Office for National Statistics

Article

Admin-based levels of overcrowding (using the bedroom standard and Valuation Office Agency number of bedrooms), feasibility research: England and Wales: January 2021

Exploration of differences in bedroom occupancy ratings derived from Census 2011 and linked Valuation Office Agency number of bedrooms data. The research demonstrates the potential of deriving levels of overcrowding using the bedroom standard from linked survey and admin data.

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1 . Main points

- This feasibility research builds on our previous work to assess how Valuation Office Agency (VOA) number of bedrooms can be used to supplement censuses and household surveys to produce sub-regional estimates of the level of overcrowding using the bedroom standard.
- Currently, the English Housing Survey (EHS) publishes the most accurate national estimates of levels of overcrowding in England (using the bedroom standard).
- The VOA bedroom standard is typically the same as the census bedroom standard at household level (median difference is zero for all local authorities, while the mean varied between negative 0.2 and 0.1).
- Our analyses indicated that the proportion of overcrowded households is likely to be larger when using the VOA bedroom standard compared with the 2011 Census bedroom standard.
- The VOA bedroom standard produces national levels of overcrowding for social rental that are higher than the levels of overcrowding for private rental households, compared with using the census bedroom standard.
- The differences are most likely driven by the different means and purposes of data collection; VOA excludes rooms incapable of comfortably holding a single bed, and surveys and census allow residents to report communal rooms (which are used for sleeping) as bedrooms.
- Additional care has to be taken when looking at sub-regional comparisons as the level of overcrowding is not consistently higher across the whole of England and Wales; we strongly encourage users to familiarise themselves with the full analysis presented in Section 4.
- Most local authorities (four out of five) would be ranked in the same order based on the level of overcrowding independent of which of the two measures is used.
- The absolute level of overcrowding may be different if the VOA bedroom standard was used, but relative comparisons between areas will often still be possible; this demonstrates the potential for supplementing household surveys with VOA number of bedrooms to produce sub-regional overcrowding statistics in intercensal years.

Disclaimer

This research does not provide official statistics on housing nor is it used in the underlying methods or assumptions in the production of official statistics. Rather, it is published to allow users to understand a new methodology that is different to that used in the 2011 Census to measure the number of bedrooms in households and could be used to measure overcrowding using household surveys in the future. These outputs should not be used for policymaking or decision-making.

It is important that the information and research presented are read alongside the analysis to aid interpretation and avoid misunderstanding. These analyses must not be reproduced without this disclaimer and warning note.

2 . Use of VOA number of bedrooms to measure overcrowding

Measuring overcrowding using occupancy ratings and the bedroom standard

Housing policy is concerned with the availability and quality of housing. Presently, the Office for National Statistics (ONS) collects data and produces outputs on housing statistics. These data and outputs are widely used across central and local government to understand the characteristics of the housing stock as well as living conditions in England and Wales. The 2011 Census collected information on accommodation type, number of rooms and number of bedrooms to meet this need.

Our 2015 user needs consultation for Census 2021 (PDF, 1.59MB) showed that measuring and understanding overcrowding is an area of interest. It was noted that overcrowding is seen as a fundamental indicator of housing deprivation. Living in such conditions is associated with adverse personal and health effects.

Overcrowding is often measured using an occupancy rating. An occupancy rating is obtained by subtracting a hypothetical number of bedrooms (or rooms) recommended for a household from the actual number of bedrooms (or rooms) it has available. A household is considered overcrowded if it has fewer bedrooms (or rooms) available than recommended (negative occupancy rating), or under-occupied if it has more (positive occupancy rating). This makes the occupancy rating a straightforward way of measuring overcrowding and under-occupancy.

In England and Wales, three different standards are commonly used to assess whether the living space available to a household is overcrowded. The Housing Act 1985 defines two of these standards: the room standard and the space standard. The Act states that if a household does not meet these standards it should be classed as overcrowded. However, in 2012 the Department for Communities and Local Government (DCLG, now MHCLG) issued guidance, Allocation of accommodation: Guidance for local housing authorities in England, which recommended that local authorities should use the non-statutory bedroom standard when assessing whether or not households are overcrowded for the purposes of housing allocation.

The bedroom standard allocates a separate bedroom to each:

- adult couple
- any remaining adult (aged 21 years or over)
- two adolescents (aged 10 to 20 years) of the same sex
- one adolescent (aged 10 to 20 years) and one child (aged 9 years or under) of the same sex
- two children (aged 9 years or under) regardless of sex
- any remaining child (aged 9 years or under)

The bedroom standard is the most widely used occupancy rating for number of bedrooms, despite being non-statutory (that is, not written into law).

Using VOA number of bedrooms to supplement household surveys

Currently, the English Housing Survey (EHS) publishes the most accurate national estimates of levels of overcrowding in England (using the bedroom standard) annually. The Welsh Housing Condition Survey (WHCS) collects the equivalent information to estimate levels of overcrowding in Wales, but this is not routinely published. However, both surveys have too small a sample size in order to produce robust sub-regional estimates.

Traditionally, the 10-yearly census fills this gap. However, it is worth noting that the census uses self-reported information provided by the residents living there whilst the EHS and WHCS use trained surveyors. It is worth noting that the levels of overcrowding reported by the census are different to the ones published by EHS (see Section 4).

Recently the Resolution Foundation published occupancy rating tables (PDF, 145KB) using data collected by the Family Resources Survey (FRS). This demonstrated that overcrowding measures that are comparable with existing census and EHS statistics could principally be derived from large-scale surveys, if the underlying measure of the number of bedrooms and household composition are comparable.

Previous research of the feasibility of using Valuation Office Agency (VOA) data to replace the number of bedrooms question on the census, demonstrated that it is feasible to link VOA data to questionnaire data and that VOA data provide a high-quality measure of number of bedrooms. The direct agreement rate between 2011 Census number of bedrooms and VOA number of bedrooms is 76%.

There are some small definitional differences in the way bedrooms are counted on both sources. The VOA excludes rooms incapable of comfortably holding a single bed (approximately anything less than two metres multiplied by two metres) and the census allows residents to report communal rooms (which are used for sleeping) as bedrooms, for example, a living room in a shared student accommodation, even if it was not originally designed for that purpose.

VOA make every effort to collect accurate and up-to-date data and maintain their accuracy, but data updates are primarily linked to the sale of properties. As part of our quality assurance of VOA data used in Census 2021 we noted that there is the potential for distortive effects, which will vary by geography and type of property.

The research in this article builds on our previous work to assess if VOA number of bedrooms can be used to supplement household surveys to produce sub-regional estimates of the level of overcrowding using the bedroom standard.

We have also published our research into replacing the census number of rooms question with VOA number of rooms and how this impacts the room occupancy rating.

3 . Deriving an occupancy rating for VOA number of bedrooms

Using 2011 Census to derive an occupancy rating for VOA number of bedrooms

We require data on household composition and the number of bedrooms to assess the feasibility of producing sub-regional estimates of the level of overcrowding using the bedroom standard. The 2011 Census meets our requirements and has a large sample which allows us to look at and compare small area estimates.

The 2011 Census data was linked to 2016 Valuation Office Agency (VOA) data at address level using unique property reference numbers (UPRNs). Properties in the VOA data that were built after 2011 were removed prior to linkage to enable better comparison with the census data. The 2011 Census records that could not be assigned a UPRN were also removed.

We used the "raw" 2011 Census data to compare 2011 Census responses with the number of bedrooms question with VOA number of bedrooms. This means that the numbers presented here are not adjusted for household and within household non-response and will differ from previously published estimates (as shown in Section 4).

This is the same methodology used in previous research and a more detailed description of the linkage methodology can be found in the previous publication, ONS working paper series number 20 (Section 13).

Statistical differences between 2011 Census number of bedrooms question and VOA number of bedrooms

We have previously explored the relationships between the 2011 Census number of rooms question, as well as VOA number of rooms to the 2011 Census household variables[1] using several linear regressions. We have repeated this analysis for 2011 Census number of bedrooms and VOA number of bedrooms.

2011 Census household variables were used as predictors and the two number of bedrooms variables were outcome variables. Comparing the regression coefficients showed that the relationship between the 2011 Census household variables and the 2011 Census number of bedrooms variable appeared similar to the relationship with the VOA number of bedrooms variable across all of the 2011 Census household variables.

This finding allows us to infer that the 2011 Census and VOA number of bedrooms variables are measuring similar statistical concepts. Tables of these analyses can be found in Section 6.

We expanded on this research by exploring the relationship between 2011 Census household variables and the difference between census number of bedrooms and VOA number of bedrooms. The 2011 Census household variables were used as predictors and the outcome variable was calculated by subtracting the VOA number of bedrooms from census number of bedrooms for each household. Categorical household variables were dummy coded.

If census number of bedrooms and VOA number of bedrooms are truly statistically similar, then we would expect the difference between the two number of bedrooms variables to be random and therefore unrelated to the predictor variables (that is, the unstandardised beta coefficients should be close to zero).

