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Material deprivation in the UK: beyond the binary

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Abstract

Traditional approaches to assessing poverty, which primarily rely on income levels, fail to reflect the diverse challenges experienced by those living in precarious conditions. As a result, complementary measures, such as material deprivation, have been developed. This study challenges the dichotomous categorisation of material deprivation in the UK and proposes a multi-group classification approach. The analytical sample is represented by 5,395 families (with children) in the UK. The 2019/20 Household Below Average Income dataset was selected for analysis as it represents the main source of material deprivation information in the UK. Latent Class Analysis was applied to this dataset. A combination of goodness of fit and interpretability favoured a five-class solution. Measurement equivalence was tested by comparing different family types and was confirmed, reinforcing the robustness of our results. The analysis revealed the nuanced reality and typologies of material deprivation, highlighting the complex interplay between child and adult deprivation and the prioritisation of resources.

keywords
material deprivation; poverty; children with disabilities

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Introduction

Income as an indicator of poverty has proven insufficient to fully capture the experiences of those living in precarious conditions. To address this, measures such as material deprivation have been developed. Despite the agreement that alternative measures of poverty are needed, questions remain about the most effective way to measure and identify material deprivation. The challenge lies in effectively differentiating between various degrees and types of deprivation. Poverty is commonly measured using a single-variable threshold. This results in individuals/ families being classified as either poor or not. An approach that applies to both income and material deprivation measures. Income poverty is often defined as having an income below 60% of a country's median equivalised income. On the other hand, in the EU, material deprivation is assessed by whether households lack seven out of a list of thirteen specified items [1]. Such methods assume that the concept being measured is unidimensional, an assumption that is seldom questioned. Although area-based metrics such as the Indices of Multiple Deprivation (IMD in England and Wales, SIMD in Scotland) are frequently cited in UK-based research, these are not direct substitutes for individual or household-level measures of material deprivation. Rather, they provide context at the neighbourhood level. At the individual and household level, research tends to rely on unidimensional indicators. This paper, therefore, explores how material deprivation might be measured in a more multidimensional way, with a particular focus on families with children.

Material deprivation - occasionally referred to as material hardship - is generally defined as the inability to access items, goods, and services which are deemed to be essential for the healthy development and well-being of a child in a given society [2]. These items usually are a reflection of societal norms [3]. Although data on child material deprivation is gathered in the UK [4], child poverty is still reported based on income measures or a combined income and material deprivation measure, but not a material deprivation measure on its own. While income is equivalised for household composition, income-based measures can be misleading in identifying people who might still struggle, even if not income-poor, especially children. Income poverty indicators mask deprivation dimensions which disproportionally affect those in low-income environments.

Material deprivation, in particular, multidimensional material deprivation, can be used as an alternative to the child income-based poverty approach [2, 5, 6]. Studying poverty from a multi-dimensional deprivation perspective might allow more in-depth investigations and nuanced understandings of the various aspects of life children might be deprived of which income measures might not capture. Moreover, multidimensionality could allow for an investigation into a family's prioritisation strategies for dealing with difficult choices.

Consequently, this paper aims to (i) examine the types of deprivation experienced by families with children in the UK and (ii) test the validity and comparability of these types of deprivation across groups of interest. Latent Class Analysis will be the primary statistical method used.

The UK context - material deprivation

Material deprivation indicators in the UK

In the UK, material deprivation statistics at the benefit unit level are based on a measure available in the Households Below Average Income (HBAI) dataset run by the Department of Work and Pension [7]. Statistics on living standards in the UK are provided through the HBAI dataset. This data is collected through the Family Resources Survey (FRS) [4] with questions related to material deprivation only included in the survey from 2004 onwards. These questions are described in Table 1.

A detailed explanation of the selection and use of the items is provided by [8]. These items cover both adult and child-specific needs and were originally designed to reflect family deprivation more broadly—not only families with children. The selection process involved drawing from three major UK surveys, among which the PSE study [9] was particularly influential. This survey adopted the consensual approach to measuring deprivation. This approach, first pioneered in the 1983 Breadline Britain study [10], bases definitions of 'necessities' on public consensus rather than expert opinion. The method involves two steps: (1) identifying items most of the population regards as essential for an acceptable standard of living, and (2) measuring where individuals go without these items not by choice, but due to insufficient resources (enforced lack). This approach not only democratised the definition of deprivation but also laid the groundwork for how material deprivation is understood today. The FRS based its item selection on findings from this approach.

Material deprivation reflects society's understanding of basic needs, hence, the question set must evolve alongside changing social norms, technological developments, and public perceptions of what constitutes a necessity. In preparation for the 2010/11 survey, the relevance of the original questions was reviewed (see [11] for further details). Importantly, this revision process employed the consensual approach, which involves determining necessities through public consensus rather than expert opinion. It included not only survey data but also focus groups and broader consultation to assess which items were widely considered essential and which were no longer viewed as necessary. Based on these findings, four new questions were added to the 2011/12 FRS.

Integrating these questions into the FRS served a dual purpose. They were necessary for developing a deprivation indicator and aimed to cross-validate the poverty classifications of the income distribution's lowest quintile (see [8]). Material deprivation is often used in tandem with income poverty as a complementary and supplementary measure [12, 13]. Research [14] highlights that financial and deprivation measures often identify distinct groups (in hardship). For example, in 2012, countries like Hungary, Romania, and Cyprus had higher material deprivation rates than income poverty rates (29.1 vs 16.9, 28.6 vs 23.9, and 15.2 vs 13.4, respectively). On the other hand, some countries reported higher income poverty rates than material deprivation, indicating that families could fall below one measure's threshold but not the other. This suggests that material deprivation may capture different aspects of poverty compared to income measures.

Table 1: Questions used in the FRS to determine material deprivation

1	Attend organised activity once a week	13	Replace broken electrical goods**
2	Celebrations on special occasions	14	Keep up to date with bills*
3	Have a warm winter coat	15	Money to decorate home*
4	Leisure equipment such as sports equipment or a bicycle	16	Money to spend on self each week*
5	At least one week's holiday away from home with family	17	Replace worn out furniture*
6	Hobby or leisure activity	18	Keep house warm*
7	Go to a playgroup at least once a week**	19	Holiday away from home one week a year not with relatives*
8	Outdoor space/facilities to play safely	20	Home contents insurance*
9	Have friends round for tea or a snack once a fortnight	21	Make savings of 10 pounds a month or more*
10	Go on school trip at least once a term**		
11	Eat fresh fruit and/or vegetables every day		
12	Enough bedrooms for every child 10 years or over and of different gender**		

*Questions related to parents/adults in the family.
**Questions specifically for children.

