DATA NOTE

The external housing environment of participants in the Avon Longitudinal Study of Parents and Children (ALSPAC): a resource for studies of influences on health [version 2; peer review: 3 approved, 2 approved with reservations]

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\textbf{Abstract}

Background: Early life environmental health exposures related to housing can have a significant impact on an individual's physical and mental health and physical development. Housing exposures can fall into two main areas – a representation of social circumstances and physical conditions.

Methods: During pregnancy and post-delivery, self-completion questionnaires concerning the housing environment were administered to the ALSPAC (Avon Longitudinal Study of Parents & Children) study mothers and their partners until the study offspring were aged 18. Data collected included types of housing, housing tenure, numbers of rooms in the home, whether shared or sole use of kitchen and indoor flushing toilet, household moves, Council Tax band, difficulties in affording rent/mortgage and becoming homeless. Here we also describe the historic development of housing in the Bristol and surrounding Avon areas.

Results: Data collected included the tenure (e.g., owned/rented) of the home, its size (indexed by the number of rooms), the presence of overcrowding (measured by the number of residents per room), presence of amenities, and frequency of household moves. This information was collected on over 13,000 women during pregnancy >8000 at age 10 and >4000 at 18 years. Council Tax bands were asked at 10 and 18 years.

Conclusions: This is the first of two Data Notes on the housing type and housing circumstances of the families enrolled in ALSPAC. The second Data Note will detail their internal housing conditions. The
data provides an excellent resource for researchers when considering the influences of housing on physical and mental health and development.

**Keywords**
ALSPAC, housing, environment, well-being, physical health, childhood, longitudinal cohort

This article is included in the **Avon Longitudinal Study of Parents and Children (ALSPAC)** gateway.
Introduction

Housing quality and housing instability can have significant impacts on physical and psychological health, including increased instances of depression and anxiety in women (Suglia et al., 2011); morbidity in infancy (e.g. Baker et al., 1998); asthma and allergies in childhood (e.g. Choi et al., 2017); and general ill-health (e.g. Marsh et al., 2000). Therefore, housing type may be an important consideration when looking at the prevalence of morbidity in parents and their offspring. In this paper we describe the data collected from families enrolled in the Avon Longitudinal Study of Parents and Children (ALSPAC), centred on the city of Bristol and surrounding areas in South-West England, regarding their housing type and circumstances during the first 18 years of life. To aid international readers, we provide a brief history of the area and the most common housing stock. The study provides an excellent resource for researchers when considering health and/or developmental outcomes of the study children and/or their parents over time. This includes data on the homes of the parents in childhood (e.g. H questionnaire: Your Health, Events & Feelings). It would assist researchers to also refer to the paper by Boyd and colleagues (2019) which describes data available in ALSPAC such as address histories, Index of Multiple Deprivation (IMD), geocoding, external air pollution, background radiation etc, and describes linkage to third-party records, whilst protecting confidentiality.

Historical background and the manmade environment

There is evidence that Bristol and the surrounding areas of the former county of Avon have been inhabited by humans since the Stone Age, with various archaeological sites such as Stanton Drew stone circle (David et al., 2004) and barrows (e.g. the bowl barrow at Southmead), iron age hill forts (e.g. in Henbury), Clifton Hill and Kings Weston Hill camps and the Druid Stoke burial chamber (in Stoke Bishop) (Ancient & Scheduled Monuments, 2022). The ancient settlement of Brycgstow (Old English: Place of the Bridge) grew up around the confluence of two rivers, the Frome and the Avon (which gave sea access via the River Severn at Avomouth) before 1000 A.D. By 1066, the population was around 4000, centred around the castle (built <1088, destroyed 1656) and within the walled town. The port was already important between the 11th and 13th centuries (in the 1240s the city port was expanded by diverting the river Frome into a deep canal (St. Augustine’s Reach). At this time, wine was the main import (from Spain, Portugal and Southwest France). Bristol exports included dyed woollen products, lead, sail cloth and rope. However, one of the exports to Dublin between the 10th and 15th centuries was Welsh and Northern English slaves. By the 1460s it was the country’s second port trading with Ireland, Iceland and Gascony. Around 1480, Bristol’s Society of Merchant Venturers began sponsoring exploration of the north Atlantic. Bristol attained city status in 1542 (Wikipedia, 2022).

As such, the city centre’s secular buildings and those in the surrounding area range in date and style from the Tudor/Elizabethan (1485-1603), Georgian (1714-1836), Victorian (1837-1901) and Edwardian (1901-1910) eras, to inter-war housing through to the contemporary, with ongoing improvements, gentrification, repurposing, and new builds.

Much of Bristol’s housing grew up around the industries that flourished in the old city including soap, potteries and glass production, tobacco, sugar and chocolate, leather, textiles, lead shot manufacturing and breweries. These influenced the layout and expansion of housing across the city (Harvey & Press, 1988), with an emphasis on cheap accommodation for employees, typically ‘two up-two down’ houses.

By far, the greatest impact on house building in the Georgian period was the trans-Atlantic slave trade. Between 1700 and 1804, 2000 Bristol ships carried an estimated 500,000 enslaved Africans to the New World. Indeed, in 1747, it was Britain’s busiest slaving port. The city also processed much of the slave-produced goods such as sugar and tobacco. The trade brought (directly or indirectly) great wealth to many merchants in the city, who moved out of the central port area and up the hill to rural Clifton where many of the elegant town-houses, crescents and villas they built can be found today. After Bristol’s decline as a slaving port, Clifton had one of the highest numbers of retired plantation owners in Britain (Lewin-Turner, 2022). Many merchants with connections to the slave trade (e.g., Edward Colston, the Farr family, the Wills family) were also great philanthropists creating schools, almshouses and the Theatre Royal.

Until 1949, there was extensive coal mining particularly to the north-east of Bristol (e.g., the Kingswood and Fishpools areas) and Bedminster to the south (see Figure 1), which led to the expansion of established villages where much of the original
Figure 1. Avon area showing the main small towns and villages. Map credit: Google Maps.

(Victorian) housing stock remains. Currently, the city has significant aerospace, media, information technology and financial services sectors, as well as tourism and education, with two universities with a combined student population of around 60,000.

The city stands at the junction of the M4 and M5 motorways, with the M32 allowing direct access to the city centre (Figure 2). Like many old British cities, the road system was not designed to cope with current traffic volumes and peak commuter time congestion. This has raised noise pollution (BBC News England, 2015) and air quality (Clean Air for Bristol, 2022) concerns. As of 28th November, 2022 Bristol City Council has introduced a ‘Clean Air Zone’ (see Bristol’s Clean Air Zone).

The housing stock
Bristol city centre is predominantly made up of a mixture of large buildings dating from the Georgian period, and post-war reconstruction to replace those lost to bombing, decay or modernisation (Figure 3). The Georgian houses are largely of single skin construction and often made of sandstone, leading to an increased risk of damp and crumbling stone due to its porous nature. Buildings from the Victorian period radiating outwards from the centre in time to a predominance of housing built in the inter-war period and more modern housing in the suburbs. These are illustrated in Figure 4 and show the diversity of ALSPAC homes. ALSPAC respondents have also reported living in caravans, houseboats and ‘prefabs’. The changing priorities of politicians, housing developers and in building standards over time result in each housing style bringing its own challenges (Hashemi, 2013).

Following the Housing & Town Planning Act of 1919, local councils became the main providers of lower cost housing and were providing ‘garden estates’ in the suburbs of 3-bedroom family homes of around 1000sq feet. However, these were largely rented to more affluent working families. By 1924, a
need for cheaper, smaller housing (~620sq feet) was required to house those displaced by increasing slum clearance. In Bristol, for example, there was a need to rehouse 25,000 inhabitants residing in 5000 unfit dwellings. The 1930 Housing Act stimulated further slum clearance with heavy subsidies to councils building social housing. Council houses were most usually built of red bricks in a certain style and there are usually at least four of these houses in every village.