Table 1 shows the results of regression analyses predicting the difference between 2011 Census number of rooms and VOA number of rooms from 2011 Census accommodation type (compared to the base category). The intercept was close to 0 and the unstandardised beta coefficients were close to 0 for all accommodation types. This suggests that on accommodation type, the VOA and census number of bedrooms measure similar statistical concepts.

Detached houses had the largest unstandardised beta coefficient of 0.07. This means that for detached houses the mean number of bedrooms estimated by census is 0.07 more than the mean number of rooms estimated by VOA. It is possible that this occurred because detached houses are more likely to have rooms that have been converted to bedrooms after the property was last sold or bedrooms that are very small. In either case they would not be recorded by the VOA as a bedroom.

Table 1: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census accommodation type, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.04	
Detached	0.07	0.04
Semi-detached	0.03	0.02
Terraced	0.01	0.00
Block of flats	-0.03	-0.02
Converted / shared house	0.01	0.00
Commercial building	0.02	0.00

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Caravan or mobile temporary structure.

2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 2 shows the results of regression analyses predicting the difference between 2011 Census number of rooms and VOA number of rooms from 2011 Census tenure (compared to the base category). Again, the intercept was close to 0. For households that own their property with a mortgage or loan the mean number of bedrooms estimated by the census is 0.11 larger than the mean number of bedrooms estimated by VOA. There is likely a relationship between tenure and accommodation type, which we will explore in more detail in Section 4.

Table 2: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census tenure, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.01	
Owns outright	0.03	0.02
Own with mortgage or loan	0.11	0.07
Shared ownership	0.00	0.00
Rents	0.02	0.01

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Lives here rent free

2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates

The regression results for other 2011 Census household variables can be found in Section 7.

While the census and VOA number of bedrooms measures are very similar, there are also some small differences, which are partially explained by the census household variables. Users will need to be aware of these differences, which are most notable for detached houses and properties owned with a mortgage or loan.

Occupancy ratings for 2011 Census number of bedrooms and VOA number of bedrooms

There are several reasons why we would expect the occupancy ratings for 2011 Census number of bedrooms and VOA number of bedrooms to measure a similar statistical concept. Firstly, both census and VOA bedroom occupancy ratings are calculated using the number of bedrooms hypothetically required by a household. In both cases, the number of bedrooms required is derived from the census questionnaire response using the number of household members and their relationships to each other (see Section 2). Secondly, we found that census number of bedrooms and VOA number of bedrooms measure similar statistical concepts.

Finally, the bedroom occupancy rating (or bedroom standard) is simply the difference between hypothetical number of bedrooms required and the actual number of bedrooms available. Therefore, we expect the census bedroom standard and VOA bedroom standard to measure a similar statistical concept and be the same in most cases.

Our further analysis has demonstrated that this is indeed the case. We found the median difference between VOA bedroom standard and 2011 Census bedroom standard was zero for all local authorities, while the mean varied between negative 0.2 and 0.1.

Notes for Deriving an occupancy rating for VOA number of bedrooms

1. The census household variables are:

- number of usual residents
- accommodation type
- landlord
- tenure
- number of bedrooms
- central heating
- number of cars or vans

4 . Levels of overcrowding using the bedroom standard and VOA number of bedrooms

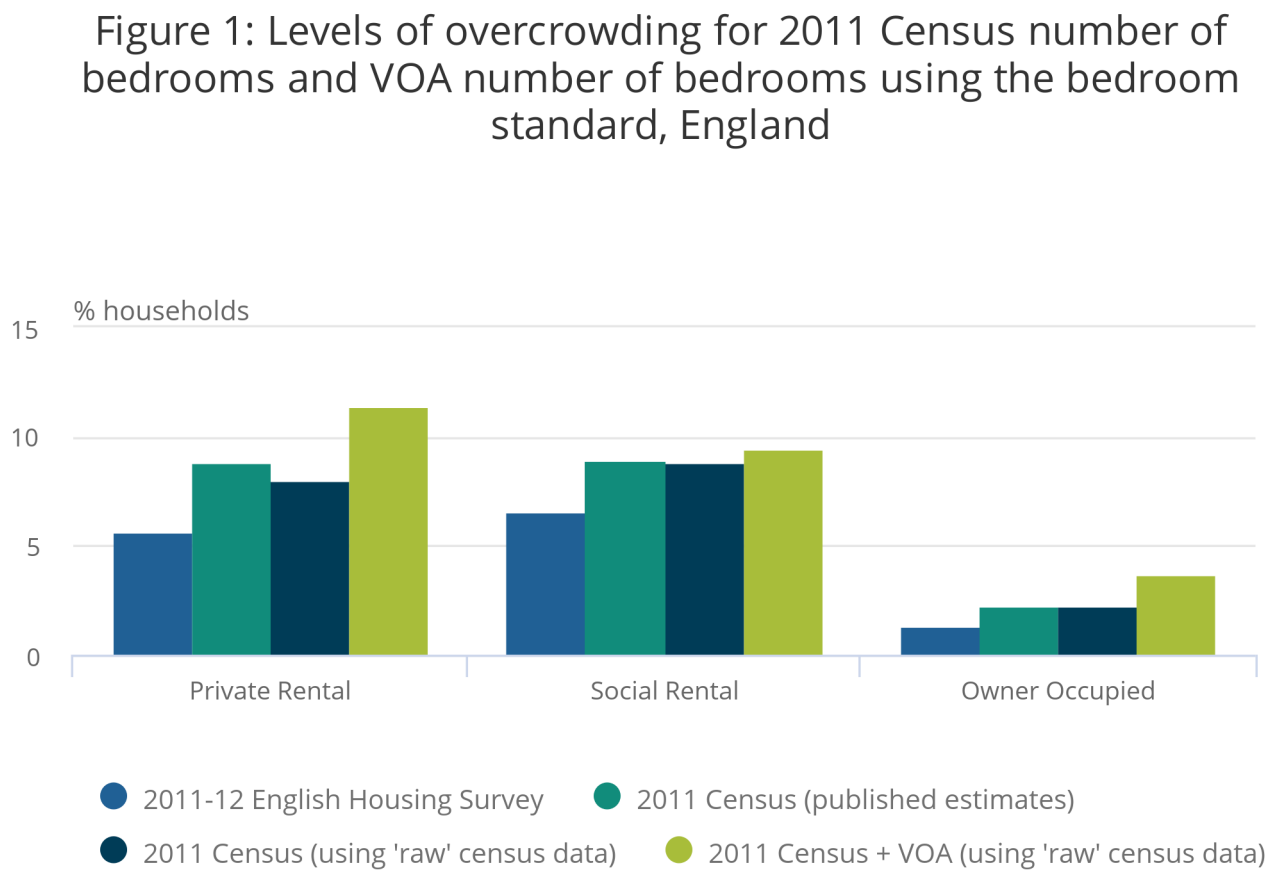
Levels of overcrowding for 2011 Census number of bedrooms question and VOA number of bedrooms

The bedroom standard is used to identify the proportion of overcrowded households. Households are considered overcrowded if the bedroom occupancy rating is "negative 1 or less" (see Section 3).

Changes in the reported level of overcrowding over time are likely to draw public attention and may affect policy decisions. Our aim is to highlight where such changes would be driven by a change to the way we measure overcrowding using Valuation Office Agency (VOA) number of bedrooms and therefore direct comparisons to levels of overcrowding measured using survey questions would be incorrect.

It is well documented that levels of overcrowding vary with tenure type (PDF, 681KB). The level of overcrowding for private rental sector (PRS), social rental sector (SRS) and owner-occupied households is shown in Figure 1 for England and in Figure 2 for Wales.