The UK measure of material deprivation

This section focuses on the application of the above described items in constructing a material deprivation index within the FRS/HBAI framework. The FRS Questions Instructions report defines material hardship as the respondent's "ability to afford a number of items that most other people agree families ought to have; their other 'unmet needs'; and whether they are managing their money and staying clear of problem debts" [15, p.286].

The answers are presented at the benefit unit[1] level rather than the individual level. The respondent specifies whether they possess each item and, if not, whether it is due to lack of need or affordability. Only those who desire but cannot afford an item are considered deprived of it. In benefit units with multiple children, the answers are aggregated, and the following priority order is used to encode the answers: "1: cannot afford, 2: doesn't need, 3: (all) have" [15, p.298].

This methodology employs an 'enforced lack' approach, distinguishing between those who do not need an item and those who cannot afford it, allowing for cultural and personal variations in child-rearing and identifying true hardship versus frugality [17–19]. Overall, a family's score is zero if they have an item or can afford it but do not want it, and one if they want but cannot afford it[2]. A prevalence-weighted approach adjusts these scores, assigning different weights to each item based on their distribution within the study sample. These weighted scores are summed for each benefit unit and then standardised, creating a scale from 0 to 100.

A threshold of 25 on this index distinguishes materially deprived families (over 25 materially deprived). Typically, scoring 25 or more equates to a family wanting but being unable to afford five to six items. This binary categorisation, however, simplifies the complexity of material deprivation, raising questions about its appropriateness.

Firstly, arbitrarily set thresholds can undermine the validity and generalisability of findings. For example, the 25 threshold in the HBAI methodology classifies 16.16% of UK families as deprived. Yet, a threshold of 1, indicating deprivation if any (needed) item is unaffordable, would arguably be more appropriate and would classify 54.12% of households as deprived, illustrating how different thresholds yield varying conclusions about material deprivation prevalence. This concern is echoed in Treanor's [20] analysis, which found that the UK and Scottish governments' official methods result in identifying almost 40% fewer families as materially deprived. Her findings suggest that the thresholds currently in use may significantly underestimate the true scale of deprivation, not only in Scotland but across the UK.

Secondly, a binary approach to material deprivation overlooks the diversity of experiences. While some families clearly fall into deprived or non-deprived categories, others lie in between. These households, not fitting neatly into either category, may still struggle with basic needs. A binary measure might wrongly categorise some of these as not deprived, potentially denying them necessary support. Moreover, the impact of lacking different items can vary significantly, from missing toys to lacking warm clothing or meals, further highlighting the need for a more nuanced measurement of material deprivation. This distinction is further illustrated in UK-based research. Main and Bradshaw found that while there is some overlap between deprived children and those in income-poor families, the two measures do not align perfectly [21]. Notably, they observed cases of children experiencing deprivation in high-income households as well as non-deprived children in low-income families. These findings reinforce the importance of using material deprivation as a multidimensional lens for understanding poverty, beyond what income measures alone can reveal.

[1]As defined by the DWP [16], a benefit unit may include a single adult or a married/cohabiting couple with any dependent children (p.47). Multiple benefit units can exist within a single household.

[2]The survey does not provide the option of "does not want the item but could not afford it even if they wanted it". While a nuanced option, it is worth noting that not asking for this clarification could lead to some families being classed as non-deprived when the reality might be different.

Background

Measuring and determining dimensions of deprivation is not a standardised process. Due to material deprivation being used as complementary to income indicators, a more simplistic categorisation of "deprived" or "not deprived" tends to be preferred when reporting the material deprivation status of a group, country, etc. These methods, however, fail to capture the complexity of deprivation. Consequently, empirical methods like Latent Class Analysis (LCA) have also been used to identify deprivation patterns through statistical modelling.

Table 2 summarises some of the existing studies focused on material deprivation along with the methods used to measure it. Two distinct analytical traditions can be observed from the studies presented in the table:

- Summative indices aggregate a fixed list of deprivation items into a single head-count or intensity score [22, 23]. Their appeal lies in transparency and ease of communication to policy makers, yet they implicitly assume that all deprivations are interchangeable and that deprivation is unidimensional.
- Person-centred, latent-structure approaches (LCA)—treat the deprivation profile itself as the unit of analysis [24, 25]. These models routinely uncover three to five qualitatively distinct clusters that are impossible to detect with a single composite score, thereby revealing heterogeneity in both severity and composition of need.

Overall, a trade-off exists between the two methods of material deprivation analysis presented in Table 2. While summative methods have been used to report material deprivation of families in the UK, LCA has not (to our knowledge). Consequently, the adoption of LCA presents an opportunity to deepen our understanding of the multifaceted nature of deprivation.

Research aim

The present study will examine the classification of material deprivation beyond its simplistic binary representation in the UK. We aim to apply an empirical approach to better understand the multifaceted experiences of those struggling to access basic needs. The paper will focus on children and their families.

This study will use a Latent Class Analysis model on the FRS deprivation items to investigate the multi-classification of deprivation and show the benefits of such a method compared to a binary classification. The latent factor structure discovered will be tested for measurement invariance across families with children with disabilities.

Research design

Material deprivation in the UK, through the HBAI dataset, is measured and reported as a binary indicator. As previously stated the aim of the paper is to investigate how deprivation varies (in type as well as degree) beyond this minimal, reductive classification of deprived vs non-deprived. To carry out this investigation, Latent Class Analysis (LCA) will be used as the primary analysis method.

LCA is a type of mixture model that aims to assign individuals to latent classes based on probabilistic classification [29–32]. Compared to other mixture models, LCA is a person-centred approach and unlike other mixture models, LCA outcomes are categorical. Consequently, this will allow us to classify individuals into multiple material deprivation classes (categories). To construct an LCA model, hypotheses are made about the number of classes. However, the precise number remains unspecified and various models are statistically evaluated to find a suitable one.

Similarly to other mixture models, LCA models can be assessed to determine whether the class structure is consistent across groups of interest. This process, referred to as measurement invariance or equivalence, is crucial as it can help us confirm the robustness and reliability of the identified LCA model across different sub-populations (i.e. groups). Moreover, if invariance is achieved, statistically significant comparisons across sub-populations can be made.

