021 Census will be the last, conventional measures of overcrowding may not be available in future years. Moreover, local authority
analysts are most interested in the ‘contemporary’ state of housing space and the preceding sections should be seen as vital context for this more recent perspective.

Figure 10 shows (A) dwellings per person in 2017 (sum of VOA council tax band counts / mid-year estimates; see Sect. 3), (B) change in dwellings per person...
in 2011–2017, (C) minimum year (the Census or administrative data year with the smallest number of dwellings per person, for 1991 to 2017). The map of dwellings per person for 2017 (Fig. 11A) exhibits similar trends to the equivalent map for 2011 (Fig. 1A), with the smallest values in parts of outer London and some other urban areas. There are no clear spatial trends to changes in dwellings per person between 2011 and 2017 (Fig. 10B), although the geography of minimum dwellings/person has some distinct features including a large number of LSOAs in London and the south east generally (and scattered neighbourhoods in other regions) which had a smaller number of dwellings per person in either 2015 or 2017 than in any of the three Census years. This is a graphic depiction of the degree to which housing provision is falling behind population growth in these areas.

An alternative perspective is offered by Fig. 11, which provides histograms of change (1991–2001, 2001–2011, and 2011–2017) in dwellings per person, for each of the regions of England. The contrast between London and all of the other regions is obvious for all three time periods – with the number of dwellings per person in the majority of LSOAs in London decreasing over all three time periods. In the other regions, the majority of LSOAs saw increases in dwellings per person – although there is considerable variation, and all regions include some LSOAs with declining numbers of dwellings per person, particularly in 2011–17. Figure 11 suggests that there are proportionally fewer LSOAs with increases in the number of dwellings per person over the period 2011–2017 than between 1991 and 2001, and between 2001 and 2011. This may be, in part, a function of differences in the data (Census as compared to VOA data)

![Change in dwellings per person: Dwellings/person 2001 minus 1991, 2011 minus 2001, 2017 minus 2011](image)

**Fig. 11** Change in dwellings per person: Dwellings/person 2001 minus 1991, 2011 minus 2001, 2017 minus 2011
although the general trends appear to be robust and they fit with a picture of year on year decrease in housing space in parts of London when Census data alone are used. The east London borough of Newham had the highest levels of overcrowding of any LA in England in 2011, and these levels appear to be rising. Newham was the LA with the top lack of supply rank in the index presented by Hudson (2018). Some 81 of a total 164 LSOAs (49%) in Newham had fewer dwellings per person in 2017 than in any previous year. Butler (2015) reports an extreme case, where 26 people were found living in a three-bedroom home in Newham. Some 1935 of a total 32,844 LSOAs had their largest overcrowding figures in 2011. Of those LSOAs and ranking from the largest to the smallest percentage for 2011, 86 of the 100 most overcrowded LSOAs were in London. Of these, 44 were in Newham and 15 were in Brent. These 100 LSOAs had a population growth of 7.1% between 2011 and 2015 (2015 count minus 2011 count / 2011 count), compared to a figure of 3.3% for all of England. Of the top 20 most overcrowded LSOAs, 16 were in Newham, 3 in Brent, and one in Oldham, Greater Manchester. Thus, the most overcrowded LSOAs tend to have populations which continue to grow at a rapid rate. In addition, they often have fewer dwellings per person in 2015 or 2017 than in any Census year of those considered. They also tend to be in the most deprived areas (top 20% by the 2015 IMD), to have high and growing population densities, large proportions of private rented households, a higher share of private rented housing in 2011 than in previous years, large BAME populations, and more terraced housing or flats/apartments/etc. than other types of accommodation (semi-detached and detached housing). Pressures on housing in such areas are clearly intense and their population and housing profiles, as well as information on rates of change, should be used to design appropriate policies to alleviate these pressures.