Figure 1: Levels of overcrowding for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, England



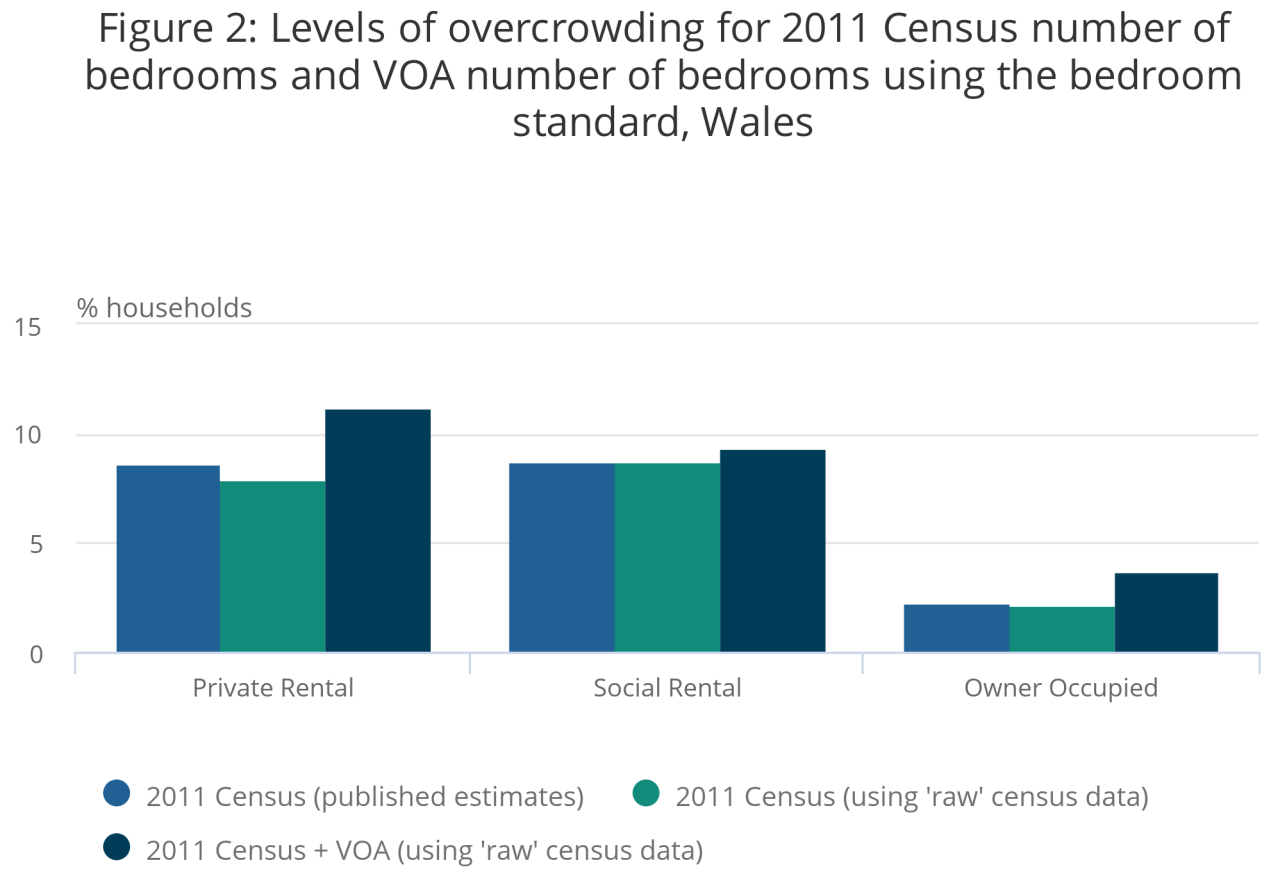
Source: Valuation Office Agency, Office for National Statistics

Notes:

1. “Raw” census data are 2011 Census responses not adjusted for household and within household non-response.

2. Proportion of overcrowded households are calculated using a bedroom occupancy rating of “-1 or less”.

Figure 2: Levels of overcrowding for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, Wales



Source: Valuation Office Agency, Office for National Statistics

Notes:

1. “Raw” census data are 2011 Census responses not adjusted for household and within household non-response.

2. Proportion of overcrowded households are calculated using a bedroom occupancy rating of “-1 or less”.

The English Housing Survey (EHS), which provides the best official estimates for levels of overcrowding in England, records lower levels of overcrowding in comparison with all of the census-based estimates.

It is worth noting that the "raw" 2011 Census data used in this article have not been adjusted for household and within household non-response (see Section 3), which explains the lower level of overcrowding for PRS and SRS compared with official 2011 Census estimates, especially in England.

For all tenure types, the level of overcrowding is higher for VOA bedroom standard than for the census bedroom standard. The differences are smallest for SRS and largest for PRS. Importantly, the EHS and 2011 Census record a higher level of overcrowding for SRS in comparison with PRS. This is the opposite to VOA bedroom standard, where PRS has the highest level of overcrowding.

These results contrast with the pattern we observed for VOA number of rooms. While the VOA and census level of overcrowding are better aligned for number of bedrooms than for number of rooms, using VOA bedroom standard would identify a higher proportion of households as being overcrowded than survey-based measures have suggested across all tenure types.

The differences are most likely driven by the different means and purposes of data collection. VOA data are collected for Council Tax banding and is concerned with establishing the "value" of a property. As part of our quality assurance of VOA data used in Census 2021 we noted that there is the potential for distortive effects, which will vary by geography and type of property. In contrast, surveys and census are more interested in the actual use as self-reported by residents. Additionally, VOA has a stricter bedroom definition compared with the census by requiring a minimum bedroom size (see Section 2).

This is likely to lead to fewer rooms being counted as bedrooms in VOA than census. For example, if a living room had been converted to a bedroom, census respondents would likely count the living room as a bedroom, while the VOA would not. This effect will vary by tenure and accommodation type.

Comparing levels of overcrowding at local authority level for 2011 Census number of bedrooms and VOA number of bedrooms

In Section 3, we noted differences between census number of bedrooms and VOA number of bedrooms for different accommodation types. And in Section 4, we confirmed that levels of overcrowding vary with tenure type, but these patterns are not fully preserved when replacing the census number of bedrooms question with VOA number of bedrooms.

We will now look into the sub-regional differences by tenure and accommodation type to better understand differences for this new measure of overcrowding. We have calculated the proportion of overcrowded households within each local authority looking at households with a bedroom occupancy rating of "negative 1 or less". We used linear regressions to explore the relationship between these two measures as recorded in Table 3.

Table 3: Coefficients for linear regressions comparing the levels of overcrowding at LA level for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, England & Wales

Tenure	Accommodation type (grouped)	Gradient	Intercept	Linear regression R2
Owner-occupied	Detached	1.25	0.01	0.95
Owner-occupied	Semi-detached	1.28	0.01	0.95
Owner-occupied	Terraced	1.32	0.01	0.9
Owner-occupied	Flats	1.11	0	0.92
Private rental	Detached	1.23	0.02	0.94
Private rental	Semi-detached	1.35	0.01	0.85
Private rental	Terraced	1.48	0.01	0.73
Private rental	Flats	1.12	0.01	0.93
Social rental	Detached	1.06	0.01	0.94
Social rental	Semi-detached	1.1	0	0.96
Social rental	Terraced	1.08	0	0.94
Social rental	Flats	1.03	0.00	0.97

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

We found that a large proportion of the variation for the census bedroom standard also explains the variation of the VOA bedroom standard (as the R^2 are large). However, for semi-detached and terraced houses in the private rented sector, the proportion of variation that can be explained is less than 90%. This is not surprising given the differences we have observed for the national level of overcrowding.

Reassuringly, the intercepts for all comparison are very close to zero, which means that both measures accurately estimate small levels of overcrowding. However, the gradients are consistently larger than one. This means that the use of VOA bedroom standard will flag a larger proportion of households as overcrowded compared with using census bedroom standard. The proportion will be most similar for owner-occupied flats and the social rental sector and the least similar for owner-occupied and privately rented terraced houses.

The differences are likely driven by the type of housing that is predominant for certain combinations of tenure and accommodation type. Different types of housing will be more or less likely to have the same (or different) number of bedrooms recorded by the census and VOA. We already highlighted that there is a minimum size requirement for bedrooms imposed by VOA and that in certain properties communal rooms might be permanently used as bedrooms, which would be recorded by surveys and censuses, but not the VOA as it does not change the value of a property for Council Tax banding.

Differences of levels of overcrowding at local authority level for 2011 Census number of bedrooms and VOA number of bedrooms

Figure 3 shows the percentage points difference between the proportion of overcrowded households using 2011 Census number of bedrooms to calculate the bedroom standard and the proportion of overcrowded households using VOA number of bedrooms to calculate the bedroom standard.

The difference between these two measures has been calculated at the local authority level by tenure and accommodation type. A value of zero indicates that there is no difference in the 2011 Census and VOA estimates, positive values indicate that the proportion of overcrowded households is larger for VOA bedroom standard compared with the 2011 Census bedroom standard, and negative values indicate that the VOA proportion is smaller.

Figure 3: Percentage point (pp) differences in the levels of overcrowding at LA level for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard by tenure and accommodation type, England & Wales

Households are identified as overcrowded if they have a bedroom occupancy rating of “-1 or less” using the bedrooms standard.

Notes

1. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.
2. Proportions of overcrowding have been suppressed if an LA had fewer than 10 overcrowded households or fewer than 100 households in total for a given tenure and accommodation type.
3. A value of zero indicates that there is no difference in the 2011 Census and VOA estimates, positive values indicate that the proportion of overcrowded households is larger for VOA bedroom standard compared with the 2011 Census bedroom standard, and negative values indicate that the VOA proportion is smaller.

Download the data

Our analyses in the previous subsection (see Table 3) indicated that the proportion of overcrowded households is likely to be larger when using the VOA bedroom standard compared with the 2011 Census bedroom standard.

This effect is particularly notable for owner-occupied and private rental terraced houses in the North West, as well as private rental houses inside London.