Bristol suffered heavy bombing during the Second World War, when almost 85,000 homes were destroyed. It was a target due to its proximity to Filton airfield and the Bristol Aeroplane Company (which built the Blenheim bomber and Beaufighter); the harbour in the city centre, the docks at Avonmouth and Portishead, and was an important railway junction. The outer suburbs and rural areas also suffered from bombing e.g. Parnall Aircraft works at Yate, Portishead docks and Weston-super-Mare. Although no area was left unscathed, and the city centre suffered severely, the residential suburbs most affected included Fishponds, Eastville, Whitchurch, Cotham and Redland (Bristol during World War 2; Historic England, 2022). Post-war there was a huge need for new homes to rehouse families and returning military personnel (Drew, 2022). This resulted in massive development of the outer edges of Bristol where much of the housing dates from the 1940s to 1980s with the timeline...
predominantly radiating outwards from the centre. The same pattern can be seen in small towns such as Weston-super-Mare, Clevedon, Nailsea, Yate and Thornbury. Destroyed buildings in the city centre were also replaced leading to a snaggletoothed skyline (Figure 3) where the Georgian/Victorian buildings are interspersed with post-war buildings in noticeably different styles.

Parts of Bristol still retain the old prefabricated ('prefabs') temporary homes erected to house bombed-out families (Drew, 2022) (see Figure 4), and in fact has the highest number of prefabs (330) still remaining in England. They provided homes for young families and also employment for factory workers who needed new items to manufacture. Many of these 'prefabs' remain despite the City Council’s attempts to replace them with more modern housing. This is partly due to historic importance and the fondness inhabitants have for their homes and the communities that have built up around them (BBC News England, 2001).

Post-war expansion of council housing during the 1950s and 1960s consisted of the development of more peripheral estates on or close to the edge of the city. By the 1970s the council was building fewer homes and concentrated on upgrading and maintaining their current stock. The Housing Act of 1980 enabled eligible council tenants the 'right-to-buy' their homes at up to 60% off the market value and many did so. Since the 1990s there has been increasing reliance on private sector building developments to include a percentage of ‘affordable’ housing, managed by Housing Associations. For a more detailed overview see The History of Council Housing (uwe.ac.uk) (2008).

Standard of housing in Bristol
According to Ige et al. (2019) in 2015, 19% of the houses in the UK were not considered to be of a decent standard. They were not adequately maintained, did not have a reasonable standard of facilities and services nor were they appropriately thermally regulated. Older buildings are more at risk of poor standards.
The Joint Strategic Needs Assessment Health and Wellbeing Profile 2022/23 (2022) showed that in Bristol, children living in the older, more affluent areas of the city (e.g. Clifton, Redland, Cotham and Kingsdown) were least likely to experience poverty, whilst those living in similarly aged dwellings in more deprived areas such as St. Pauls and St Werburghs had poorer quality housing. Therefore, whilst ownership of Georgian/Victorian houses in affluent areas might be considered an indicator of wealth, these houses were built to last but fall short of modern standards, with expensive upgrades required for treatment of damp, for crumbling masonry, lead pipe replacement and installation of double-glazing. The majority of privately owned Georgian/Victorian homes in the affluent areas have been upgraded; and some (often in the private rental sector) had been poorly maintained in the past, but are now much better regulated, with fire doors, safety certification and improved insulation. Whilst these older homes may look impressive, are certainly very valuable, and the city remains a desirable place to live (Hawker, 2022), the ability to buy and run such large homes has meant that many have been split into flats/apartments or Houses in Multiple Occupation (HMOs – these are defined as a building/flat where more than one household share basic amenities such as a toilet, bathroom or kitchen). Due to complex preservation requirements (see Bristol City Council 2022a; Bristol City Council 2022b) and private landlords wishing to keep costs low, many of these buildings, in the historic heart particularly, remain under-developed with damp problems, inadequate heating and absence of double-glazing.
buildings are traditionally less energy efficient than new builds (Moran et al., 2012). The lack of heat retention and rising heating costs lead to families inadequately ventilating the home. For HMOs, Bristol City Council have recently introduced a licensing scheme (Bristol City Council, 2022c), whereby landlords must register any HMOs to enable inspection to ensure living standards are acceptable.

Housing outside Bristol
About 25% of the ALSPAC families live in the surrounding small towns (with 1991 populations) such as the coastal towns south-west of Bristol: Weston-Super-Mare (77,000), Clevedon (21,275), Portishead (22,400); Nailsea (15,500) to the south; and Yate/Chipping Sodbury (2011 pop. 35,000), Thornbury (2011 pop. 12,000) to the north, as well as in more rural areas. The housing in these towns is of a similar mix and spread to most of Bristol. The seaside resorts of Weston-Super-Mare, Clevedon and Portishead became popular in the Victorian period (Roethe, 2020). These areas developed hugely post-war, along with old villages such as Thornbury and Chipping Sodbury with newer homes dating predominantly from the 1960s through to the 1980s. Yate, however, is considered a “new town” sparsely populated up until the post-war period, a huge amount of building has occurred since the 1960s.

Methods
ALSPAC sample
Pregnant mothers (n=14,541) resident in the former county of Avon in South-West England were recruited into the ALSPAC study. These mothers all had an expected delivery date between 1st April 1991 to 31st December 1992 and usually delivered at one of the three main maternity units (St. Michael’s (central Bristol), Southmead (north Bristol) and Weston-Super-Mare General Hospital). Of the initial 14,541 pregnancies enrolled, there were a total of 14,676 fetuses and 14,062 live births. Of these children, 13,988 were still alive at 1 year of age. Mothers were considered enrolled if they had returned at least one questionnaire or attended a “Children in Focus” clinic by 19th July 1999. At the age of 7, the study team reached out to eligible mothers who had not joined the study initially and recruited additional families in order to boost numbers. Therefore, from age 7 the total sample number is 15,454 pregnancies, resulting in 15,589 fetuses of which 14,901 were alive at 1 year of age (Boyd et al., 2013; Fraser et al., 2013; Northstone et al., 2019).

Data collection
Data has primarily been collected via multiple, self-completion questionnaires, which were sent to the study mother, at frequent intervals during pregnancy and throughout the study child’s life. Detailed data were collected on the types and size of housing, ownership status, frequency of household moves, living with parents and becoming homeless. Other reports of housing conditions in childhood were reported by parents using free text (this can be made available to researchers for coding on request). These data were collected even if the respondent had moved out of area or abroad. Subsequently, record linkage to the NHS and National Statistics Postcode Lookup facility, linkage with third-parties’ physical environment records or social or built environment records enables geocoding. This includes the location of schools attended by the offspring. Some ALSPAC publications have relied on geocoded data or geospatial techniques; or used location-based data as covariates such as adjusting for social position using the Index of Multiple Deprivation (IMD); or used geographical areas to support multilevel modelling (see Boyd et al., 2019 for more detail). For those wishing to research the broader external environment (e.g. proximity to main roads, green spaces and power lines) it is worth reading this paper in conjunction with Boyd et al., 2019.

Paper-based questionnaires were administered between 1990 and 2011 via post. In accordance with the advice of the ALSPAC Ethics and Law Committee, partners were only included in the study if the mothers wished to include them. Questionnaires were sent to the mother who then passed the questionnaire on to the partner with a separate pre-paid return envelope. This method meant that ALSPAC was not able to follow-up or communicate directly with the partners (Boyd et al., 2013; Fraser et al., 2013). Therefore, the numbers of partners’ questionnaires returned were less than those received for the mothers. Around 75% of mothers had partners who participated in the study.