In statistical terms, measurement invariance evaluates whether, across groups, the prob- ability distribution of observed scores conditioned on class membership is the same or not [33]. Mellenbergh defines measurement equivalence as: $f(Y \mid O, g) = f(Y \mid O)$ [34], where g is the group membership, and we want to observe how likely two people with the same latent class but distinct groups are to provide a specific set of answers [35]. This is necessary to confirm that the identified latent classes have an equivalent meaning across the groups under study. In the example used in this paper, measurement invariance would show that irrespective of whether a family has a child with disabilities or not, their response pattern would be statistically similar. That is assuming both groups have a comparable likelihood of belonging to a given latent class. In contrast, if there is no invariance, comparisons should not be made between groups as the constructs represented by each class are different (and the reliability of the results could be questioned).

To evaluate measurement invariance, this study adopts a comparative analysis between two distinct models: an unconstrained and constrained model. In the unconstrained model, model parameters, such as slopes and intercepts, are allowed to vary freely across groups. This approach provides a baseline assessment of how these parameters manifest in each group independently. In contrast, in the constrained model, these parameters are held equal across groups, testing the hypothesis of measurement invariance directly. If the constrained model has an acceptable measurement fit and no decline from the unconstrained model, then measurement invariance is proven.

In summary, LCA will allow us to test both the dimensionality of material deprivation as well as whether the meaning of the latent classes discovered is the same across groups of interest.

Data source

Secondary data analysis was carried out using the 2019/20 Household Below Average Income (HBAI) survey [3] [7]. The

[3]While more recent versions of the survey are available, the 2019/20 one was deemed appropriate as new statistics might not be comparable with previous statistics due to smaller sample size and the effect of a global pandemic on overall poverty patterns.

Table 2: Examples of research which classifies material deprivation

Study reference	Focus of study	Method used	Analysis of deprivation
Thomas [22]	The study focused on examining the effect of material hardship on children's well-being in the US. The effect of material hardship is studied both cross-sectionally and longitudinally.	LCA and latent transition analysis.	The study categorised material hardship into three levels (limited, moderate, and severe) based on specific hardships and their frequency, using latent class analysis (LCA). It also explored changes in these hardship levels over time through latent transition analysis (LTA) across five points in the survey used. A total of nine hardship items were available in the survey.
Oh [26]	The study aimed to assess the multidimensionality of child deprivation and to provide a detailed picture of the material and social forms of deprivation among children in the US.	The paper used the MODA method to assess deprivation. In short, the MODA method consists of creating an adjusted headcount ratio for overall deprivation, assess the individual contribution of each dimension to the overall deprivation level by decomposing the adjusted headcount ratio and finding a proportion of children who are at higher risk of poverty by identifying an overlap between deprivation and income poverty.	12 indicators were used which led to eight dimensions of deprivation being identified.
Hwang and Nam [25]	Multidimensional poverty among different age cohorts in South Korea.	LCA as well as a headcount ratio for overall material deprivation rates.	Ten indicators that were split into five pre-determined dimensions were used. The LCA results identified three groups of deprivation: all deprived, some deprived, and less deprived.
Saunders et al. [22]	To study child material deprivation in Australia.	Used both a preference and prevalence weighting and unweighted approach to calculate a child deprivation index.	18 items were used to study deprivation; descriptive statistics were provided for each item; the paper also split the items into two broad groups: having items and doing activities – material deprivation and social exclusion; the index of multiple deprivation is calculated for each group as well as overall.
Shamrova and Lampe [27]	Investigate child material deprivation patterns across regions of the world.	LCA to identify groups of children with distinct patterns of material deprivation.	Using international data, eight material deprivation items were available; LCA identified five patterns of child material deprivation, ranging from extreme to no deprivation.
Denny et al.- [28]	To examine if there is any relation between household deprivation, neighbourhood deprivation and health indicators among secondary school students in New Zealand.	LCA was used to identify groups of students based on dichotomised indicators of household deprivation.	Latent class analyses were used to group students by household poverty based on nine indicators of household socioeconomic deprivation. The analysis resulted in a three-class model being selected – no deprivation, moderate/ housing deprivation and high deprivation.

Continued

Table 2: Continued

Study reference	Focus of study	Method used	Analysis of deprivation
Nepomnyaschy and Garfinkel [23]	To examine the effect of non-resident fathers' involvement with children on the child's household material hardship level using longitudinal data from the US.	Created a summed score based on the eight items available in the data; analysed each item individually.	Material hardship, in this case, was used as the dependent variable. An ordinary least square model was used to estimate the number of hardships in a child's mother's household. A total of eight material hardship items were available in the data.

HBAI dataset is derived from the Family Resources Survey, a cross-sectional survey representative of the UK population, sponsored by the Department of Work and Pensions [4]. The survey's interviewees are adults aged sixteen[4] and above ([16] for further details on sampling procedures). In 2019/20, the survey had the participation of 19,244 households and 22,733 benefit units[5].

The survey gathers data on the demographic, economic, and social conditions of UK house- holds, including detailed child-related data acquired via proxy interviews[6]. The final HBAI material deprivation indicators (see Table 1 for details) are used for this analysis as they are the best data on material deprivation in the UK.

Sample

This study focuses on families with dependent children as its target population. It employs an analytical subsample of 5,395 families, all of which are included in the HBAI dataset and have at least one dependent child (this includes children aged 0-16 and those aged 16-19 who are in full-time education)[7].

Group selection: children with disabilities

As a test of measurement invariance, we assess the latent class structure of families with children with disabilities against those without children with disabilities. This sub-population was selected as previous research has shown differences across poverty measures exist between this group and families raising children without disabilities [36, 37]. According to the FRS/HBAI, disability is a "physical or mental impairment that has a 'substantial' and 'long-term' negative effect on [the child's] ability to do normal daily activities", where 'substantial' means more than minor or trivial, and 'long-term' means 12 months or more." [17, p.51][8]. This definition is based on one provided by the Equality Act of 2010. Overall, 696 families with children with disabilities were in the analytical sample, compared to 4,699 without disabilities (see Supplementary Table 4 for further summary statistics for the data used).

Manifest variables of material deprivation

To create an LCA model, manifest indicators are required. These are directly observed variables, which individually can only measure one thing, while together, they could form a latent construct which cannot be directly observed. The material deprivation indicators directly captured by the FRS are used in this analysis. A detailed description of these indicators was provided in previous sections of the paper. As mentioned above, the enforced lack approach will be applied to the material deprivation indicators. As a result, in the analysis that follows, these indicators will be dichotomised as either: (i) the individual has the item[9] or can afford the item but does not want it, or (ii) the individual would like the item but cannot afford it. Although acknowledging that individuals experiencing poverty may report not wanting an item as a result of cognitive dissonance, this methodology mirrors the approach used in the HBAI, allowing a straightforward comparison between the deprivation measures used in the HBAI and those introduced in this study.