Contrary to the general trend, the proportion of overcrowded households is likely to be smaller when using the VOA bedroom standard compared to 2011 Census bedroom standard:

- for owner-occupied and private rental flats in some local authorities (for example, North Warwickshire)
- for social rental properties (especially flats) in some local authorities (for example, South Gloucestershire)

We also want to remind users that VOA make every effort to collect accurate and up-to-date data and maintain their accuracy, but data updates are primarily linked to the sale of properties. As part of our quality assurance of VOA data used in Census 2021 we noted that there is the potential for distortive effects, which will vary by geography and type of property.

5 . Suitability of using VOA number of bedrooms to measure overcrowding

Valuation Office Agency (VOA) number of bedrooms is not a simple drop-in replacement for asking a number of bedrooms question on surveys or censuses. Historically, there has been a lot of variation of what should be counted as a bedroom for different surveys and the census. The most accurate estimates for the level of overcrowding have been produced through the use of trained surveyors as done by the English Housing Survey, however, this is costly and not feasible to implement on a large scale.

In this respect, VOA data are presenting a way of collecting consistent high-quality data on number of bedrooms using a consistent definition. However, the analysis we presented in Section 4 indicates that especially in the private rented sector there is likely a difference between what is actually used as a bedroom (and can be recorded in a survey or census) and what was the intended use of a bedroom when the property was built.

Properties that use a communal room as a bedroom, that is not then available for communal use, are relatively speaking "crowded". In effect this is what the use of VOA number of bedrooms determines, but it breaks with the historical way of measuring overcrowding using the bedroom standard.

Our analysis shows that there is benefit in linking VOA number of bedrooms to household surveys as it provides information on living conditions without the need to ask additional questions. It also opens the opportunity for more regular sub-national or sub-regional estimates of levels of overcrowding if the sample size of the chosen household survey permits it. It is even possible to produce levels of overcrowding using VOA number of bedrooms for historical surveys where the number of bedrooms was not collected.

If this methodology was to be implemented, we strongly recommend that comparisons across geographies and different time points should only be undertaken within accommodation and tenure types. Further methodological work would be required to enable robust comparisons between tenure types.

If the rankings are similar then the level of overcrowding within tenure and accommodation types could be safely compared for geographical areas. To provide an indication if these rankings might be preserved, we used Spearman's rank correlation to assess if local authorities in England and Wales rank the same when calculating the level of overcrowding using the 2011 Census bedroom standard and comparing it with the VOA bedroom standard. Table 4 lists the Spearman's rank correlation coefficient by tenure and accommodation type.

We found that the Spearman's rank correlation coefficient is 0.79 or larger for all tenure and accommodation types. This means four in five local authorities would be ranked in the same order based on the level of overcrowding independent of the measure used. The absolute level of overcrowding may be different if VOA bedroom standard was used, but relative comparisons between areas will often still be possible.

Table 4: Spearman’s rank correlation coefficients for comparing the levels of overcrowding at LA level for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, England & Wales

Tenure	Accommodation type (grouped)	Spearman’s rank correlation coefficients
Owner-occupied	Detached	0.78
Owner-occupied	Semi-detached	0.82
Owner-occupied	Terraced	0.85
Owner-occupied	Flats	0.90
Private rental	Detached	0.91
Private rental	Semi-detached	0.91
Private rental	Terraced	0.86
Private rental	Flats	0.93
Social rental	Detached	0.91
Social rental	Semi-detached	0.96
Social rental	Terraced	0.94
Social rental	Flats	0.96

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

6 . Linear regression results predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census household variables

In this section we present supplementary results for linear regression predicting 2011 Census number of bedrooms and Valuation Office Agency (VOA) number of bedrooms from 2011 Census household variables that were not reproduced in Section 3.

Table 5: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census accommodation type, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.32		2.37	
Detached	1.17	0.45	1.00	0.43
Semi-detached	0.61	0.26	0.49	0.23
Terraced	0.43	0.17	0.32	0.14
Block of flats	-0.64	-0.21	-0.70	-0.25
Converted / shared house	-0.61	-0.10	-0.72	-0.12
Commercial building	-0.21	-0.02	-0.40	-0.03

Source: Valuation Office Agency and Office for National Statistics

Table 6: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census tenure, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.50		2.39	
Owns outright	0.50	0.21	0.58	0.27
Owns with mortgage or loan	0.61	0.26	0.60	0.29
Shared ownership	-0.27	-0.02	-0.15	-0.01
Rents	-0.26	-0.11	-0.15	-0.07

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Lives here rent free
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 7: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census landlord, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	3.05		2.93	
Housing association / charitable trust	-0.96	-0.24	-0.82	-0.23
Council	-0.88	-0.23	-0.75	-0.22
Private landlord / letting agency	-0.70	-0.22	-0.62	-0.21
Employer	-0.08	0.00	0.06	0.00
Relative / friend	-0.46	-0.05	-0.35	-0.04

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Other landlord
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 8: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census central heating status, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.79		2.72	
No central heating	-0.47	-0.07	-0.35	-0.05

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Has central heating
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 9: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census self-contained status of accomodation, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.54		2.50	
Self-contained	0.25	0.04	0.21	0.04

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Not self-contained
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 10: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of cars or vans owned, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.24		2.29	
Number of cars or vans	0.45	0.40	0.36	0.36

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Table 11: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of usual residents, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.00		2.18	
Number of usual residents	0.33	0.40	0.23	0.33

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Table 12: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of rooms, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	0.50		0.87	
Number of rooms	0.42	0.76	0.34	0.69

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

7 . Linear regression results predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census household variables

In this section we present supplementary results for linear regression results predicting the difference between 2011 Census number of bedrooms and Valuation Office Agency (VOA) number of bedrooms from 2011 Census household variables that were not reproduced in Section 3. The tables for the linear regression results predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census accommodation type and tenure can be found in Table 1 and Table 2 respectively in Section 3.

Table 13: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census landlord, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.08	
Housing association / charitable trust	-0.09	-0.03
Council	-0.09	-0.04
Private landlord / letting agency	-0.01	0.00
Employer	-0.06	0.00
Relative / friend	-0.06	-0.01

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Other landlord.
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 14: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census self-contained status of accommodation, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.03	
Self-contained	0.03	0.01

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Not self-contained
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 15: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census central heating status, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.07	
No central heating	-0.08	-0.02

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Has central heating
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 16: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of rooms, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	-0.34	
Number of rooms	0.07	0.20

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates

Table 17: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of cars or vans owned, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	-0.02	
Number of cars or vans	0.08	0.10

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Table 18: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of usual residents, England & Wales
Valuation Office Agency and Office for National Statistics

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	-0.14	
Number of usual residents	0.09	0.16

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

8 . Data sources and quality

Transforming population, migration and social statistics

We are transforming the way we produce population, migration and social statistics to better meet the needs of our users and to produce the best statistics from all available data. More information about the programme of work to put administrative (admin) data at the core of population, migration and social statistics is available.

We have published research demonstrating how Valuation Office Agency (VOA) property attribute data can be used to produce admin-based statistics on property type and floor space. More information about the VOA data can be found in the source overview, and summaries of the how we are using it to replace the number of rooms question in Census 2021 together with a summary of the quality assurance are available.

Feedback

We welcome users providing feedback on this research and the methodology used to produce them, including how they might be improved and potential uses of the data. Please email your feedback to admin.based.characteristics@ons.gov.uk and include "Housing" in the subject line of your response.

9 . Related links

Estimating the number of rooms in Census 2021: an update on deriving an occupancy rating for Valuation Office Agency number of rooms
Article | Released 18 January 2021
Exploration of differences in room occupancy ratings derived from Census 2011 and linked Valuation Office Agency number of rooms data. The research aims to provide further assurance for the replacement of the number of rooms question in Census 2021.

Estimating the number of rooms and bedrooms in the 2021 Census: An alternative approach using Valuation Office Agency data
Article | Released 27 June 2017
An assessment of the Valuation Office Agency (VOA) dataset as a potential for replacing the questions on number of rooms and bedrooms on the 2021 Census.

Valuation Office Agency property attribute data: quality assurance of administrative data used in Census 2021
Article | Released 31 July 2020
Summary of the quality assurance undertaken on administrative data for Valuation Office Agency property attribute data used in Census 2021.

Valuation Office Agency data
Data source | Released 27 June 2017
More information about the VOA property attribute data.

ONS working paper series number 20 -- Feasibility of using donor-based imputation for census outputs on number of rooms using Valuation Office Agency data
Methodology | Released 10 July 2020
Demonstration of using a donor-based imputation method (CANCEIS) to address missing values when replacing the number of rooms question on Census 2021.

Office for National Statistics

Article

Admin-based levels of overcrowding (using the bedroom standard and Valuation Office Agency number of bedrooms), feasibility research: England and Wales: January 2021

Exploration of differences in bedroom occupancy ratings derived from Census 2011 and linked Valuation Office Agency number of bedrooms data. The research demonstrates the potential of deriving levels of overcrowding using the bedroom standard from linked survey and admin data.