Each questionnaire and associated dataset were given a letter as an identifying prefix. The variable naming convention for these datasets uses the letter prefix followed by the unique number of the variable. For example, variable a008 is from questionnaire A, variable number 008. Variables from partner questionnaires use a double-letter prefix plus variable number (e.g. pk2030).

Table 1 shows the time points each of the parents’ questionnaires were administered that included questions on housing. Questionnaires A, B, C, D, PA and PB were completed during pregnancy (see Iles-Caven et al., 2020) for full details). Post-delivery, questionnaires were sent to parents at regular intervals until the child was 18 years of age.

All of the ALSPAC questionnaires can be viewed here. The ALSPAC team have provided a useful Questionnaire Topic guide which summarises the information contained in each questionnaire.

A fully searchable data dictionary and variable search tool exist on the study website. This tool provides an easy identification tool for researchers looking for variables relating to a specific topic over the length of the study.

Results
One of the reasons Avon had been chosen as the site of the cohort study had been the relatively low levels of outward migration. During pregnancy both the mother and her partner were asked “How long have you lived in or near Avon?”, with the following possible responses: <1 year; 1–4 years; 5–9 years; 10+ years and whole life (variables a002 and pa002). For mothers, 53.4% had lived their entire life in the area compared with 50.9% of partners. Numbers for 10+ years were 16.9% and 20.4%; 5–9 years 11.1% and 11.9%; 1–4 years 13.6% and 13.5%; and for less than 1 year 5% and 3.3% respectively.
Table 1. Timeline of questionnaires concerning housing sent to the study child’s parents.

| Mothers Questionnaires      | Partners Questionnaires     |
|-----------------------------|-----------------------------|
| Questionnaire prefix        | Approximate age of study child | Questionnaire prefix | Approximate age of study child |
| A*                          | 8–28 weeks gestation        | PA*                  | 12 weeks gestation            |
| B*                          | 18–23 weeks gestation       | PB*                  | 18 weeks gestation            |
| C*                          | 32–40 weeks gestation       | PC                   | 8 weeks                      |
| D*                          | 14–37 weeks gestation       | PD                   | 8 months                     |
| E                           | 8 weeks                     | PE                   | 21 months                    |
| F                           | 8 months                    | PF                   | 33 months                    |
| G                           | 21 months                   | PG                   | 47 months                    |
| H                           | 33 months                   | PH                   | 61 months                    |
| J                           | 47 months                   | PJ                   | 73 months                    |
| K                           | 61 months                   | PK                   | 85 months                    |
| L                           | 73 months                   |                       |                             |
| M                           | 85 months                   | PM                   | 110 months                   |
| P                           | 110 months                  | PP                   | 134 months                   |
| Q                           | 122 months                  |                       |                             |
| R                           | 134 months                  |                       |                             |
| T                           | 18 years                    |                       |                             |

*Questionnaires administered depending on the week of gestation of enrolment

Types of housing

Table 2 describes the type of housing the mother lives in: detached, or semi-detached homes, terraced housing, apartments (flats), room(s) and other types of accommodation (these have not been coded but are available in text format on request). The proportion living in detached homes increased steadily over time whereas those in terraced, self-contained apartments, room(s) and ‘other’ accommodation decreased.

In Table 3 and Table 4 the lowest floors of the accommodation and the number of rooms used for living and sleeping are summarised. The move to lower floors over time is likely a reflection of families with young children applying for and being moved to a council house or being able to afford a home with a garden for a growing family. There are currently 65 old style (council owned) tower blocks in Bristol (11+ stories). These are situated in more deprived areas: Ashton Gate 3, Lawrence Hill 2, Barton Hill 8, Hartcliffe 8, Brislington 2, Bedminster 8, Redfield 1, Withywood 3, Jacob’s Wells 1, Henbury 3, Easton 3, Shirehampton 3, St Jades 2, Kingsdown 6, St George 2, Redcliffe 8, Lawrence Weston 2. Over the last 20 years or so the gradual redevelopment of the former industrial zone around the harbour, the Avon and Frome rivers has resulted in many new luxury flat developments but these are rarely higher than 7/8 floors and not aimed at the social housing sector. However, planning permission has been given to build two blocks of 20+ stories and others are in discussion (Bristol Campaign against Tower Blocks, 2022).

Features of the home that were recorded include the type of kitchen (and whether it is large enough for the family to sit and eat), whether there is an indoor flushing toilet, a garden or a balcony. For each of these features, the mother reported whether or not the family has sole use or whether it was shared with others (Table 5a–Table 5e). It should be noted that the details of whether there is a kitchen without room to sit and eat are not always consistent with the details of the presence of a kitchen with such facilities (Table 5a and Table 5b); this is sometimes due to a failure to respond to the second question having answered the first but may also indicate that there is more than one kitchen in some homes.

Financial aspects

Housing tenure in the U.K. can be complex, but is a good marker of socio-economic status. It distinguishes between homes that were being bought (mortgaged); were owned outright; rented from the Council or rented from a non-profit housing association (social housing); or rented from a private landlord, the latter can be furnished or unfurnished accommodation (Table 6). As previously mentioned, the Housing Act of 1980 allowed long-standing council tenants to purchase their home far below market value and about 2% of ALSPAC respondents indicated that they had done this. This also gave them the option to sell that home in the future at current market value.

All homes are expected to pay a Council Tax, the amount (known as the tax band) being related to the size, layout, character,
Table 2. The type of home. (The variables comprise the questionnaire source and variable number (e.g. a008 is in the A questionnaire administered at 8–28 weeks gestation – see Table 1 for time of administration).

| Variable | N     | Whole Detached | Whole Semi-Detached | End of Terrace | Terrace | Self-Contained Flat | Rooms | Other |
|----------|-------|----------------|---------------------|---------------|---------|---------------------|-------|-------|
| a008     | 13,285| 1,915 (14.4%)  | 4,573 (34.4%)       | -             | 4,284 (32.3%) | 2,117 (15.9%)      | 196 (1.5%) | 200 (1.5%) |
| f306     | 11,097| 1,865 (16.8%)  | 4,080 (36.8%)       | -             | 3,526 (31.8%) | 1,412 (12.7%)      | 74 (0.7%)  | 140 (1.3%) |
| g354     | 10,191| 1,981 (19.4%)  | 3,489 (34.2%)       | 992 (9.7%)    | 2,567 (25.2%) | 1,062 (10.4%)      | 17 (0.2%)  | 83 (0.8%) |
| h264     | 9,539 | 2,064 (21.6%)  | 3,422 (35.9%)       | 926 (9.7%)    | 2,296 (24.1%) | 761 (8.0%)         | 9 (0.1%)   | 61 (0.6%) |
| k5030    | 8,903 | 2,256 (25.3%)  | 3,330 (37.4%)       | 876 (9.8%)    | 1,934 (21.7%) | 426 (4.8%)         | 8 (0.1%)   | 73 (0.8%) |
| m2030    | 8,267 | 2,426 (29.3%)  | 3,092 (37.4%)       | 773 (9.3%)    | 1,643 (19.9%) | 262 (3.2%)         | 5 (0.1%)   | 66 (0.8%) |
| pk2030   | 4009  | 1,360 (33.9%)  | 1,497 (37.3%)       | 336 (8.4%)    | 713 (17.8%)  | 73 (1.8%)          | <5 (0.1%)  | 26 (0.7%) |
| q2040    | 8,013 | 2,641 (33.0%)  | 3,047 (38.0%)       | 723 (9.0%)    | 1,370 (17.1%) | 165 (2.1%)         | <5 (0.0%)  | 65 (0.8%) |

* Details of the other types of accommodation (e.g. caravan, boat) are available as text.