Not all 21 material deprivation indicators available in the HBAI dataset (see Table 1) were used in the final analysis.

The "Go to a playgroup at least once a week" only applies to children "under 6 and [who] do not attend primary or private school" [15, p.301], while the question about "Go on a school trip at least once a term" only applies to children "aged 6 or older in Benefit Unit or younger than 6 and attend primary or private school" [15, p.301]. Given that both indicators try to capture children's interaction with each other, but at different ages, we combined these indicators into a single one - school trip/playground. For the new indicator, if a family is deprived of one item but not the other, the indicator classifies them as deprived (this applies to 4.65% of cases - see Table 3).

The indicator related to the number of bedrooms available in the household is removed as the item does not apply to over 90% of the families interviewed[10]. After the above adjustments, 19 items were used in the final LCA models.

[4]This excludes dependent children aged 16 to 19.

[5]As defined by the Department for Work and Pensions [17], "A benefit unit may consist of a single adult, or a married or cohabiting couple, along with any dependent children" (p.47). A household may include multiple benefit units. The term 'benefit unit' is used interchangeably with 'family' in this study for ease of reading.

[6]Not all individual questions can be answered by proxy, in which case non-responses are recorded.

[7]The inclusion of these families was determined using the DEPCHL DB variable in the HBAI dataset. For additional details on the variables used and their development, refer to the HBAI user guide [7].

[8]A variable is available which gives the number of children with disabilities present in a family.

[9]Item here refers to both material items and activities.

[10]To be applicable, the family needed to have two children over the age of ten of different genders – there are only 352 families who have more than one child, the age of the youngest child is over ten, and there is at least one boy and one girl in the family. We recognise that not having an item, as opposed to not needing it, signifies deprivation. However, categorising the substantial number of units that do not need the item

Table 3: Summary statistics of the FRS variables that were re-coded for this study

	Has item	Does not have item
Go to a playgroup at least once a week	5338	57
Go on a school trip at least once a term	5181	214
Deprived of both items		10
School trip/ playground	5134	261

Data analysis

We first provide a preliminary examination of the dataset through summary statistics, focusing particularly on families who want but cannot afford the deprivation items included; a contingency table that compares each deprivation item with the material deprivation classification as defined by the HBAI is provided.

Next, Latent Class Analysis is employed. An upward modelling approach was used to select the number of classes for this analysis. Initial comparisons were made between LCA models with a minimum number of two classes and models with up to ten classes. A 19-item LCA was conducted[11], the results of which will be discussed in the following sections. All LCA models were run and tested in R using the glca package [38] with a maximum number of iterations of 5,000 and fifty repetitions.

The goodness of fit measures used to judge these models are consistent with the ones used for invariance testing in this paper. To prove measurement invariance, the goodness of fit measures for the constrained model need to be at least if not better than those for the unconstrained LCA model. While there is no consensus on a single assessment method, various criteria are available. The chi-square test is the most known one, but it is dependent on sample size [39]. Alternative indices are the information criteria ones - Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC) and Consistent Akaike Information Criterion (CAIC) [40, 41]. When comparing between models using the AIC, BIC or CAIC fit measures, the model with the lowest value is considered to be a better one. In combination with statistical fit indices, theoretical interpretability was also taken into consideration when choosing the final model.

To summarise, the analytical strategy will consist of the following steps: select the optimal number of latent classes for the full sample; repeat the process for the groups of interest; test for measurement invariance; and explore the latent classes and their interaction with the HBAI' classification of material deprivation.

Results

Summary statistics for those who would like to have the items but cannot afford to buy them are presented in Table 4. This table is a cross-tabulation of the distribution of families who cannot afford the specified items or activities and their material deprivation status, following the approach outlined in the HBAI survey. To facilitate a forthcoming analysis of structural differences in deprivation patterns, the results are delineated by groups based on the presence or absence of a child with disabilities within the family.

We can observe from the results that there are some families who, even though are not classified as materially deprived, still cannot afford some of the items on the list. While the observation may appear self-evident given the deprivation methodology used, it is important to highlight that using a latent binary index classification diminishes the nuanced complexity of deprivation. For instance, a significant proportion of non-materially deprived families, both with (26.75%) and without disabilities (16.15%), cannot afford holidays. Similarly, items related to disposable income, like personal spending, furniture replacement, or savings, are unaffordable for some of these families. This suggests that not being classified as materially deprived (according to the HBAI classification) does not necessarily preclude social exclusion or financial challenges.

While we acknowledge the presence of two distinct groups of people, those who are deprived and those who are clearly not, we believe that there is more nuance in-between these two extreme categories. The HBAI methodology treats deprivation as an absolute binary latent construct. However, we are challenging this framework and proposing the existence of additional types of deprivation. The preliminary results in Table 4, support our argument and suggest the possibility of (at least) an additional type of deprivation: families affording basic needs yet struggling with items/ activities impacting self and overall well-being. Therefore, testing a multi-classification approach to deprivation is crucial for a more accurate representation of families' diverse experiences with material deprivation.

Latent class analysis

LCA models with 19 material deprivation items were developed to assess and compare a multi- classification approach to deprivation. The number of classes tested ranged from two to ten classes (the maximum being determined arbitrarily). In evaluating the Bayesian Information Criterion (BIC) goodness of fit measure, where lower values are preferable, the six-class model emerges as the best fitting as it has the lowest BIC value. Nonetheless, similar BIC values are observed for the models with five and seven classes, making them viable alternatives. Similarly, for families raising children without disabilities, a similar range of classes—five to seven—can be considered appropriate. In contrast, for families with children with disabilities, a four-class model appears optimal, but

together with those that already have it would inaccurately represent their status in the dataset and, consequently, skew the analysis.

[11]To sensitivity test the decision to exclude the items mentioned in previous sections, LCA models with all 21 deprivation items available in HBAI were tested. The results of this analysis, the specifics of which can be found in Supplementary Table 3, are very similar, strengthening our decision described above to use only 19 items for subsequent analysis.