Contact:
Andreea Butnaru, Lizzie Gunner, Shannon Bull, Joe Herson and Stephan Tietz
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Release date:
18 January 2021

Next release:
To be announced

Table of contents

1 . Main points

- This feasibility research builds on our previous work to assess how Valuation Office Agency (VOA) number of bedrooms can be used to supplement censuses and household surveys to produce sub-regional estimates of the level of overcrowding using the bedroom standard.
- Currently, the English Housing Survey (EHS) publishes the most accurate national estimates of levels of overcrowding in England (using the bedroom standard).
- The VOA bedroom standard is typically the same as the census bedroom standard at household level (median difference is zero for all local authorities, while the mean varied between negative 0.2 and 0.1).
- Our analyses indicated that the proportion of overcrowded households is likely to be larger when using the VOA bedroom standard compared with the 2011 Census bedroom standard.
- The VOA bedroom standard produces national levels of overcrowding for social rental that are higher than the levels of overcrowding for private rental households, compared with using the census bedroom standard.
- The differences are most likely driven by the different means and purposes of data collection; VOA excludes rooms incapable of comfortably holding a single bed, and surveys and census allow residents to report communal rooms (which are used for sleeping) as bedrooms.
- Additional care has to be taken when looking at sub-regional comparisons as the level of overcrowding is not consistently higher across the whole of England and Wales; we strongly encourage users to familiarise themselves with the full analysis presented in Section 4.
- Most local authorities (four out of five) would be ranked in the same order based on the level of overcrowding independent of which of the two measures is used.
- The absolute level of overcrowding may be different if the VOA bedroom standard was used, but relative comparisons between areas will often still be possible; this demonstrates the potential for supplementing household surveys with VOA number of bedrooms to produce sub-regional overcrowding statistics in intercensal years.

Disclaimer

This research does not provide official statistics on housing nor is it used in the underlying methods or assumptions in the production of official statistics. Rather, it is published to allow users to understand a new methodology that is different to that used in the 2011 Census to measure the number of bedrooms in households and could be used to measure overcrowding using household surveys in the future. These outputs should not be used for policymaking or decision-making.

It is important that the information and research presented are read alongside the analysis to aid interpretation and avoid misunderstanding. These analyses must not be reproduced without this disclaimer and warning note.

2 . Use of VOA number of bedrooms to measure overcrowding

Measuring overcrowding using occupancy ratings and the bedroom standard

Housing policy is concerned with the availability and quality of housing. Presently, the Office for National Statistics (ONS) collects data and produces outputs on housing statistics. These data and outputs are widely used across central and local government to understand the characteristics of the housing stock as well as living conditions in England and Wales. The 2011 Census collected information on accommodation type, number of rooms and number of bedrooms to meet this need.

Our 2015 user needs consultation for Census 2021 (PDF, 1.59MB) showed that measuring and understanding overcrowding is an area of interest. It was noted that overcrowding is seen as a fundamental indicator of housing deprivation. Living in such conditions is associated with adverse personal and health effects.

Overcrowding is often measured using an occupancy rating. An occupancy rating is obtained by subtracting a hypothetical number of bedrooms (or rooms) recommended for a household from the actual number of bedrooms (or rooms) it has available. A household is considered overcrowded if it has fewer bedrooms (or rooms) available than recommended (negative occupancy rating), or under-occupied if it has more (positive occupancy rating). This makes the occupancy rating a straightforward way of measuring overcrowding and under-occupancy.

In England and Wales, three different standards are commonly used to assess whether the living space available to a household is overcrowded. The Housing Act 1985 defines two of these standards: the room standard and the space standard. The Act states that if a household does not meet these standards it should be classed as overcrowded. However, in 2012 the Department for Communities and Local Government (DCLG, now MHCLG) issued guidance, Allocation of accommodation: Guidance for local housing authorities in England, which recommended that local authorities should use the non-statutory bedroom standard when assessing whether or not households are overcrowded for the purposes of housing allocation.

The bedroom standard allocates a separate bedroom to each:

- adult couple
- any remaining adult (aged 21 years or over)
- two adolescents (aged 10 to 20 years) of the same sex
- one adolescent (aged 10 to 20 years) and one child (aged 9 years or under) of the same sex
- two children (aged 9 years or under) regardless of sex
- any remaining child (aged 9 years or under)

The bedroom standard is the most widely used occupancy rating for number of bedrooms, despite being non-statutory (that is, not written into law).

Using VOA number of bedrooms to supplement household surveys

Currently, the English Housing Survey (EHS) publishes the most accurate national estimates of levels of overcrowding in England (using the bedroom standard) annually. The Welsh Housing Condition Survey (WHCS) collects the equivalent information to estimate levels of overcrowding in Wales, but this is not routinely published. However, both surveys have too small a sample size in order to produce robust sub-regional estimates.

Traditionally, the 10-yearly census fills this gap. However, it is worth noting that the census uses self-reported information provided by the residents living there whilst the EHS and WHCS use trained surveyors. It is worth noting that the levels of overcrowding reported by the census are different to the ones published by EHS (see Section 4).

Recently the Resolution Foundation published occupancy rating tables (PDF, 145KB) using data collected by the Family Resources Survey (FRS). This demonstrated that overcrowding measures that are comparable with existing census and EHS statistics could principally be derived from large-scale surveys, if the underlying measure of the number of bedrooms and household composition are comparable.

Previous research of the feasibility of using Valuation Office Agency (VOA) data to replace the number of bedrooms question on the census, demonstrated that it is feasible to link VOA data to questionnaire data and that VOA data provide a high-quality measure of number of bedrooms. The direct agreement rate between 2011 Census number of bedrooms and VOA number of bedrooms is 76%.

There are some small definitional differences in the way bedrooms are counted on both sources. The VOA excludes rooms incapable of comfortably holding a single bed (approximately anything less than two metres multiplied by two metres) and the census allows residents to report communal rooms (which are used for sleeping) as bedrooms, for example, a living room in a shared student accommodation, even if it was not originally designed for that purpose.

VOA make every effort to collect accurate and up-to-date data and maintain their accuracy, but data updates are primarily linked to the sale of properties. As part of our quality assurance of VOA data used in Census 2021 we noted that there is the potential for distortive effects, which will vary by geography and type of property.

The research in this article builds on our previous work to assess if VOA number of bedrooms can be used to supplement household surveys to produce sub-regional estimates of the level of overcrowding using the bedroom standard.

We have also published our research into replacing the census number of rooms question with VOA number of rooms and how this impacts the room occupancy rating.

3 . Deriving an occupancy rating for VOA number of bedrooms

Using 2011 Census to derive an occupancy rating for VOA number of bedrooms

We require data on household composition and the number of bedrooms to assess the feasibility of producing sub-regional estimates of the level of overcrowding using the bedroom standard. The 2011 Census meets our requirements and has a large sample which allows us to look at and compare small area estimates.

The 2011 Census data was linked to 2016 Valuation Office Agency (VOA) data at address level using unique property reference numbers (UPRNs). Properties in the VOA data that were built after 2011 were removed prior to linkage to enable better comparison with the census data. The 2011 Census records that could not be assigned a UPRN were also removed.

We used the "raw" 2011 Census data to compare 2011 Census responses with the number of bedrooms question with VOA number of bedrooms. This means that the numbers presented here are not adjusted for household and within household non-response and will differ from previously published estimates (as shown in Section 4).

This is the same methodology used in previous research and a more detailed description of the linkage methodology can be found in the previous publication, ONS working paper series number 20 (Section 13).

Statistical differences between 2011 Census number of bedrooms question and VOA number of bedrooms

We have previously explored the relationships between the 2011 Census number of rooms question, as well as VOA number of rooms to the 2011 Census household variables[1] using several linear regressions. We have repeated this analysis for 2011 Census number of bedrooms and VOA number of bedrooms.

2011 Census household variables were used as predictors and the two number of bedrooms variables were outcome variables. Comparing the regression coefficients showed that the relationship between the 2011 Census household variables and the 2011 Census number of bedrooms variable appeared similar to the relationship with the VOA number of bedrooms variable across all of the 2011 Census household variables.

This finding allows us to infer that the 2011 Census and VOA number of bedrooms variables are measuring similar statistical concepts. Tables of these analyses can be found in Section 6.

We expanded on this research by exploring the relationship between 2011 Census household variables and the difference between census number of bedrooms and VOA number of bedrooms. The 2011 Census household variables were used as predictors and the outcome variable was calculated by subtracting the VOA number of bedrooms from census number of bedrooms for each household. Categorical household variables were dummy coded.

If census number of bedrooms and VOA number of bedrooms are truly statistically similar, then we would expect the difference between the two number of bedrooms variables to be random and therefore unrelated to the predictor variables (that is, the unstandardised beta coefficients should be close to zero).

Table 1 shows the results of regression analyses predicting the difference between 2011 Census number of rooms and VOA number of rooms from 2011 Census accommodation type (compared to the base category). The intercept was close to 0 and the unstandardised beta coefficients were close to 0 for all accommodation types. This suggests that on accommodation type, the VOA and census number of bedrooms measure similar statistical concepts.