Table 3. The range in lowest levels of living accommodation (the median at all time points was the ground-level floor).

| Variable | Time point | N     | Range       |
|----------|------------|-------|-------------|
| a009     | Pregnancy  | 13,251| Basement – 16th |
| f307     | 8m         | 10,785| Basement – 19th |
| g355     | 21m        | 10,029| Basement – 23rd |
| h265     | 33m        | 9,402 | Basement – 29th |
| k5040    | 5y         | 8,753 | Basement - 15th |
| m2040    | 7y         | 8,176 | Basement - 9th |
| pk2040   | 7y         | 3,990 | Basement - 9th |
| q2050    | 10y        | 7,952 | Basement - 10th |

Table 4. Numbers of rooms in the home used for living or sleeping. (0 will include bedsits, caravans etc).

| Variable | Time point | No. rooms       | N     | Range |
|----------|------------|-----------------|-------|-------|
| a043     | Pregnancy  | No. living rooms excluding kitchen | 13,291 | 0–11  |
| a044     | Pregnancy  | No. bedrooms    | 13,253 | 0–9   |
| a045     | Pregnancy  | Total rooms     | 13,184 | 0–18  |
| f343     | 8m         | No. excluding kitchen | 11,091 | 0–12  |
| f344     | 8m         | No. bedrooms    | 11,054 | 0–9   |
location and value of the home. Bands are based on the rateable value of the property as of 1st April 1991 and rise on average about 2–3% per annum. The current (2022) tax amounts per annum for Bristol City Council range from the lowest band, A (£1,487) to the highest H/I (£4,461). Other councils covering the ALSPAC area are South Gloucestershire and North Somerset, which have slightly lower rates in 2022 than Bristol. This tax covers the costs of the police, education, social care and facilities such as waste and recycling collection, local libraries and upkeep of public spaces, etc. The Council Tax bands of the homes in which the mothers were living when the study children were aged 10 and 18 are shown in Table 7.
Table 5e. Presence of a balcony.

| Variable | Time point | N     | % sole use | % shared | % none |
|----------|------------|-------|------------|----------|--------|
| a050     | pregnancy  | 13,432| 6.5        | 1.0      | 92.5   |
| f350     | 8m         | 11,139| 6.7        | 0.7      | 92.6   |
| g419     | 21m        | 10,058| 5.2        | 0.5      | 94.3   |
| h299     | 33m        | 9,224 | 6.2        | 0.6      | 93.2   |
| k5084    | 5y         | 8,560 | 6.1        | 0.4      | 93.4   |
| m2084    | 7y         | 8,026 | 5.7        | 0.3      | 94.0   |
| pk2084   | 7y         | 3,855 | 7.8        | 0.2      | 92.0   |
| q2094    | 10y        | 7,726 | 5.9        | 0.1      | 93.9   |

Table 6. Housing tenure: Numbers (%) in each category of housing.

| Variable | N     | Mort | BBC  | OO  | RC  | PRF | PRUF | HAR | Other |
|----------|-------|------|------|-----|-----|-----|------|-----|-------|
| a006     | 13,335| 9,469| -    | -   | 288 | 1,918| 575  | 395 | 220   | 470  |
| f304     | 11,091| 8,299| -    | -   | 246 | 1,485| 249  | 354 | 180   | 278  |
| g352     | 10,204| 7,691| 209  | 96  | 1,278| 195  | 340  | 180 | 215   | 196  |
| h262     | 9,579 | 7,290| 220  | 117 | 1,115| 148  | 297  | 196 | 196   | 196  |
| k5010    | 8,898 | 6,877| 74   | 254 | 960  | 105  | 265  | 134 | 209   | 180  |
| m2010    | 8,275 | 6,535| 81   | 334 | 714  | 61   | 230  | 173 | 37    | 72   |
| pk2040   | 4018  | 3426 | 33   | 168 | 170  | 28   | 84   | 37  | 72    | 110  |
| q2010    | 8,031 | 6,280| 127  | 527 | 548  | 33   | 209  | 197 | 110   | 110  |
| t1010    | 4,154 | 2,770| 12   | 953 | 120  | 20   | 134  | 89  | 56    | 56   |

* Mortgaged included owned outright.
Mort = mortgaged; BBC = being bought from the Council; OO = Owned outright; RC = Rented from the Council; PRF = private rented, furnished; PRUF = private rented unfurnished; G = Housing Association rented; Other = eg. Boat, caravan (details available as text)

Table 7. The Council Tax band of the study participants’ homes (A is the lowest; H/I the highest).

| Variable | N  | A   | B  | C  | D   | E   | F   | G   | H/I |
|----------|----|-----|----|----|-----|-----|-----|-----|-----|
| q2020    | 5,178| 233 | 1,319| 1,241| 1,169| 607| 335| 230| 44 |
| t1013    | 2,750| 83  | 550 | 652 | 713  | 358| 216| 146| 32 |

* The median Council Tax band in Bristol is B, and C in S Glos and N Somerset.
Information was collected on whether the parents reported having difficulty in paying for their accommodation. Table 8 shows that the proportion stating they had difficulties reduced over time.

**Stability of the home**

Many of the mothers moved home before and during the child’s life: three-quarters had moved in the 5 years prior to the pregnancy, and subsequently over 10% had moved during each of the first 4 years of the child’s life (Table 9). In parallel there were small numbers of mothers and their partners who had been made homeless during the pregnancy and subsequently, this reduced over time (Table 10). Reported homelessness is likely to mean the family unit may have sought emergency accommodation via the City Council and/or resided in temporary accommodation, such as a ‘Bed and Breakfast’ or hotel or with family and friends.

Not all families were living in their own home – during pregnancy 6% were living in their parents’ home, but this reduced to around 1% by the time the children were aged over 2 years, and less still as time went on (Table 11).

**Strengths and limitations**

The strength of this data is that the ALSPAC dataset is large with over 14,000 mothers initially enrolled in the study (Boyd et al., 2013) and the ongoing support and commitment from the study families. The only inclusion requirements at enrolment were the geographical location of residence and the expected date of delivery. The participants recruited to the

---

**Table 8. How difficult it is to pay the rent or mortgage.**

| Variable Name | N   | Time point | Very difficult | Fairly difficult | Some difficulty | Not difficult | Paid by Social Security # |
|---------------|-----|------------|----------------|------------------|-----------------|--------------|--------------------------|
| c523          | 11,999 | Pregnant  | 4.6%           | 7.7%             | 17.9%           | 69.7%        | NA                       |
| f803          | 11,114 | 8 m       | 4.8%           | 8.4%             | 19.3%           | 67.6%        | NA                       |
| pd683         | 7,052  | 8 m       | 5.5%           | 9.3%             | 22.9%           | 62.3%        | NA                       |
| g838          | 10,065 | 21 m      | 3.3%           | 7.2%             | 16.6%           | 64.7%        | 8.2%                     |
| pe463         | 6,066  | 21 m      | 3.4%           | 6.9%             | 19.1%           | 66.3%        | 4.3%                     |
| k6203         | 8,772  | 5 years   | 1.6%           | 4.2%             | 13.8%           | 72.0%        | 8.5%                     |
| r9003         | 7,426  | 11 years  | 1.1%           | 2.6%             | 10.3%           | 76.1%*       | NA                       |
| pp9003        | 3,558  | 11 years  | 0.7%           | 2.1%             | 10.6%           | 81.1%        | 5.5%                     |

*Further 10.1% stated that they were not responsible for paying; NA = not asked
# Monetary assistance from the state for people with an inadequate or no income.