Table 4: Percentage of families (with children) not able to buy the specified items and their material deprivation status according to the HBAI's classification

Question	Not materially deprived		Materially deprived	
	% of families with No child disability	% of families with child disability	% of families with No child disability	% of families with child disability
	N = 4037	N = 486	N = 662	N = 210
Attend organised activity once a week	1.16	2.06	32.48	36.67
Enough bedrooms for every child 10 years or over and of a different gender	0.62	1.85	5.14	8.1
Celebrations on special occasions	0.02	0.62	11.18	17.14
Have a warm winter coat	0.02	0	3.63	6.19
Leisure equipment such as sports equipment or a bicycle	0.72	0.21	27.95	31.43
At least one week's holiday away from home with family	16.15	26.75	84.89	86.19
Hobby or leisure activity	0.54	1.03	23.11	30
Go to a playgroup at least once a week	0.25	0	5.44	5.24
Outdoor space / facilities to play safely	3.67	3.09	21.6	25.71
Have friends round for tea or a snack once a fortnight	0.69	0.62	19.64	22.86
Go on school trip at least once a term	0.62	1.85	19.79	23.33
Eat fresh fruit and/or vegetables every day	0.2	0	10.57	11.9
Replace broken electrical goods	7.38	9.26	73.87	76.67
Keep up to date with bills	2.38	1.85	32.18	40.48
Money to decorate home	5.82	9.47	62.99	61.43
Money to spend on self each week	13.67	20.58	81.87	79.52
Replace worn out furniture	12.06	16.46	82.48	85.24
Keep house warm	1.31	2.06	32.48	31.9
Holiday away from home one week a year not with relatives	22.15	32.92	91.99	94.29
Home contents insurance	8.5	11.32	68.43	66.67
Make savings of 10 pounds a month or more	19.62	26.54	83.23	88.57
Go to a playground/ on a school trip	0.87	1.85	24.32	26.67

models with five or six classes could also be considered. The statistical results, coupled with the need for interpretability and the additional metrics, a five-class model has been identified as the most suitable choice for both the full sample and the specified subgroups (see Supplementary Table 1 for exact figures).

These results also strengthen our argument against a binary classification of material deprivation. Across all the goodness of fit indices, a two-class model consistently underperforms. This observation underscores the inadequacy of a simplistic binary approach in capturing the complex nature of material deprivation.

Measurement invariance

The multigroup LCA allowed us to examine whether the material deprivation latent class structure is different between families whose children have a disability and those who do not, in the dataset used. To test for measurement invariance, the results for a constrained and unconstrained model are compared. Given the results from the previous section, measurement invariance was tested on a five-class LCA model[12] the results of which are available in Table 5.

[12]Measurement invariance was also tested for fours and six-class models and in both cases, the assumption of invariance held.

The constrained model is preferred based on lower values in BIC and AIC, indicating that the groups maintain invariance. Consequently, families with and without children with disabilities in the same latent class exhibit similar probabilities of having or not the items used to determine material deprivation. Given the presence of invariance, the concept of material deprivation can be uniformly interpreted across groups.

Exploration of the latent classes of material deprivation

LCA models help us identify subgroups within a population and offer an understanding of the characteristics that define each latent class. In Figure 1 the distribution of each deprivation item across each of the five LCA typologies of material deprivation/ hardship is shown. Supplementary Table 2 further provides the response probabilities for the absence of each item in each class, along with the prevalence of each class.

A significant contrast is evident, in terms of item accessibility, between class five (top of Figure 1), at 58% prevalence, and class one (bottom of Figure 1), at 5% prevalence. Class five likely represents families not experiencing material deprivation who can afford all the items considered in the analysis. In contrast, class one is indicative of extreme

Table 5: Goodness of Fit Table for group invariance testing

	AIC	CAIC	BIC	Res.Df	Chi-Squared
Constrained model	47683.33	48465.43	48362.43	5291	7335.63
Unconstrained model	47758.67	49262.13	49064.13	5196	7220.96

deprivation, consisting of families lacking access to numerous items. Notably, in class one, items deemed essential for children, such as winter coats, fresh fruits or vegetables, celebrations, or safe play spaces, are still available to families compared to items needed by the adults in a family. This pattern is also seen in class two with a 13% prevalence. Class two's distinction from class one mainly lies in this increased likelihood of children's involvement in organised activities. Based on the results of these two classes, it can be argued that parents will choose to go without certain items just to make sure their children have what they need. This observation supports the argument that child deprivation is often a consequence of adult deprivation. The remaining classes, three and four, each prevalent at 14% and 11% respectively, differ primarily in terms of the families' ability to afford holidays. Class three might represent a mild form of adult deprivation, while class four could be characterised by deprivation in life's enjoyment. The typology of material deprivation described above was for the full data sample. Similar patterns were observed for families whose children do not have disabilities as well as families whose children have disabilities. The overall structure of the classes is the same across groups, but there are differences in class prevalence and item response probabilities. For example, those with disabilities have a higher prevalence for latent classes with mild to severe deprivation (classes four to one) compared to families with no child disability. This is to be expected as it is known those with disabilities are more likely to be in poverty and materially deprived [37, 42] (see Table 4).

Also, going on holiday seems to be something those whose children have disabilities are less likely to do, as these items have a probability of 1[13] in classes one and two.

Material deprivation: LCA vs HBAI deprivation

The HBAI dataset provides the material deprivation score and classification for the UK. As described in previous sections, a score of zero to 100 is computed using prevalence weighting, based on which families with children's deprivation classification is determined. If a family has a score below 25, they are not materially deprived, but if the score is above 25, they are considered materially deprived. Our interest lies in examining the interaction between these deprivation scores and the latent classes of deprivation previously identified.

This examination is particularly focused on how the application of a 25-point threshold impacts our understanding of material deprivation. This interaction can be observed in Figure 2. It is evident from the visualisation that there is a clear delineation at one of the extremes - the class representing no deprivation aligns neatly with the scoring classification. At the other extreme, class 1, surpasses the threshold score, yet exhibits a wide range distribution across the HBAI's score. Moreover, the intermediate classes (two to four) span the 25-point threshold, with their distribution spreading across both sides of the threshold. This observation highlights a critical point: using a fixed threshold hides the complexities of material deprivation. While the score distinctly identifies those who are extremely deprived, it masks the nuances uncovered with the LCA across those classified as non-deprived. The same pattern is observed when the results for families with child disability and those without are shown.