Detached houses had the largest unstandardised beta coefficient of 0.07. This means that for detached houses the mean number of bedrooms estimated by census is 0.07 more than the mean number of rooms estimated by VOA. It is possible that this occurred because detached houses are more likely to have rooms that have been converted to bedrooms after the property was last sold or bedrooms that are very small. In either case they would not be recorded by the VOA as a bedroom.

Table 1: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census accommodation type, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.04	
Detached	0.07	0.04
Semi-detached	0.03	0.02
Terraced	0.01	0.00
Block of flats	-0.03	-0.02
Converted / shared house	0.01	0.00
Commercial building	0.02	0.00

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Caravan or mobile temporary structure.

2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 2 shows the results of regression analyses predicting the difference between 2011 Census number of rooms and VOA number of rooms from 2011 Census tenure (compared to the base category). Again, the intercept was close to 0. For households that own their property with a mortgage or loan the mean number of bedrooms estimated by the census is 0.11 larger than the mean number of bedrooms estimated by VOA. There is likely a relationship between tenure and accommodation type, which we will explore in more detail in Section 4.

Table 2: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census tenure, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.01	
Owns outright	0.03	0.02
Own with mortgage or loan	0.11	0.07
Shared ownership	0.00	0.00
Rents	0.02	0.01

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Lives here rent free

2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates

The regression results for other 2011 Census household variables can be found in Section 7.

While the census and VOA number of bedrooms measures are very similar, there are also some small differences, which are partially explained by the census household variables. Users will need to be aware of these differences, which are most notable for detached houses and properties owned with a mortgage or loan.

Occupancy ratings for 2011 Census number of bedrooms and VOA number of bedrooms

There are several reasons why we would expect the occupancy ratings for 2011 Census number of bedrooms and VOA number of bedrooms to measure a similar statistical concept. Firstly, both census and VOA bedroom occupancy ratings are calculated using the number of bedrooms hypothetically required by a household. In both cases, the number of bedrooms required is derived from the census questionnaire response using the number of household members and their relationships to each other (see Section 2). Secondly, we found that census number of bedrooms and VOA number of bedrooms measure similar statistical concepts.

Finally, the bedroom occupancy rating (or bedroom standard) is simply the difference between hypothetical number of bedrooms required and the actual number of bedrooms available. Therefore, we expect the census bedroom standard and VOA bedroom standard to measure a similar statistical concept and be the same in most cases.

Our further analysis has demonstrated that this is indeed the case. We found the median difference between VOA bedroom standard and 2011 Census bedroom standard was zero for all local authorities, while the mean varied between negative 0.2 and 0.1.

Notes for Deriving an occupancy rating for VOA number of bedrooms

1. The census household variables are:

- number of usual residents
- accommodation type
- landlord
- tenure
- number of bedrooms
- central heating
- number of cars or vans

4 . Levels of overcrowding using the bedroom standard and VOA number of bedrooms

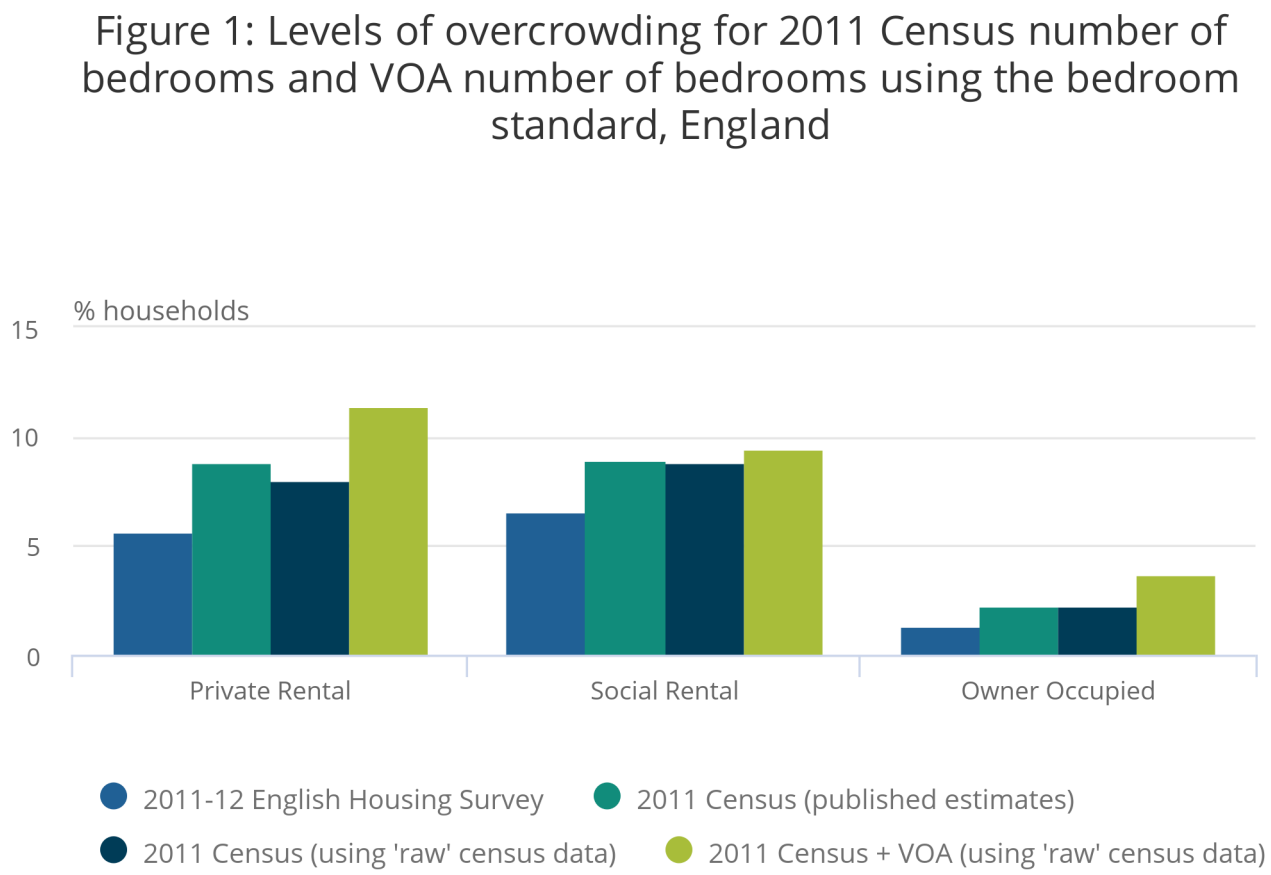
Levels of overcrowding for 2011 Census number of bedrooms question and VOA number of bedrooms

The bedroom standard is used to identify the proportion of overcrowded households. Households are considered overcrowded if the bedroom occupancy rating is "negative 1 or less" (see Section 3).

Changes in the reported level of overcrowding over time are likely to draw public attention and may affect policy decisions. Our aim is to highlight where such changes would be driven by a change to the way we measure overcrowding using Valuation Office Agency (VOA) number of bedrooms and therefore direct comparisons to levels of overcrowding measured using survey questions would be incorrect.

It is well documented that levels of overcrowding vary with tenure type (PDF, 681KB). The level of overcrowding for private rental sector (PRS), social rental sector (SRS) and owner-occupied households is shown in Figure 1 for England and in Figure 2 for Wales.

Figure 1: Levels of overcrowding for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, England