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**Table 9. Moving home.**

| Moved during period               | Variable name | Proportion (N) moved |
|-----------------------------------|---------------|---------------------|
| From 5 years before pregnancy     | a005          | 75.9% (9917)        |
|                                   | pa005         | 74.6% (6239)        |
| 1st half of pregnancy             | b591          | 10.2% (1214)        |
|                                   | pb181a        | 10.5% (1040)        |
| 1st 7m of pregnancy               | c470          | 13.8% (1654)        |
| Mid-pregnancy to 4wk PP           | e421          | 12.2% (1418)        |
| Mid-pregnancy to 8 wks PP         | pc221a        | 11.7% (972)         |
| In 1st 8 months PP                | f302          | 14.1% (1523)        |
| Moved during period | Variable name | Proportion (N) moved |
|---------------------|---------------|---------------------|
|                     | pd241a        | 10.8% (758)         |
| 8 – 21m             | g321a         | 16.7% (1718)        |
|                     | pe321a        | 15.1% (927)         |
| 18 – 33m            | h231          | 19.9% (1903)        |
|                     | pf5021        | 18.3% (998)         |
| 30 – 47m            | j321          | 19.6% (1878)        |
|                     | pg3021        | 17.7% (900)         |
| 4 – 5y              | k4021a        | 13.1% (1170)        |
|                     | ph4021        | 12.8% (575)         |
| 5 – 6y              | l4021         | 12.7% (1079)        |
|                     | pj4021        | 12.2% (542)         |
| 6 – 9y              | p4021         | 24.2% (1896)        |
| At 10y              | pm2021        | 23.0% (831)         |
| 9 – 11y             | r5021         | 17.0% (1274)        |
|                     | pp5021        | 16.0% (578)         |
| 17 – 18y            | t3320         | 4.4% (181)          |

*No. of moves in period of time
*Age or date at last move

**Table 10. Made homeless.**

| Became homeless during period | Variable name | Proportion (n) homeless |
|--------------------------------|---------------|------------------------|
| 1st half of pregnancy         | b593          | 1.7% (205)             |
|                                | pb183         | 1.2% (121)             |
| 1st 7m of pregnancy           | c472          | 2.3% (268)             |
| Mid-pregnancy to 4wks PP      | e423          | 1.3% (148)             |
| Mid pregnancy to 8wks PP      | pc223         | 1.1% (88)              |
| First 8 months PP             | f243a         | 2.2% (125)             |
|                                | pd243         | 0.7% (52)              |
| 8 – 21m                       | g323a         | 1.0% (105)             |
|                                | pe323         | 0.5% (30)              |
| 30 – 47 m                     | j323          | 0.8% (78)              |

| Became homeless during period | Variable name | Proportion (n) homeless |
|--------------------------------|---------------|------------------------|
| 4 – 5y                         | k4023a        | 0.5% (47)              |
|                                | pg3023        | 0.5% (25)              |
| 5 – 6y                         | l4023         | 0.6% (49)              |
|                                | ph4023        | 0.3% (15)              |
| 6 – 9y                         | p4023         | 0.8% (62)              |
|                                | pj4023        | 0.4% (16)              |
| 9 – 11y                        | r5023         | 0.5% (35)              |
|                                | pm2023        | 0.3% (12)              |
| 17 – 18y                       | t3320         | 0.1% (5)               |

PP = postpartum
Table 11. Whether the mother lives in her own home, with her parents or with others.

| Variable name | Time point | N    | Own Home | Partner's Home | Parent's Home | Partner's Parents Home | Other |
|---------------|------------|------|----------|----------------|---------------|------------------------|-------|
| a007          | Pregnancy  | 13,232 | 11,747 (88.8%) | -              | 801 (6.1%)    | -                      | 684 (5.2%) |
| f305          | 8m         | 11,049 | 10,432 (94.4%) | -              | 355 (3.2%)    | -                      | 262 (2.4%) |
| g353          | 21m        | 10,146 | 9,698 (95.6%) | 119 (1.2%)     | 151 (1.5%)    | 32 (0.3%)              | 146 (1.4%) |
| h263          | 33m        | 9,489  | 9,116 (96.1%) | 100 (1.1%)     | 103 (1.1%)    | 20 (0.2%)              | 147 (1.6%) |
| k5020         | 5y         | 8,572  | 8,572 (97.2%) | 66 (0.8%)      | 64 (0.7%)     | 18 (0.2%)              | 102 (1.2%) |
| m2020         | 7y         | 8,243  | 7,991 (96.9%) | 99 (1.2%)      | 51 (0.6%)     | 14 (0.2%)              | 88 (1.1%)  |
| pk2020        | 7y         | 4002   | 3856 (96.4%)  | 76 (1.9%)      | 12 (0.3%)     | 7 (0.2%)               | 51 (1.3%)  |
| q2030         | 10y        | 7,979  | 7,793 (97.7%) | 58 (0.7%)      | 33 (0.4%)     | 6 (0.1%)               | 89 (1.1%)  |

study were broadly representative of the general population of new parents resident in the area at the time in terms of sex, ethnicity and socio-economic status (Fraser et al., 2013).

Further strengths include the breadth and frequency of data collection with availability of repeat measures (e.g. of health and mental health, child development); an extensive biobank and the breadth of genetic sampling and proteomics data; geocoded residence and school history data from pregnancy onwards. In addition, some data is available on the parents and grandparents of the original parent cohort mainly in regard to life events, place of birth and household moves, demographics and smoking history. Children born to the offspring cohort are also being followed-up. This makes the data very flexible and relatable to intergenerational aspects of the family’s life.

A limitation of this study is the lack of diversity, because at the time of enrolment, the county of Avon was mainly Caucasian, therefore there were too few non-white participants (<6% in all) to allow for detailed analysis by ethnic background. Increasing attrition means that the cohort has an over-representation of the more affluent, those with higher educational attainment and females. ALSPAC invests considerable resources into collecting data from health and administrative records to track participants, and participation initiatives aimed at increasing response rates.

Ethical approval and consent
Prior to commencement of the study, approval was sought from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. Consent for the use of data collected via questionnaires and clinics was implied from participants following the recommendations of the ALSPAC Ethics and Law Committee at the time. Questionnaires were completed in the participants own home and the return of the questionnaires was taken as continued consent for their data to be included in the study (Birmingham, 2018). Full details of the approvals obtained are available from the study website. Study members have the right to withdraw their consent for elements of the study or from the study entirely at any time.

Data availability
ALSPAC data access is through a system of managed open access. The steps below highlight how to apply for access to the data included in this paper and all other ALSPAC data.

1. Please read the ALSPAC access policy which describes the process of accessing the data and biological samples in detail, and outlines the costs associated with doing so.

2. You may also find it useful to browse our fully searchable research proposals database, which lists all research projects that have been approved since April 2011.

3. Please submit your research proposal (https://proposals.epi.bristol.ac.uk/) for consideration by the ALSPAC Executive Committee using the online process. You will
receive a response within 10 working days to advise you whether your proposal has been approved.

If you have any questions about accessing data, please email: alspac-data@bristol.ac.uk (data) or bbl-info@bristol.ac.uk (samples).

Author contributions
Genette Ellis – Formal analysis, Investigation, Project administration, Writing – Original draft presentation, Writing - Review and editing, Validation, Visualisation.

Yasmin Iles-Caven - Funding acquisition, Project administration, Writing – Review and editing.

Jean Golding – Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing - Review and editing.