Discussion

The material deprivation binary index used in the HBAI dataset is a primary measure in UK-based deprivation research, often cited in mainstream media and reports by organisations focused on poverty and inequality. While the index serves as a crucial tool in poverty studies, it provides only a summarised view of deprivation. Using a narrow view can limit our understanding of poverty and the effectiveness of strategies aimed at poverty alleviation. Additionally, the current index approach to measuring material deprivation operates under assumptions of both unidimensionality and universality[14], which have not been empirically verified. This raises two main questions: Is material deprivation accurately represented by a single dimension? And, is the material deprivation structure the same across different demographic groups in society?

The present study has identified five typologies of material deprivation using the HBAI data and shown how these classes map onto the HBAI's deprivation score. We then tested the invariance of the five classes' structure across two groups. The results show that classifying material deprivation requires a multi-dimensional approach, and the structure identified is comparable across groups.

Compared to other latent variable models, Latent Class Analysis allowed us to gain a more nuanced understanding of material deprivation. Based on the results discussed above, material deprivation of families in the UK is more complex than the generally used binary classification of deprived vs non-deprived. Using LCA, we identified five typologies of deprivation that portray a need for choices concerning which items a family should go without based on their financial means and personal values. This highlights the profound impact of deprivation on individuals' autonomy in making choices. The inability to access items considered essential by societal standards results in a significant loss of autonomy, reflecting the deeper consequences of material deprivation.

[13] A probability of 1 suggests that all individuals within that latent class are extremely likely to exhibit the specific characteristic.

[14] the assumption that the structure of material deprivation remains consistent across various societal groups.

Figure 1: Material deprivation items and latent classes distribution - total sample

Figure 2: Density of FRA material deprivation score and latent class membership - total sample

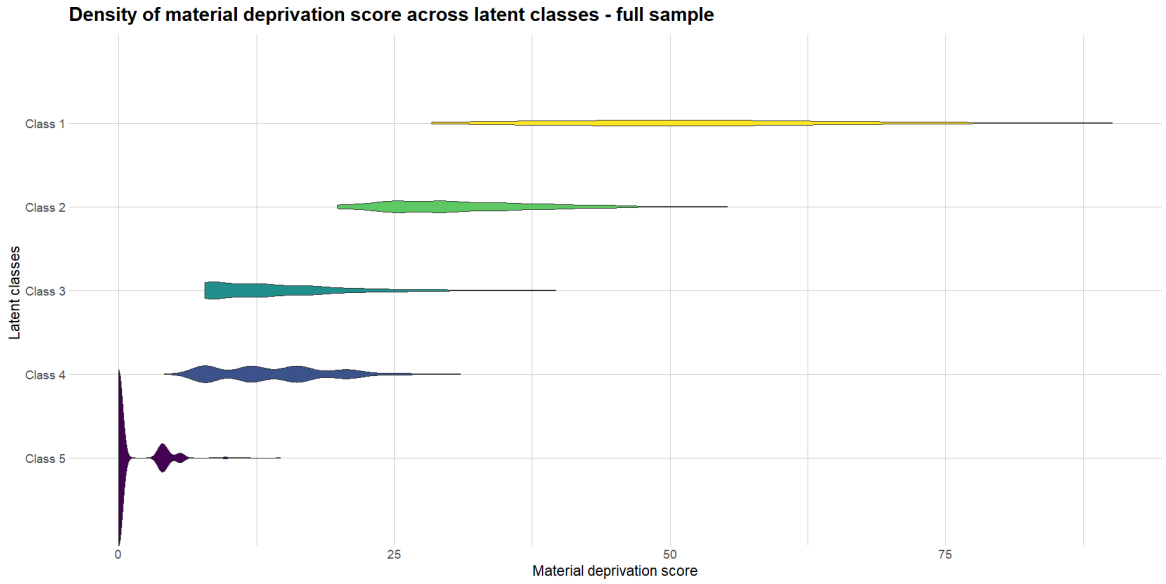


Figure 3 offers an insightful illustration of how families navigate the interplay between item prioritisation and financial constraints given their deprivation classification. From the figure, we can observe how items might become available to a family based on their deprivation class. For example, while classes three and four exhibit comparable levels of deprivation and financial resources, their choice/prioritisation of items differs. This delineation allows us to conceptualise these classes in terms of choosing between social activity deprivation and material possession deprivation, with neither being a desirable state.

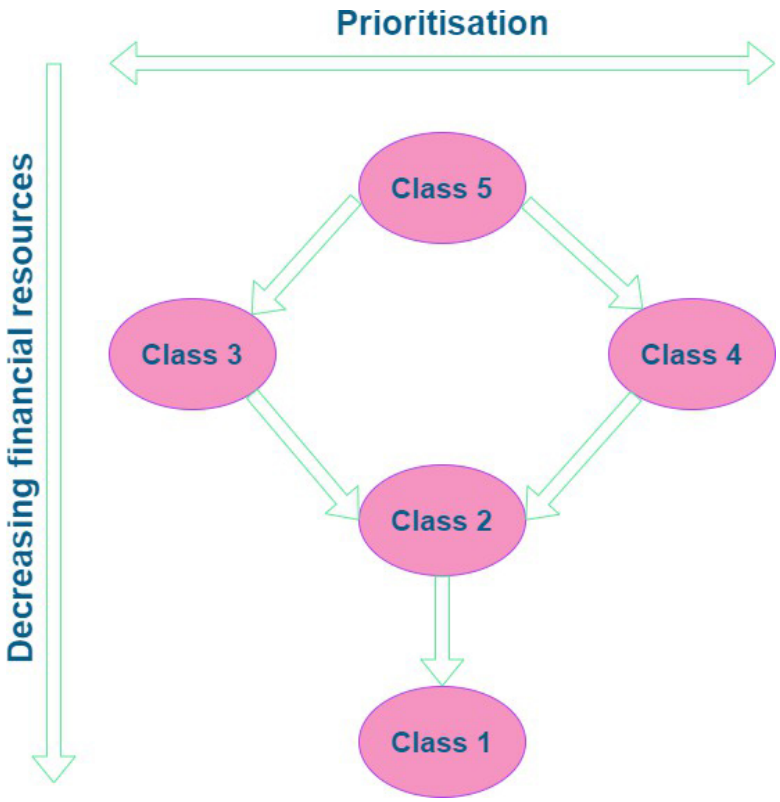
The distinction in decision-making patterns among these classes makes it clear that a dichotomous classification hides these nuanced experiences of deprived families. Figure 3 shows a decline in the autonomy of choice across classes. From class five, where families can choose freely among items to class one, where there is little to no freedom in accessing basic necessities[15]. This captures the diminishing autonomy across the deprivation spectrum.