Conclusions

The paper reveals multiple features of the changing local geographies of households in England between 1971 and 2011, with insights into possible local increases in demand for housing using administrative data for 2015 and 2017. The results suggest that, while there is now more housing space available per person than before in most neighbourhoods, inequalities in household space are the highest they have been. Specific findings are that:

- While at the national level growth in the number of dwellings between 2001 and 2011 outpaced growth in household residents, the population grew faster than the housing stock in the London region and in some parts of every other region.
- The most pronounced trends in overcrowding between 1971 and 2011, and between 2001 and 2011 specifically, were increases in outer London.
- The number of rooms per person declined in much of the wider south east between 2001 and 2011.
- In some neighbourhoods in London and the south east generally there was a smaller number of dwellings per person in either 2015 or 2017 than in any of the three Census years for which data are available (1991, 2001, and 2011).
• Reductions in housing space per capita were greatest in the densest neighbourhoods of most regions, highlighting the specifically urban nature of contemporary housing shortages.

The present paper is part of a programme of work on local-level changes in populations (e.g., Lloyd et al., 2017) and housing (see Lloyd & Gleeson, 2018 on housing tenure change). The availability of a wide array of population and housing variables for multiple time periods opens up possibilities to build a sophisticated understanding of the ways in which neighbourhoods have changed, and the challenges these areas are facing. As an example, it is possible to assess how local-level changes in overcrowding (or other measures of household space) might relate to health status or other outcomes.

The PopChange resource could be expanded in multiple ways. VOA data (as used here to estimate dwelling numbers) have been assessed for their ability to measure characteristics such as numbers of rooms and bedrooms, and housing stock characteristics. Data on house prices, for example, could also be used to enhance understanding of local housing demand. In line with the use of VOA data in this paper, these approaches could remove reliance on decadal Census data for spatial analysis of some household characteristics. The ONS have concluded that “the VOA data are of sufficient statistical quality to replace one or both of the questions on rooms and bedrooms in the 2021 Census”. The VOA data do provide important insights into the number of dwellings and estimates can (with Mid-year population estimates used as denominators) be regularly updated. However, the VOA data do not equal the richness of Census data. For instance, overcrowding cannot be estimated without knowing how many rooms are available to each self-contained household. Given that the different measures of household spaces are not necessarily strongly related, the loss of Census questions on the number of rooms is unfortunate. Despite these shortcomings, the VOA data could be used more widely to highlight fine-grained variation in the nature of the housing crisis to inform local policy making and service provision. The PopChange housing change resource can be used to support schemes for alleviating local housing pressures and it can be added to using any recent data available for LSOAs (albeit with future changes in LSOAs necessitating some form of ‘look up’ between old and new zones). All of the data used in the present analyses are freely available as a part of the PopChange resource and additional variables and time points will be added to the resource in due course. The production of data from future Censuses (or administrative data sources) on fixed geographies, as well as geographies that change over time, would obviously make

4 https://www.ons.gov.uk/census/censustransformationprogramme/administrativedata/censusproject/datasourceoverview/valuationofficeagencydata
5 https://www.ons.gov.uk/peoplepopulationandcommunity/housing/bulletins/housepricestatisticsformallareas/yearendingjune2017
6 https://www.ons.gov.uk/census/censustransformationprogramme/questiondevelopment/housingcommunalestablishmentsandvisitors/estimatingthenumberoffroomsandbedroomsinthe2021censusanalternativeapproachusingvaluationofficeagencydata
7 https://www.qub.ac.uk/research-centres/GIS/Research/PopChange/
analyses of change through time more straightforward. The production of population grids (e.g., 1 km grid cells, which unlike LSOAs are not based on the population structure at any given time point) as a planned output from the 2021 Census is a step in this direction, assuming that other data will also be provided in a grid format.

Local area (per local authority) housing space profiles (and associated data) summarising changes in overcrowding since 1971 and dwellings per person since 1991 have been disseminated to LAs across England. These were refined in consultation with LA analysts. Discussion around the resource and the analyses strongly suggested that the post 2011 element is considered a key feature and the ability to regularly update the resource is important. Thus, VOA data (and potentially other sources) will provide a focus of future work.