Kate Northstone – Funding acquisition, Writing - Review and editing.

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We are extremely grateful to all the families who took part in this study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses.

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**Appendix 1. Summaries of a sample of ALSPAC publications using external housing environment data.**

| Author          | Brief summary                                                                                                                                                                                                                                                                                                                                 |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Boyd et al., 2019** | Describes ALSPAC data concerning the physical and social environment including spatial and temporal information collected on the three generations (parents (G0), offspring (G1), grandchildren (G2)) on: (a) Area-level built and social characteristics (e.g. neighbourhood crime rates, density and location of fast-food retailers); (b) Exposure measurements (such as temperature and air pollution concentrations including nitrogen dioxide, radiation and electrical magnetic fields); (c) Respondent-reported data relating directly to places and spaces (e.g. homes and schools) that they inhabit (for example, neighbourhood safety, traffic density, the indoor environment of their home); (d) Direct measurements on the participants (e.g. blood lead, cadmium and total mercury concentrations and other heavy metals and VOCs); (e) Location information required to link these diverse data. This paper and its supplementary material list many publications mainly using the internal housing environment. |
| **Baker et al., 1998** | Examined the effect of deprivation, crowding, maternal smoking and breast feeding on infant morbidity from wheeze and diarrhoea in the first 6 months of life. Deprivation was associated with heightened morbidity from wheeze and diarrhoea, but results suggested that breast feeding was protective was particularly associated with reduced severity and duration. |
| **Sidebotham et al., 2002** | Four indicators of deprivation all showed significant relationships with the child being on the at-risk register. Adjusted odds ratios were 2.33 for paternal unemployment; 7.65 for council housing; 2.16 for overcrowding; and 2.33 for car ownership. There was a strong relationship between the number of indicators of deprivation and the risk of maltreatment. In a second model, maternal unemployment, high mobility (> 3 house moves in the previous 5 years) and a poor social network were also significant with odds ratios of 2.82, 2.81, and 3.09, respectively. |
| **Baker & Henderson, 1999** | 63.4% (1239) of an ALSPAC sub-sample lived in owner occupied/mortgaged accommodation (relatively affluent) and 36.6% (715) lived in council house/rented accommodation (relatively deprived). Wheeze was significantly more likely for infants living in council house/rented accommodation (p < 0.0001), their mothers (p < 0.001) and their fathers (p < 0.01). |
| **Chan et al., 2021** | Emotional and physical IPV and financial adversity independently and jointly increased the risk of incident homelessness. The effects of emotional and physical IPV are comparable to or greater than the risk of financial adversity. |
| **Taylor et al., 2013** | The strongest categorical predictor of blood lead levels (BLL) was having a coal fire (p = 0.008), followed by highest education attainment (p<0.001), haemoglobin level (p = 0.014), alcohol consumption (p = 0.001), age (p = 0.006), cigarette smoking (p = 0.001) and coffee consumption (p=0.001). Dietary calcium intake was protective against high BLL (p = 0.041). Neighbourhood quality index also assessed. |
| **Fuertes et al., 2020** | This study provided some evidence that children living in more vegetated places or live in close proximity to green spaces have better lung function up to 24 years of age. It used repeated greenspace and lung function data at 8, 15 and 24 years. |
Tested if CTVB (Council Tax Valuation Band) of maternal home address at the time of delivery predicted breast-feeding and personal and socio-economic attributes of the mothers. Random selection of 1390 mothers divided equally between all CTVBs during pregnancy with outcomes at 8 weeks postpartum (attitudes to breast-feeding prior to delivery; breast-feeding intention and uptake; demographic and socio-economic attributes of the mothers). CTVB predicted only one attitude: maternal convenience of bottle-feeding. Only a third of infants in the lowest CTVB band A were still fully breast fed at 4 weeks, whereas 57% of those living in the highest bands CTVB (E+) were fully breast fed. CTVB was strongly associated with maternal social class, home conditions, parental educational attainment, family income and smoking habit.

Looked at incidence of domestic violence at 5 timepoints (during pregnancy to 33 months post-partum). Found inadequate housing (crowding index/periods of homelessness); availability of basic amenities in the home (no hot water or no indoor toilet, bath or shower or no kitchen); housing defects/infestation and financial difficulties were all significant at P<0.001 for emotional or physical abuse (or both).

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Current Peer Review Status: ? ? ✓ ✓ ✓

Version 2

Reviewer Report 26 January 2024

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Marlee Bower

The University of Sydney, Sydney, Australia

This article describes a dataset of the housing conditions of 13,000 women during and over the 18 years after pregnancy, using the Avon Longitudinal Study of Parents and Children. The dataset refers to people residing in Bristol area. I think the dataset looks really exciting and provides a lot of fascinating covariates which will be invaluable for housing researchers to access and use.

I commend the authors for careful consideration of past reviewer comments, particularly around clarification around living/sleeping conditions, homelessness etc.

In saying that, I think that there are still certain improvements that could be made to the manuscript in order to improve accessibility and readability. Firstly, I know that this has been covered by several previous reviewers, but I think the authors need to remove the over-detailed information about the history of the Bristol housing context. The full second paragraph starting "There is evidence that Bristol..." should be removed. Also the sixth paragraph starting "By far, the greatest impact on house building in the Georgian period..." should be removed. Neither provides useful context to the housing data and actually is quite hard to follow. The rest of the introduction could also be tightened to remove extraneous historical detail, keeping text limited to how the historical context shaped the physical structure of housing or impacted the nature of housing tenure.

More evidence should be provided for the variables included in the database, especially when they are purported to also act as a proxy to other broader social indicators, e.g. "Housing tenure in the U.K. can be complex, but it is a good marker of socio-economic status." (p9) or "The move to lower floors over time is likely a reflection of families with young children applying for and being moved to a council house or being able to afford a home with a garden for a growing family" (p9).
Is the rationale for creating the dataset(s) clearly described?
Yes

Are the protocols appropriate and is the work technically sound?
Yes

Are sufficient details of methods and materials provided to allow replication by others?
Yes

Are the datasets clearly presented in a useable and accessible format?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Housing and its link to mental health and social wellbeing

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 26 January 2024

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Marcella Ucci
University College London (UCL), London, UK

Overall the protocol clearly articulates key details of the dataset and its value. I provide below some suggestions which the authors may wish to consider:

1. The section with the historical overview of Bristol and the housing stock is interesting. However it would be useful, if possible, to also provide some relevant details on housing type/stock/tenure from the Census (the latest and the past one?). This would give a clearer understanding of how the area which has been described in a historical sense may relate to other areas, by providing means for comparison via Census information.

2. Accordingly, a more specific discussion of some of the key housing variables could be provided, in relation to other metrics. For example, how are metrics such as the number of room variable related to similar metrics in the Census, or the English Housing Survey or the Understanding Society Dataset? i.e. to what extent are they similar variables (e.g. is it number of rooms or rooms used for sleeping).

3. Although I understand that data dictionary etc. is available elsewhere and links were provided, I did find it rather time-consuming to look for which questions/answers were asked for the housing variables. Could some further information be provided to assist the
reader with this task, perhaps more specific links to sections of the questionnaires with the housing variables, or include in an appendix the name of the variables so one might search them more easily in the various other resources already available online?

4. It is noted that this version has a title which refers to 'external housing environment': I am not sure how useful this is. How is tenure or number of rooms relevant to 'external housing environment'? Not sure this reference to 'external' helps explain the focus of this aspect of the dataset/protocol.

I trust these comments are useful and help complement an otherwise excellent submission.