This study also used measurement invariance to show that the latent structure of deprivation is robust across families with children with and without disabilities. Despite the generally more challenging circumstances faced by families with child disability, the LCA deprivation structure shows a similar decision-making model. Nevertheless, those whose children have disabilities still struggle more (see Table 4).

The density violins in Supplementary Figures 1 and 2 offer an interesting perspective on the interaction between the LCA deprivation classes and the HBAI deprivation

[15] Class five may also hide some variation in terms of economic statuses, covering both the "just managing" individuals and those who are affluent. The "just managing" group, while not forced to choose between essential needs, might face limitations regarding the quality or variety of their purchases.

Figure 3: Priorities on latent classes



score. For families with disabled children, those who are extremely deprived are concentrated in a higher material deprivation score bracket, often surpassing the 60-mark. In contrast, families without disabled children do not exhibit such pronounced clustering at the higher end of the deprivation spectrum. This suggests that, within class five, families with disabled children face more severe deprivation than those without disabled children. Moreover, the violins for families with disabled children display a more concentrated clustering across each class, whereas in families without disabled children, the distribution is more dispersed. This could be due to additional expenses and challenges associated with disability care, which may not be as variable as in other family contexts, leading to more uniformly high deprivation scores within these groups.

These findings illustrate the limitations of a binary classification method with an arbitrary threshold, which can limit our understanding of the nuanced experiences of deprivation. The distinct clustering observed in families with disabilities underscores the need for a more granular approach to understanding material deprivation, one that captures the varied intensities and experiences of hardship in different family contexts. Overall, the results show material deprivation as a latent construct formed of more than a unidimensional binary measure. While the enforced lack approach might influence the results, this approach aligns with the HBAI methodology, allowing for direct comparisons.

Despite its key contributions, the study has some limitations. While the FRS is a key source of material deprivation data and was the basis for our analysis, it is not the only large-scale dataset available in the UK. Our reliance on this dataset restricts our analysis to the specific range of items related to deprivation included in this survey. Second, the cross-sectional nature of the FRS limits our ability to explore families' transition between different dimensions of deprivation. Longitudinal birth cohort studies such as the Millennium Cohort Study [43] and Growing Up in Scotland [44] which collect material deprivation data, particularly focused on children and families could be used for further analysis. It would be specifically interesting to observe the effect of disability over time, as well as how the prioritisation choices might change. Finally, given the change in material deprivation items (see: McKnight et al. [45]), future research should test the multidimensionality of these and their invariance across groups.

Finally, as Shamrova and Lampe argued in their paper, context is essential when analysing material deprivation items [27]. However, the dataset used lacks contextual factors of material deprivation. For example, not having friends around, does not mean children do not meet their friends in other environments. Overall, this study provides a multidimensional child deprivation approach in the UK. The study offers a detailed picture of the deprivation dimensions of families with children and exemplifies the need for a multidimensional approach rather than a binary classification. Thus, this study provides the foundation for further research into multidimensional material deprivation. For instance, an investigation into intra and inter- item class variability (what is each family giving up). Longitudinal analysis to observe the transition between classes of the same family and the interaction between socio-demographic elements and typologies of deprivation.

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Statement on conflicts of interest

The authors declare no competing interests.

Ethics statement

This article does not contain any study with human participants performed by any of the authors.

Data availability statement

The datasets used in this study are available in the UK Data Service repository, with the identifiers: http://doi.org/10.5255/UKDA-SN-5828-12 and http://doi.org/10.5255/UKDA-SN-8802-1.

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Supplementary material

Supplementary Table 1: Model fit indices for LCA models with the full sample and with the groups of interest

Nb. Classes	Total Sample - families with children (N = 5395)			
	AIC	**CAIC**	**BIC**	**Chi-squared**
2	51870.43	52166.57	52127.57	10408.37
3	49315.41	49763.41	49704.41	7813.35
4	48529.28	49129.15	49050.15	6987.23
5	47814.81	48566.54	48467.54	6232.76
6	47519.77	48423.36	48304.36	5897.71
7	47428.19	48483.65	48344.65	5766.13
8	47366.04	48573.37	48414.37	5663.99
9	47310.65	48669.84	48490.84	5568.59
10	47263.37	48774.42	48575.42	5481.31
	Families with no child disability (N = 4699)			
	AIC	**CAIC**	**BIC**	**Chi-squared**
2	42649.8	42940.55	42901.55	8433.62
3	40669.04	41108.89	41049.89	6412.86
4	40000.81	40589.76	40510.76	5704.63
5	39502.63	40240.68	40141.68	5166.45
6	39275.04	40162.19	40043.19	4898.86
7	39204.95	40241.21	40102.21	4788.77
8	39161.16	40346.52	40187.52	4704.98
9	39120.66	40455.12	40276.12	4624.48
10	39090.96	40574.52	40375.52	4554.78
	Families with no child disability (N = 696)			
	AIC	**CAIC**	**BIC**	**Chi-squared**
2	9010.18	9226.45	9187.45	2928.66
3	8498.07	8825.25	8766.25	2376.55
4	8337.85	8775.94	8696.94	2176.33
5	8256.04	8805.03	8706.03	2054.51
6	8222.03	8881.93	8762.93	1980.5
7	8207.33	8978.13	8839.13	1925.8
8	8208.41	9090.12	8931.12	1886.89
9	8216.03	9208.65	9029.65	1854.5
10	8223.68	9327.21	9128.21	1822.16

Supplementary Table 2: Latent class prevalence and response probabilities (do not have items) – full sample

	Class 1 (0.05)	**Class 2 (0.13)**	**Class 3 (0.11)**	**Class 4 (0.14)**	**Class 5 (0.58)**
holiday not with relatives	0.94	0.97	0.16	0.96	0.04
holiday away	0.91	0.88	0.02	0.87	0
savings of at least £10 a month	0.87	0.79	0.55	0.45	0.07
replace furniture	0.86	0.83	0.52	0.18	0.01
money for self	0.84	0.76	0.46	0.3	0.03
organised activity	0.76	0.1	0.05	0.04	0
fix electrical goods	0.76	0.73	0.34	0.07	0.01
home insurance	0.71	0.6	0.24	0.26	0.01
decorate home	0.7	0.53	0.28	0.12	0
hobby activity	0.68	0.02	0.03	0.03	0
leisure equipment	0.54	0.12	0.05	0.02	0
have friend round	0.49	0.05	0.04	0.02	0
school trip/ playground	0.46	0.11	0.06	0.02	0
up to date with bills	0.42	0.23	0.08	0.04	0.01
keep house warm	0.42	0.22	0.07	0.02	0.01
celebrations	0.31	0.03	0.01	0	0
space to play safely	0.3	0.13	0.09	0.06	0.03
eat fruit/ veg	0.26	0.03	0.01	0	0
winter coat	0.1	0.01	0	0	0