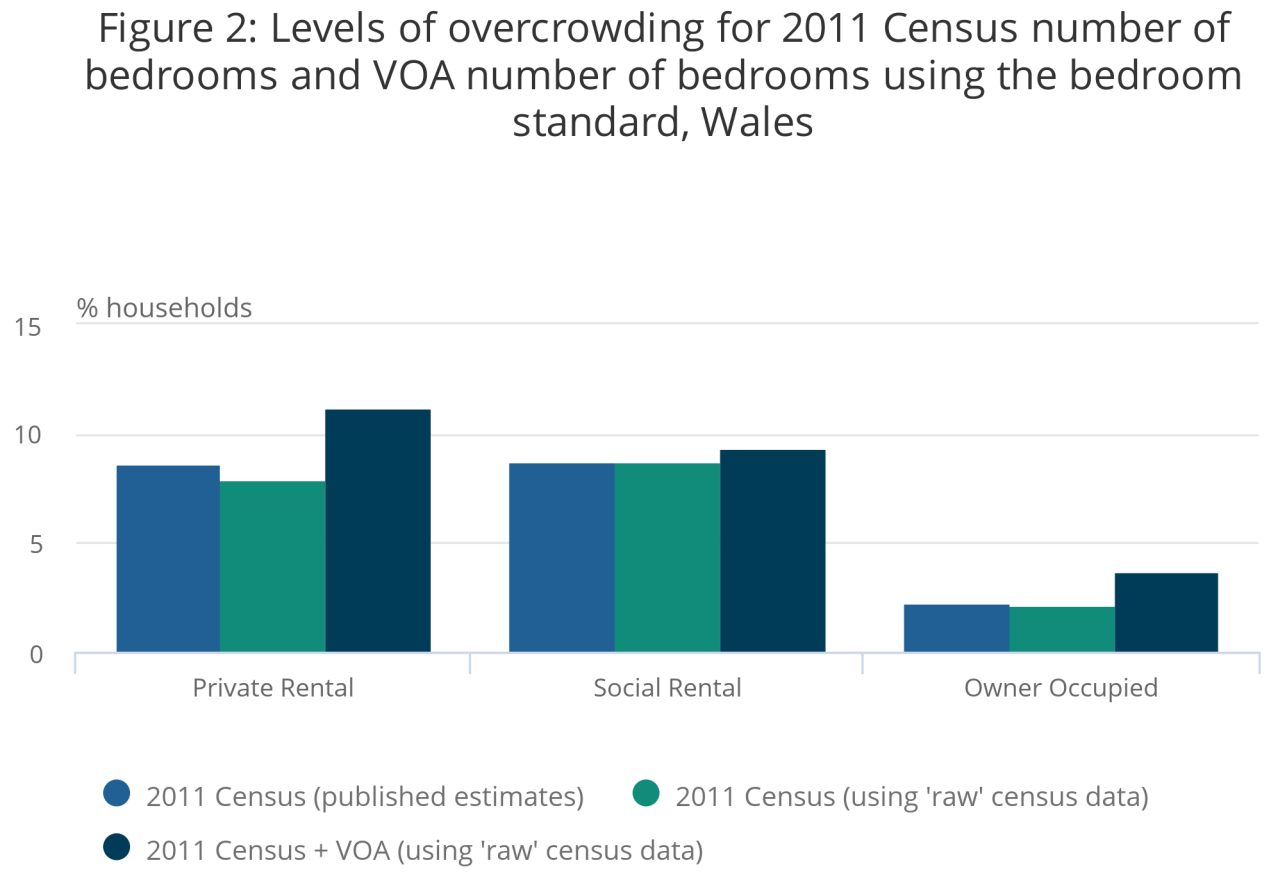
Source: Valuation Office Agency, Office for National Statistics

Notes:

1. “Raw” census data are 2011 Census responses not adjusted for household and within household non-response.

2. Proportion of overcrowded households are calculated using a bedroom occupancy rating of “-1 or less”.

Figure 2: Levels of overcrowding for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, Wales



Source: Valuation Office Agency, Office for National Statistics

Notes:

1. “Raw” census data are 2011 Census responses not adjusted for household and within household non-response.

2. Proportion of overcrowded households are calculated using a bedroom occupancy rating of “-1 or less”.

The English Housing Survey (EHS), which provides the best official estimates for levels of overcrowding in England, records lower levels of overcrowding in comparison with all of the census-based estimates.

It is worth noting that the "raw" 2011 Census data used in this article have not been adjusted for household and within household non-response (see Section 3), which explains the lower level of overcrowding for PRS and SRS compared with official 2011 Census estimates, especially in England.

For all tenure types, the level of overcrowding is higher for VOA bedroom standard than for the census bedroom standard. The differences are smallest for SRS and largest for PRS. Importantly, the EHS and 2011 Census record a higher level of overcrowding for SRS in comparison with PRS. This is the opposite to VOA bedroom standard, where PRS has the highest level of overcrowding.

These results contrast with the pattern we observed for VOA number of rooms. While the VOA and census level of overcrowding are better aligned for number of bedrooms than for number of rooms, using VOA bedroom standard would identify a higher proportion of households as being overcrowded than survey-based measures have suggested across all tenure types.

The differences are most likely driven by the different means and purposes of data collection. VOA data are collected for Council Tax banding and is concerned with establishing the "value" of a property. As part of our quality assurance of VOA data used in Census 2021 we noted that there is the potential for distortive effects, which will vary by geography and type of property. In contrast, surveys and census are more interested in the actual use as self-reported by residents. Additionally, VOA has a stricter bedroom definition compared with the census by requiring a minimum bedroom size (see Section 2).

This is likely to lead to fewer rooms being counted as bedrooms in VOA than census. For example, if a living room had been converted to a bedroom, census respondents would likely count the living room as a bedroom, while the VOA would not. This effect will vary by tenure and accommodation type.

Comparing levels of overcrowding at local authority level for 2011 Census number of bedrooms and VOA number of bedrooms

In Section 3, we noted differences between census number of bedrooms and VOA number of bedrooms for different accommodation types. And in Section 4, we confirmed that levels of overcrowding vary with tenure type, but these patterns are not fully preserved when replacing the census number of bedrooms question with VOA number of bedrooms.

We will now look into the sub-regional differences by tenure and accommodation type to better understand differences for this new measure of overcrowding. We have calculated the proportion of overcrowded households within each local authority looking at households with a bedroom occupancy rating of "negative 1 or less". We used linear regressions to explore the relationship between these two measures as recorded in Table 3.

Table 3: Coefficients for linear regressions comparing the levels of overcrowding at LA level for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, England & Wales

Tenure	Accommodation type (grouped)	Gradient	Intercept	Linear regression R2
Owner-occupied	Detached	1.25	0.01	0.95
Owner-occupied	Semi-detached	1.28	0.01	0.95
Owner-occupied	Terraced	1.32	0.01	0.9
Owner-occupied	Flats	1.11	0	0.92
Private rental	Detached	1.23	0.02	0.94
Private rental	Semi-detached	1.35	0.01	0.85
Private rental	Terraced	1.48	0.01	0.73
Private rental	Flats	1.12	0.01	0.93
Social rental	Detached	1.06	0.01	0.94
Social rental	Semi-detached	1.1	0	0.96
Social rental	Terraced	1.08	0	0.94
Social rental	Flats	1.03	0.00	0.97

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

We found that a large proportion of the variation for the census bedroom standard also explains the variation of the VOA bedroom standard (as the R^2 are large). However, for semi-detached and terraced houses in the private rented sector, the proportion of variation that can be explained is less than 90%. This is not surprising given the differences we have observed for the national level of overcrowding.

Reassuringly, the intercepts for all comparison are very close to zero, which means that both measures accurately estimate small levels of overcrowding. However, the gradients are consistently larger than one. This means that the use of VOA bedroom standard will flag a larger proportion of households as overcrowded compared with using census bedroom standard. The proportion will be most similar for owner-occupied flats and the social rental sector and the least similar for owner-occupied and privately rented terraced houses.

The differences are likely driven by the type of housing that is predominant for certain combinations of tenure and accommodation type. Different types of housing will be more or less likely to have the same (or different) number of bedrooms recorded by the census and VOA. We already highlighted that there is a minimum size requirement for bedrooms imposed by VOA and that in certain properties communal rooms might be permanently used as bedrooms, which would be recorded by surveys and censuses, but not the VOA as it does not change the value of a property for Council Tax banding.

Differences of levels of overcrowding at local authority level for 2011 Census number of bedrooms and VOA number of bedrooms

Figure 3 shows the percentage points difference between the proportion of overcrowded households using 2011 Census number of bedrooms to calculate the bedroom standard and the proportion of overcrowded households using VOA number of bedrooms to calculate the bedroom standard.

The difference between these two measures has been calculated at the local authority level by tenure and accommodation type. A value of zero indicates that there is no difference in the 2011 Census and VOA estimates, positive values indicate that the proportion of overcrowded households is larger for VOA bedroom standard compared with the 2011 Census bedroom standard, and negative values indicate that the VOA proportion is smaller.

Figure 3: Percentage point (pp) differences in the levels of overcrowding at LA level for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard by tenure and accommodation type, England & Wales

Households are identified as overcrowded if they have a bedroom occupancy rating of “-1 or less” using the bedrooms standard.

Notes

1. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.
2. Proportions of overcrowding have been suppressed if an LA had fewer than 10 overcrowded households or fewer than 100 households in total for a given tenure and accommodation type.
3. A value of zero indicates that there is no difference in the 2011 Census and VOA estimates, positive values indicate that the proportion of overcrowded households is larger for VOA bedroom standard compared with the 2011 Census bedroom standard, and negative values indicate that the VOA proportion is smaller.

Download the data

Our analyses in the previous subsection (see Table 3) indicated that the proportion of overcrowded households is likely to be larger when using the VOA bedroom standard compared with the 2011 Census bedroom standard.

This effect is particularly notable for owner-occupied and private rental terraced houses in the North West, as well as private rental houses inside London.

Contrary to the general trend, the proportion of overcrowded households is likely to be smaller when using the VOA bedroom standard compared to 2011 Census bedroom standard:

- for owner-occupied and private rental flats in some local authorities (for example, North Warwickshire)
- for social rental properties (especially flats) in some local authorities (for example, South Gloucestershire)

We also want to remind users that VOA make every effort to collect accurate and up-to-date data and maintain their accuracy, but data updates are primarily linked to the sale of properties. As part of our quality assurance of VOA data used in Census 2021 we noted that there is the potential for distortive effects, which will vary by geography and type of property.