The PopChange resource provides a powerful tool for local authorities to chart local-level changes in housing characteristics. It can be used to, for example, identify neighbourhoods with a rapid growth in overcrowding, or areas with rapid population growth but only a slow increase in dwelling numbers. While LAs provide the basis for reallocation of central government funds, housing characteristics are highly spatially variable and local-level data are essential in the design and implementation of meaningful policies on housing provision, and reduction of housing inequalities between population sub-groups and between regions and neighbourhoods. Data on local-level trajectories in housing change should be a core part of such processes.

### Table 7 Dwellings per person in 1991, 2001 and 2011

| Region                  | 1991 | 2001 | 2011 |
|-------------------------|------|------|------|
| East                    | 0.414| 0.428| 0.433|
| East Midlands           | 0.413| 0.431| 0.435|
| London                  | 0.436| 0.431| 0.411|
| North East              | 0.422| 0.443| 0.454|
| North West              | 0.415| 0.438| 0.446|
| South East              | 0.414| 0.424| 0.428|
| South West              | 0.427| 0.442| 0.454|
| West Midlands           | 0.404| 0.422| 0.424|
| Yorkshire and The Humber| 0.418| 0.434| 0.439|
| England                 | 0.418| 0.432| 0.433|
Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Barker, K. (2004). Review of Housing Supply. Final Report – Recommendations. London: HMSO.
Bentley, D. and McCallum, A. (2019). Rise and Fall: The Shift in Household Growth Rates Since the 1990s. London: Civitas. https://www.civitas.org.uk/content/files/riseandfalltheshiftinhousholdgrowthrateassincethe1990s.pdf. Accessed 9 June 2022.
Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. Wiley.
Bramley, G., Pawson, H., White, M., Watkins, D. and Pleace, N. (2010). Estimating Housing Need. London: Department for Local Government and Communities. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6338/1776873.pdf. Accessed 9 June 2022.
Butler, P. (2015). Housing raid finds 26 people living in three-bedroom east London home. The Guardian, 25th June 2015. https://www.theguardian.com/society/2015/jun/25/overcrowding-housing-raid-26-living-three-bedroom-east-london. Accessed 9 June 2022.
Catney, G., & Simpson, L. (2014). How persistent is demographic variation between ethnic groups? The case of household size in England and Wales. Population, Space and Place, 20, 201–221.
Champion, T. (Ed.). (1989). Counterurbanisation: The Changing Pace and Nature of Population Deconcentration. Arnold.
Champion, T. (2008). Population change in England since 1981: Is an ‘urban renaissance’ really underway? Geocarrefour, 83, 79–86.
DCLG. (2017). Fixing our Broken Housing Market. Department for Communities and Local Government.
Dorling, D., Ford, J., Holmans, A., Thomas, B., & Wilcox, S. (2005). The Great Divide: An Analysis of Housing Inequality. Shelter.
Dorling, D., & Thomas, B. (2016). People and Places: A 21st-Century Atlas of the UK. Policy Press.
Finney, N., & Harries, B. (2015). Which ethnic groups are hardest hit by the housing crisis? In S. Jivraj & L. Simpson (Eds.), Ethnic Identity and Inequalities in Britain: The Dynamics of Diversity (pp. 141–160). Policy Press.
Galster, G., & Wessel, T. (2019). Reproduction of social inequality through housing: A three-generational study from Norway. Social Science Research, 78, 119–136.
Genolini, C., Alacoque, X., Sentenac, M. and Arnaud, C. (2015). kml and kml3d: R packages to cluster longitudinal data. Journal of Statistical Software, 65(4), 1–34. http://www.jstatsoft.org/v65/i04/. Accessed 9 June 2022.
Gleeson, J. (2015a). Housing – location matters. Town and Country Planning, October 2015a, 461–463.
Gleeson, J. (2015b). Housing in London 2015b. London: Greater London Authority. https://www.london.gov.uk/sites/default/files/housing_in_london_2015_v3.pdf. Accessed 9 June 2022.
Gregory, I. N., Dorling, D., & Southall, H. R. (2001). A century of inequality in England and Wales using standardized geographical units. Area, 33, 297–311.
Hudson, N. (2018). A Housing Crisis? More like a series of local crises needing local solutions. Residential Analysts. http://resi-analysts.com/wp-content/uploads/2018/11/A-Housing-Crisis-2018-10-15-v3.pdf. Accessed 9 June 2022.
Ipsos MORI (2018). Brexit and the NHS top Britons’ concerns, with worry about housing rising. https://www.ipsos.com/ipsos-mori/en-uk/brexit-and-nhs-top-britons-concerns-worry-about-housing-rising. Last accessed 7th January 2018.
Johnston, R., Owen, D., Manley, D., & Harris, R. (2016). House price increases and higher density housing occupation: The response of non-white households in London, 2001–2011. *International Journal of Housing Policy, 16*, 357–375.