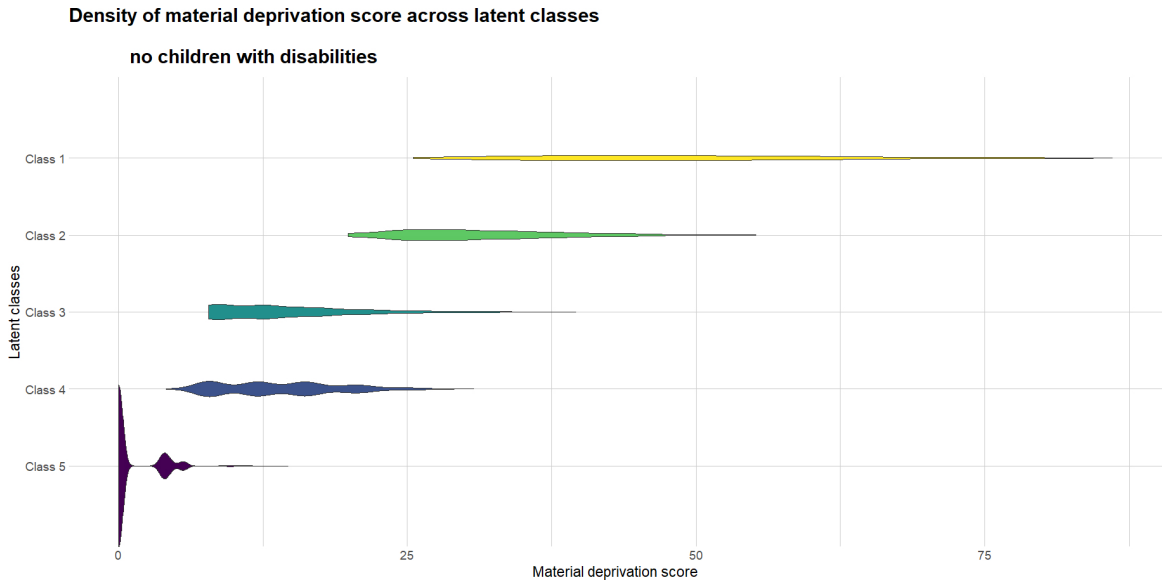
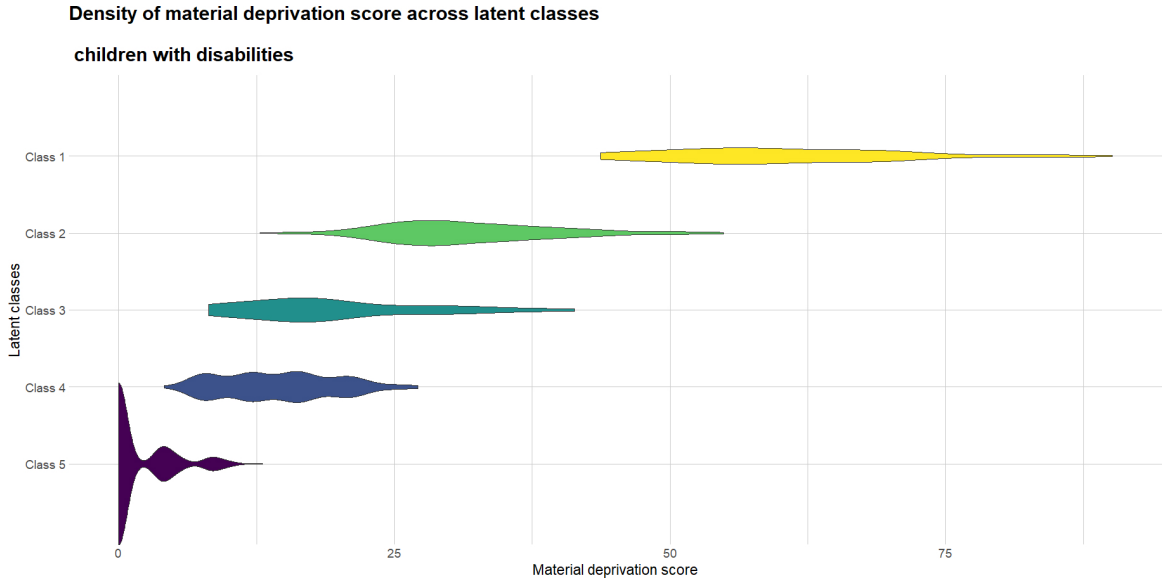
Supplementary Table 3: Goodness of fit statistics for LCA models with 21 items of deprivation

	AIC	**CAIC**	**BIC**	**Gsq**
1	53006.61	53333.12	53290.12	11202.61
2	50431.56	50925.12	50860.12	8583.56
3	49645.41	50306.02	50219.02	7753.4
4	48923.88	49751.55	49642.55	6987.88
5	48630.66	49625.37	49494.37	6650.65
6	48538.95	49700.72	49547.72	6514.95
7	48475.5	49804.32	49629.32	6407.49
8	48422.87	49918.74	49721.74	6310.87
9	48360.6	50023.52	49804.52	6204.59

Supplementary Table 4: Summary statistics

	% of families with No child disability	**% of families with child disability**
	N = 4699	**N = 696**
Education		
Degree or above	47.31	28.16
No qualifications	6.83	12.07
Qualification below degree level	45.26	59.48
Student	0.6	0.29
Employment status		
At least one adult in work	90.44	71.7
Workless family	9.56	28.3
Single parent		
Couple	75.63	58.62
Lone parent	24.37	41.38
Occupational Classification		
Admin/ Skilled trade/ Caring	24.15	31.61
Elementary/ None	42.69	28.59
Managers, Prof, Asso Prof	12.39	19.11
Sales/ Process/ Plant operator	20.77	20.69
	Average	Average
Number of adults in BU	1.76	1.59
Age of the youngest child	6.94	8.63

Supplementary Figure 1: Density of FRA material deprivation score and latent class membership



Supplementary Figure 2: Density of FRA material deprivation score and latent class membership