5 . Suitability of using VOA number of bedrooms to measure overcrowding

Valuation Office Agency (VOA) number of bedrooms is not a simple drop-in replacement for asking a number of bedrooms question on surveys or censuses. Historically, there has been a lot of variation of what should be counted as a bedroom for different surveys and the census. The most accurate estimates for the level of overcrowding have been produced through the use of trained surveyors as done by the English Housing Survey, however, this is costly and not feasible to implement on a large scale.

In this respect, VOA data are presenting a way of collecting consistent high-quality data on number of bedrooms using a consistent definition. However, the analysis we presented in Section 4 indicates that especially in the private rented sector there is likely a difference between what is actually used as a bedroom (and can be recorded in a survey or census) and what was the intended use of a bedroom when the property was built.

Properties that use a communal room as a bedroom, that is not then available for communal use, are relatively speaking "crowded". In effect this is what the use of VOA number of bedrooms determines, but it breaks with the historical way of measuring overcrowding using the bedroom standard.

Our analysis shows that there is benefit in linking VOA number of bedrooms to household surveys as it provides information on living conditions without the need to ask additional questions. It also opens the opportunity for more regular sub-national or sub-regional estimates of levels of overcrowding if the sample size of the chosen household survey permits it. It is even possible to produce levels of overcrowding using VOA number of bedrooms for historical surveys where the number of bedrooms was not collected.

If this methodology was to be implemented, we strongly recommend that comparisons across geographies and different time points should only be undertaken within accommodation and tenure types. Further methodological work would be required to enable robust comparisons between tenure types.

If the rankings are similar then the level of overcrowding within tenure and accommodation types could be safely compared for geographical areas. To provide an indication if these rankings might be preserved, we used Spearman's rank correlation to assess if local authorities in England and Wales rank the same when calculating the level of overcrowding using the 2011 Census bedroom standard and comparing it with the VOA bedroom standard. Table 4 lists the Spearman's rank correlation coefficient by tenure and accommodation type.

We found that the Spearman's rank correlation coefficient is 0.79 or larger for all tenure and accommodation types. This means four in five local authorities would be ranked in the same order based on the level of overcrowding independent of the measure used. The absolute level of overcrowding may be different if VOA bedroom standard was used, but relative comparisons between areas will often still be possible.

Table 4: Spearman’s rank correlation coefficients for comparing the levels of overcrowding at LA level for 2011 Census number of bedrooms and VOA number of bedrooms using the bedroom standard, England & Wales

Tenure	Accommodation type (grouped)	Spearman’s rank correlation coefficients
Owner-occupied	Detached	0.78
Owner-occupied	Semi-detached	0.82
Owner-occupied	Terraced	0.85
Owner-occupied	Flats	0.90
Private rental	Detached	0.91
Private rental	Semi-detached	0.91
Private rental	Terraced	0.86
Private rental	Flats	0.93
Social rental	Detached	0.91
Social rental	Semi-detached	0.96
Social rental	Terraced	0.94
Social rental	Flats	0.96

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

6 . Linear regression results predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census household variables

In this section we present supplementary results for linear regression predicting 2011 Census number of bedrooms and Valuation Office Agency (VOA) number of bedrooms from 2011 Census household variables that were not reproduced in Section 3.

Table 5: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census accommodation type, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.32		2.37	
Detached	1.17	0.45	1.00	0.43
Semi-detached	0.61	0.26	0.49	0.23
Terraced	0.43	0.17	0.32	0.14
Block of flats	-0.64	-0.21	-0.70	-0.25
Converted / shared house	-0.61	-0.10	-0.72	-0.12
Commercial building	-0.21	-0.02	-0.40	-0.03

Source: Valuation Office Agency and Office for National Statistics

Table 6: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census tenure, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.50		2.39	
Owns outright	0.50	0.21	0.58	0.27
Owns with mortgage or loan	0.61	0.26	0.60	0.29
Shared ownership	-0.27	-0.02	-0.15	-0.01
Rents	-0.26	-0.11	-0.15	-0.07

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Lives here rent free
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 7: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census landlord, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	3.05		2.93	
Housing association / charitable trust	-0.96	-0.24	-0.82	-0.23
Council	-0.88	-0.23	-0.75	-0.22
Private landlord / letting agency	-0.70	-0.22	-0.62	-0.21
Employer	-0.08	0.00	0.06	0.00
Relative / friend	-0.46	-0.05	-0.35	-0.04

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Other landlord
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 8: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census central heating status, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.79		2.72	
No central heating	-0.47	-0.07	-0.35	-0.05

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Has central heating
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 9: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census self-contained status of accomodation, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.54		2.50	
Self-contained	0.25	0.04	0.21	0.04

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Not self-contained
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 10: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of cars or vans owned, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.24		2.29	
Number of cars or vans	0.45	0.40	0.36	0.36

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Table 11: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of usual residents, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	2.00		2.18	
Number of usual residents	0.33	0.40	0.23	0.33

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Table 12: Coefficients for linear regressions predicting 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of rooms, England & Wales

	2011 Census number of bedrooms		VOA number of bedrooms	
	Unstandardised beta coefficient (B)	**Standardised beta coefficient ()**	**Unstandardised beta coefficient (B)**	**Standardised beta coefficient ()**
Intercept	0.50		0.87	
Number of rooms	0.42	0.76	0.34	0.69

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

7 . Linear regression results predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census household variables

In this section we present supplementary results for linear regression results predicting the difference between 2011 Census number of bedrooms and Valuation Office Agency (VOA) number of bedrooms from 2011 Census household variables that were not reproduced in Section 3. The tables for the linear regression results predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census accommodation type and tenure can be found in Table 1 and Table 2 respectively in Section 3.

Table 13: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census landlord, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.08	
Housing association / charitable trust	-0.09	-0.03
Council	-0.09	-0.04
Private landlord / letting agency	-0.01	0.00
Employer	-0.06	0.00
Relative / friend	-0.06	-0.01

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Other landlord.
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 14: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census self-contained status of accommodation, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.03	
Self-contained	0.03	0.01

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Not self-contained
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 15: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census central heating status, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	0.07	
No central heating	-0.08	-0.02

Source: Valuation Office Agency and Office for National Statistics

Notes

1. Reference category: Has central heating
2. This work uses research datasets, which may not exactly reproduce National Statistics aggregates.

Table 16: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of rooms, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	-0.34	
Number of rooms	0.07	0.20

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates

Table 17: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of cars or vans owned, England & Wales

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	-0.02	
Number of cars or vans	0.08	0.10

Source: Valuation Office Agency and Office for National Statistics

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Table 18: Coefficients for linear regressions predicting the difference between 2011 Census number of bedrooms and VOA number of bedrooms from 2011 Census number of usual residents, England & Wales
Valuation Office Agency and Office for National Statistics

	Unstandardised beta coefficient (B)	Standardised beta coefficient ()
Intercept	-0.14	
Number of usual residents	0.09	0.16

Notes

1. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

8 . Data sources and quality

Transforming population, migration and social statistics

We are transforming the way we produce population, migration and social statistics to better meet the needs of our users and to produce the best statistics from all available data. More information about the programme of work to put administrative (admin) data at the core of population, migration and social statistics is available.

We have published research demonstrating how Valuation Office Agency (VOA) property attribute data can be used to produce admin-based statistics on property type and floor space. More information about the VOA data can be found in the source overview, and summaries of the how we are using it to replace the number of rooms question in Census 2021 together with a summary of the quality assurance are available.

Feedback

We welcome users providing feedback on this research and the methodology used to produce them, including how they might be improved and potential uses of the data. Please email your feedback to admin.based.characteristics@ons.gov.uk and include "Housing" in the subject line of your response.

9 . Related links

Estimating the number of rooms in Census 2021: an update on deriving an occupancy rating for Valuation Office Agency number of rooms
Article | Released 18 January 2021
Exploration of differences in room occupancy ratings derived from Census 2011 and linked Valuation Office Agency number of rooms data. The research aims to provide further assurance for the replacement of the number of rooms question in Census 2021.

Estimating the number of rooms and bedrooms in the 2021 Census: An alternative approach using Valuation Office Agency data
Article | Released 27 June 2017
An assessment of the Valuation Office Agency (VOA) dataset as a potential for replacing the questions on number of rooms and bedrooms on the 2021 Census.

Valuation Office Agency property attribute data: quality assurance of administrative data used in Census 2021
Article | Released 31 July 2020
Summary of the quality assurance undertaken on administrative data for Valuation Office Agency property attribute data used in Census 2021.

Valuation Office Agency data
Data source | Released 27 June 2017
More information about the VOA property attribute data.

ONS working paper series number 20 -- Feasibility of using donor-based imputation for census outputs on number of rooms using Valuation Office Agency data
Methodology | Released 10 July 2020
Demonstration of using a donor-based imputation method (CANCEIS) to address missing values when replacing the number of rooms question on Census 2021.