Lloyd, C. D. (2014). *Exploring Spatial Scale in Geography*. John Wiley and Sons.

Lloyd, C. D. (2015). Assessing the spatial structure of population variables in England and Wales. *Transactions of the Institute of British Geographers, 40*, 28–43.

Lloyd, C. D., Catney, G., Williamson, P., & Bearman, N. (2017). Exploring the utility of grids for analysing long term population change. *Computers, Environment and Urban Systems, 66*, 1–12.

Lloyd, C. D. and Gleeson, J. (2018). *Housing tenure change in England*. PopChange Briefing 3. Liverpool: Centre for spatial demographics research, University of Liverpool.

Lloyd, C. D., & Gleeson, J. (2020). *Housing Space Change in England*. School of Natural and Built Environment, Queen’s University Belfast.

MHCLG. (2018). *English housing survey 2016 to 2017: Headline Report*. London: Ministry of housing, communities and local government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/705821/2016-17_EHS_Headline_Report.pdf. Accessed 9 June 2022.

MHCLG. (2019). *Housing Supply: Net Additional Dwellings, England*: 2018–19. London: Ministry of Housing, Communities and Local Government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850825/Housing_Supply_England_2018-19.pdf. Accessed 9 June 2022.

OBR. (2017). *The Evolution of Population Projections Since 1955*. London: Office for Budget Responsibility. https://obris.uk/box/the-evolution-of-population-projections-since-1955/. Accessed 9 June 2022.

Office of the Deputy Prime Minister. (2004). *The Impact of Overcrowding on Health and Education: A Review of the Evidence and Literature*. Office of the Deputy Prime Minister.

ONS. (2022). 2011 residential-based area classifications. Titchfield: Office for national statistics. https://www.ons.gov.uk/methodology/geography/geographicalproducts/areaclassifications/2011areaclassifications. Accessed 9 June 2022.

R Core Team (2017) R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. https://www.R-project.org/.

Sasse, T.and Haddon, C. (2018). *How Government can work with Academia*. London: Institute for Government. https://www.instituteforgovernment.org.uk/sites/default/files/publications/IFG_govemment_academia_June_2018_vb.pdf. Accessed 9 June 2022.

Shelter. (2005). *Full House? How Overcrowded Housing Affects Families*. Shelter.

Smith, T., Noble, M., Noble, S., Wright, G., McLennan, D., & Plunkett, E. (2015). *The English Indices of Deprivation 2015 Technical Report*. Department for Communities and Local Government.

Sharkey, P. (2012). Temporary integration, resilient inequality: Race and neighborhood change in the transition to adulthood. *Demography, 3*, 889–912.

Thompson, E., J. (1995) The 1991 Census of Population in England and Wales. *Journal of the Royal Statistical Society, Series A*, 158, 203–40.

Tunstall, B. (2015). Relative housing space inequality in England and Wales, and its recent rapid resurgence. *International Journal of Housing Policy, 15*, 105–126.

Tunstall, R., Bevan, M., Bradshaw, J., Croucher, K., Duffy, S., Hunter, C., Jones, A., Rugg, J., Wallace, A. and Wilcox, S. (2013). The Links between Housing and Poverty: an Evidence Review. York: Joseph Rowntree Foundation. https://www.jrf.org.uk/file/43609/download?token=oS0HCPDp&type=full-report. Accessed 9 June 2022.

Wilson, W. and Barton, C. (2018) Tackling the under-supply of housing in England. Briefing paper 07671. London: House of Commons Library.

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.