Is the rationale for creating the dataset(s) clearly described?
Yes

Are the protocols appropriate and is the work technically sound?
Yes

Are sufficient details of methods and materials provided to allow replication by others?
Partly

Are the datasets clearly presented in a useable and accessible format?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Housing and health, environmental design and engineering, buildings and health/wellbeing

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 03 November 2023
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Alexandra Farrow
School of Health and Lifesciences, Brunel University London, London, UK

This scientifically sound paper provides a unique historical record of the external environment of the participants of the 13,000 participants of the ALSPAC cohort. As such it will be an asset to a varied academic audience. The social aspects that have been recorded as the study followed the participants is not likely to be repeated.
Is the rationale for creating the dataset(s) clearly described?
Yes

Are the protocols appropriate and is the work technically sound?
Yes

Are sufficient details of methods and materials provided to allow replication by others?
Yes

Are the datasets clearly presented in a useable and accessible format?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Epidemiology and environmental exposures

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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**Version 1**

Reviewer Report 11 November 2022

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**Rebecca Bentley**

1 Centre for Health Policy, Melbourne School of Population and Global Health, University of Melbourne, Melbourne, Vic, Australia
2 Centre for Health Policy, Melbourne School of Population and Global Health, University of Melbourne, Melbourne, Vic, Australia

This data note provides information on housing data collected as part of the Avon Longitudinal Study of Parents and Children from 1991.

While the title of the paper suggests a focus on home environments, this data note focusses specifically on tenure, type of home, size and overcrowding, presence of amenities and frequency of moves. There is a second data note planned that will cover internal housing conditions (which some researchers might equate more closely with home environments).

The section entitled 'historical background and manmade environment' contains historical detail on the geographic area that dates to the stone age. While interesting, much of this text is not
relevant to the housing-health relationships covered from 1991 on. This section, and some of the
text of housing stock, could be much more succinctly summarised. Of use to readers most is
information pertaining to noise and air pollution from motorways in the area.

The data note could be made more useful to housing and health researchers with two additional
sets of information:

1. More on the housing and health relationships that are explorable using these data (flagging
any sources of bias). The paper broadly describes physical and mental health and childhood
development as health outcomes. It would be useful to know how the health information
maps to this housing information more specifically (e.g., asthma, allergies etc.) and what
research has already been undertaken using these data. I note also that all measures are
self-reported and issues relating to misclassification bias could also be addressed in this
note.

2. An overarching framework for conceptualising housing as an exposure. For example, using
the concepts of housing affordability, security and suitability to categorise and group
available measures (e.g., see Mansour et al 2022)1. These interrelated terms are useful for
organising the many dimensions of measurement available on housing and an exposure
that affects health. This might also offer a way to tie data notes one and two together (given
that housing affordability, for example, is likely to be associated with housing condition).
Authors might also consider these measures within a life course framework.

References
1. Mansour A, Bentley R, Baker E, Li A, et al.: Housing and health: an updated glossary, J Epidemiol
Community Health. 76 (9): 833-838 PubMed Abstract | Publisher Full Text

Is the rationale for creating the dataset(s) clearly described?
Yes

Are the protocols appropriate and is the work technically sound?
Partly

Are sufficient details of methods and materials provided to allow replication by others?
Yes

Are the datasets clearly presented in a useable and accessible format?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** social epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of
expertise to confirm that it is of an acceptable scientific standard, however I have
significant reservations, as outlined above.
We have added the word ‘external’ to the title and hope this clarifies the content.

The section entitled ‘historical background and manmade environment’ contains historical detail on the geographic area that dates to the stone age. While interesting, much of this text is not relevant to the housing-health relationships covered from 1991 on. This section, and some of the text of housing stock, could be much more succinctly summarised. Of use to readers most is information pertaining to noise and air pollution from motorways in the area.

As in our response to Reviewer 1, we gave such historical detail to aid international researchers who may not be familiar with the evolution of Bristol and the Avon area and its effect on housing and open spaces for example. The detail around the Bristol Blitz in WW2 is pertinent to this cohort where we have information on housing type from the grandparents to the index offspring and now their own children.

The data note could be made more useful to housing and health researchers with two additional sets of information:

1. More on the housing and health relationships that are explorable using these data (flagging any sources of bias). The paper broadly describes physical and mental health and childhood development as health outcomes. It would be useful to know how the health information maps to this housing information more specifically (e.g., asthma, allergies etc.) and what research has already been undertaken using these data. I note also that all measures are self-reported and issues relating to misclassification bias could also be addressed in this note.

Response: We have added text along the lines of the following: There are 2000+ papers published using ALSPAC data. The authors have selected a few papers that specifically mention ‘housing’ in relation to health outcomes and we have put these in an additional table (Appendix 1).

In regard to misclassification bias, whilst this is possible in self-reported data, tenure and type of home is unlikely to be erroneous. The address histories have been geocoded and enables linkage to the Index of Multiple Deprivation (IMD) for which we have derived variables, and also the wider environment such as proximity to main roads, green spaces and power lines. Geocoding could also clarify any misclassification errors. For those wishing to research the broader external environment it is worth reading this paper in conjunction with Boyd et al., 2019.

1. An overarching framework for conceptualising housing as an exposure. For example, using the concepts of housing affordability, security and suitability to categorise and group available measures (e.g., see Mansour et al 2022)\(^1\). These interrelated terms are useful for organising the many dimensions of measurement available on housing and an exposure that affects health. This might also offer a way to tie data notes one and two together (given that housing affordability, for example, is likely to be associated with housing condition). Authors might also consider these measures within a life course framework.

Response: It is feasible to consider the housing measures in this paper within the life course of both the parent and offspring cohorts. We agree that an overarching framework
to conceptualise housing as an exposure would be useful, but is without the remit of this purely descriptive paper.

**Competing Interests:** None

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Anna L. Hansell

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2 Centre for Environmental Health and Sustainability, University of Leicester, Leicester, UK

The article describes data on housing environment of individuals in the ALSPAC study. The title states the housing environment data provide “a resource for studies of influences on health”.

The paper provides an interesting description of the variables held, but a major limitation is that it currently doesn't give any examples of how they have been used in health studies or how the authors consider they could be used in health studies in the future. The housing variables are considered separately from other measures such as deprivation/education/household income, or indoor environment (the latter of which I understand is the subject of another paper).

The introduction ‘Historical background and the manmade environment’ going back to the Stone Age is interesting but didn't seem particularly relevant to future health studies – particularly as this would potentially impact all individuals in the study. It doesn't help with use of the dataset (except perhaps the last paragraph about the motorways). Similar issues apply to the paragraph on bombing during the Second World War. Additionally, it mainly relates to Bristol, while the paper states many of the families live in surrounding areas. I would suggest this information is shortened.

Standard of Housing – page 4. This paragraph has two possibly contradictory statements. Firstly “Older buildings are more at risk of poor standards” and secondly “in Bristol, children living in older, more affluent areas of the city were less likely to experience poverty”. Please could wording be looked at.

Figure 4 – typical Bristol housing. It's unclear if this actually relates to housing stock lived in by participants. E.g. are there any families living in prefabs?

Results – there will be drop out from the study over time and this is usually in families that are more disadvantaged, so you end up with a wealthier cohort than the one you started with. Therefore housing types will differ over time due to selection bias. Has this been looked at? If not,
then at least a table on SES of those leaving the study to illustrate the selection bias would be useful. How many of these are moving out of study area and how many are lost to follow-up?

There is some variability with percentages in a lot of the tables and I wondered if this was related to response rate for the questionnaire so there is some chance variability (as well as bias). Is it relevant to add this here or at least to Table 1.

Table 2 and subsequent tables. Table 2 in particular didn't have the key that the ‘a’ in front of the variable means it relates to the ‘A’ questionnaire – it took me a while to work this out. Please could time-point be added or a footnote be added to clarify this.

Table 3 – is the move to lower floors a reflection of a city policy to knock down tower blocks or is it that families with small children are moving?

Table 4 – How is it possible to have zero living or sleeping rooms in a house (ranges start from zero)? Please could this be explained. This suggests a house with only toilet and/or kitchen. It would also be useful to see the median here.

Table 5c. The last row adds up to 99.3%, while the rest of the rows add up to 100%. Please could this be checked. If due to missing data, a footnote would be useful.

Table 6 Housing tenure. English housing tenure is a complicated area and something it would be worth explaining more in the introduction or methods as to why these categories were chosen and are meaningful. E.g. being bought from council – will be council housing but this is sometimes then sold on. It also relates more strongly to certain political eras. Private rented had fewer regulations in the 1980s but is better regulated now with insulation, safety certificates etc. Also, it’s unclear whether housing tenure is a marker for SES or environmental conditions or social conditions/neighbourhood or all of these. How does this correlate with other measures of SES? Have these analyses been conducted?

Table 9. Moving home – how does this compare with other cohorts e.g. Born in Bradford? Is there a cohort effect or a geographical effect? Also the Longitudinal Survey looks at how far people move from the original home – have any such analyses been conducted for ALSPAC? This comparison information would be useful.

Table 10. Please could the definition of homeless used be included.

**Is the rationale for creating the dataset(s) clearly described?**
Yes

**Are the protocols appropriate and is the work technically sound?**
Partly

**Are sufficient details of methods and materials provided to allow replication by others?**
Yes

**Are the datasets clearly presented in a useable and accessible format?**
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Environmental epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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**Author Response 01 Dec 2022**

**Yasmin Iles-Caven**

Thank you for your thorough and considered review.

You said: The introduction ‘Historical background and the manmade environment’ going back to the Stone Age is interesting but didn't seem particularly relevant to future health studies – particularly as this would potentially impact all individuals in the study. It doesn't help with use of the dataset (except perhaps the last paragraph about the motorways). Similar issues apply to the paragraph on bombing during the Second World War. Additionally, it mainly relates to Bristol, while the paper states many of the families live in surrounding areas. I would suggest this information is shortened.

Response: We have altered the title to make it clear we are describing the external housing environment.

We have changed ‘Many ALSPAC families’ to ‘About 25% ...’. We have added text that the small towns and villages often reflect similar growth to Bristol (radiating out from the historical centre) and expanded on the growth and reasons for social housing. Our main reason for including the historical background was for an international audience, to explain the extent of ancient to post-war modern buildings radiating out from what was old Bristol centered on the Castle and old walled city. In addition, data has been collected from the parents on the type of housing in which they lived as children and so we have multigenerational housing encompassing the index offspring back to their grandparents (many of whom lived through the Second World War).

You said: Standard of Housing – page 4. This paragraph has two possibly contradictory statements. Firstly “Older buildings are more at risk of poor standards“ and secondly “in Bristol, children living in older, more affluent areas of the city were less likely to experience poverty”. Please could wording be looked at.

Response: We have expanded on this to make it clearer.

You said: Figure 4 – typical Bristol housing. It’s unclear if this actually relates to housing stock lived in by participants. E.g. are there any families living in prefabs?

Response: We have added to this slightly. There was the option in the questionnaires for ‘Other’ (types of housing) and the text answers included houseboats, prefabs and caravans for example.
You said: Results – there will be drop out from the study over time and this is usually in families that are more disadvantaged, so you end up with a wealthier cohort than the one you started with. Therefore housing types will differ over time due to selection bias. Has this been looked at?

Response: Whilst this is true of ALSPAC in that participation some 30 years since enrolment has declined and those parents still participating are more likely to have a degree, to be female and more affluent and less likely to have suffered adversity in the index pregnancy or be from a non-white background, it is also true that housing type over time will differ due to selection bias. However, in Britain at least, younger families are more likely to live in cheaper flats/small houses/council or shared accommodation until they can get established on the property ladder and by middle age are more likely to live in a more expensive home in a favourable neighbourhood. Within the last 20+ years, things have changed considerably. Currently, in the Avon area, monthly rents are often more expensive than a mortgage repayment. The ability of the younger generation to amass a deposit of tens of thousands of pounds means that first time buyers are likely to be much older than they were a generation ago.

We are not aware of any research specifically looking at housing type over time and potential biases therein. However, this is eminently feasible in this cohort with the data described in this publication.

You said: If not, then at least a table on SES of those leaving the study to illustrate the selection bias would be useful. How many of these are moving out of study area and how many are lost to follow-up?

Response: Since enrolment, the mothers/families have always been encouraged to continue participating in the study even if they moved out of area (including abroad). Since 2014 online questionnaires enable contact with participants even more feasible. For the clinic examinations, ‘out of area’ participants are still invited, and travel/accommodation expenses reimbursed up to a ceiling, including air travel. Even so, ALSPAC goes to considerable lengths to attract the disengaged and track those lost to follow-up. We have enhanced the Strengths and Limitations section.

You said: There is some variability with percentages in a lot of the tables and I wondered if this was related to response rate for the questionnaire so there is some chance variability (as well as bias). Is it relevant to add this here or at least to Table 1.

Response: We have double-checked all the tables, apart from a few typos, the variability with percentages often 99.9 or 100.1 are due to rounding.

You said: Table 2 and subsequent tables. Table 2 in particular didn't have the key that the 'a' in front of the variable means it relates to the ‘A’ questionnaire – it took me a while to work this out. Please could time-point be added or a footnote be added to clarify this.

Response: We have added a sentence in Table 2’s title as to the variable naming convention and to refer to Table 1 for the timing of the questionnaire.

You said: Table 3 – is the move to lower floors a reflection of a city policy to knock down tower blocks. Or is it that families with small children are moving?

Response: The move to lower floors is more a reflection of families with young children applying for and being moved from a flat to a council house. We have added some text about Bristol's tower blocks.
You said: Table 4 – How is it possible to have zero living or sleeping rooms in a house (ranges start from zero)? Please could this be explained. This suggests a house with only toilet and/or kitchen. It would also be useful to see the median here.

Response: The range beginning at zero includes bedsits or studio flats and also caravans and houseboats.

You said: Table 5c. The last row adds up to 99.3%, while the rest of the rows add up to 100%. Please could this be checked. If due to missing data, a footnote would be useful.

Response: This is a typo and has been corrected.

You said: Table 6 Housing tenure. English housing tenure is a complicated area and something it would be worth explaining more in the introduction or methods as to why these categories were chosen and are meaningful. E.g. being bought from council – will be council housing but this is sometimes then sold on. It also relates more strongly to certain political eras. Private rented had fewer regulations in the 1980s but is better regulated now with insulation, safety certificates etc. Also, it’s unclear whether housing tenure is a marker for SES or environmental conditions or social conditions/neighborhood or all of these. How does this correlate with other measures of SES? Have these analyses been conducted?

Response: We are unaware of comparative analyses looking at all of these, but tenure certainly has been used as a marker for SES. Please see Appendix 1 for a selection of papers.

You said: Table 9. Moving home – how does this compare with other cohorts e.g. Born in Bradford? Is there a cohort effect or a geographical effect? Also the Longitudinal Survey looks at how far people move from the original home – have any such analyses been conducted for ALSPAC? This comparison information would be useful.

Response: The authors are unaware of any comparisons with other cohorts. The aim of this data note is to describe the data available in ALSPAC and thus enable researchers to undertake comparative research if they wish.

You said: Table 10. Please could the definition of homeless used be included. We have done this.

Response: None