Residential Moving and Preventable Hospitalizations

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abstract

OBJECTIVES: To investigate the association between moving home in the first year of life and subsequent emergency admissions for potentially preventable hospitalizations.

METHODS: We undertook a cohort analysis of linked anonymized data on 237 842 children in the Welsh Electronic Cohort for Children. We included children born in Wales between April 1, 1999 and December 31, 2008. The exposure was the number of residential moves from birth up to 1 year. The main outcome was emergency admissions for potentially preventable hospitalizations (PPH) between the age of 1 and 5 years.

RESULTS: After adjustment for confounders, we identified that moving home frequently in the first year of life was associated with an increased risk of emergency PPH between the ages of 1 and 5 when compared with not moving. We found significant differences associated with ≥2 moves for the following: ear, nose, and throat infections (incidence risk ratio [IRR], 1.44; 95% confidence interval [CI], 1.29–1.61); convulsions/epilepsy (IRR, 1.58; 95% CI, 1.23–2.04); injuries (IRR, 1.33; 95% CI, 1.18–1.51); dehydration/gastroenteritis (IRR, 1.51; 95% CI, 1.21–1.88); asthma (IRR, 1.61; 95% CI, 1.19–2.16); influenza/pneumonia (IRR, 1.15; 95% CI, 1.00–1.32); and dental conditions (IRR, 1.30; 95% CI, 1.03–1.64) for ≥1 moves.

CONCLUSIONS: Children who move home in the first year of life are at substantially increased risk of emergency admissions for PPH in early childhood. Additional research that focuses on enhancing health and social support services for highly mobile families, educating parents about safety risks, and improving housing quality is warranted.

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Professor Hutchings conceptualized and designed the study, performed the experiments, analyzed the data, and led on writing the manuscript; Ms Evans contributed to the design of the study, performed the experiments, led on the data analysis, contributed to cleaning and validation of data sets, and helped draft the manuscript; Drs Barnes, Maddocks, and James-Ellison contributed to the design of the study, provided clinical, child health, and policy input, and helped draft the manuscript; Drs Demmler and Healy contributed to the design of the study, performed the experiments, contributed to cleaning and validation of data sets, and helped draft the manuscript; Mr Heaven contributed to the design of the study, contributed to cleaning and validation of data sets, and helped draft the manuscript; Dr Lyons contributed to the design of the study, provided public health, data linkage, and policy input, and helped draft the manuscript; Drs Paranjothy and Rodgers contributed to the design of the study, performed the experiments, and helped draft the manuscript; and Dr Dunstan contributed to the design of the study, performed the experiments, provided senior support for statistical data analysis, and helped draft the manuscript.

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WHAT'S KNOWN ON THIS SUBJECT: Frequent residential mobility is associated with behavioral and emotional effects in children and may result in increased health care utilization. Moving home can present an injury risk for children, resulting in hospital admissions and morbidity that is potentially preventable.

WHAT THIS STUDY ADDS: We identified that children who moved just once in their first year of life had more potentially preventable hospitalizations compared with children who did not move.

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The impact of moving home (residential mobility) during childhood on health outcomes has previously been studied, but the evidence to date has largely focused on behavioral, emotional, and educational outcomes in children.[1,2] Frequently moving home in childhood is associated with poorer health outcomes in later life,[3,4] including higher rates of drug use,[5] smoking,[6] and attempted suicide.[1,7,8] Most research relating to the effects of residential mobility on health outcomes is from North America, where rates of mobility are high. Studies in Canada, the United States, and Finland have examined the association between moving home and healthcare utilization, with conflicting results. Studies in the United States and Canada reported that children who had frequently moved home in childhood were less likely to have a regular site for healthcare and were more likely to use an emergency department, see multiple providers of healthcare, and have less continuity of care.[1] However, researchers in Finland found no association between address changes and use of primary care services.[9] The Millennium Cohort study explored mobility and some health outcomes,[10] and a comparative UK and US study explored the effects of mobility on health care utilization,[11] but we are not aware of any UK studies that have examined the effects of early residential moves on future hospitalizations.

One mechanism through which an association between mobility might arise may be because of causal pathways; for example, because of severed links with professionals, or because of stress associated with moving. Supporting families with infants is a key role of health care providers after the birth of a child. Frequently moving home, particularly during infancy, may prevent the development of relationships with health professionals (especially in relation to early years health services)[12] and affect continuity of care and appropriate monitoring and follow up of health problems. Frequently moving home also presents an increased risk of unintentional injury for young children.[10,13,14] This could be because of the unfamiliar environment, or a combination of this and the introduction of hazards in the home owing to inadequate housing standards.

Other factors that are likely to have an impact on hospitalization may be considered as confounders and should be dealt with in the adjustment of analyses as they could cause spurious associations between mobility and hospitalizations. For example, deprived families are thought to move home more frequently and are more likely to live in damp and poorly ventilated housing, causing them to have increased illness rates due to infections and respiratory related conditions.[15] Research has also recognized that family structure can result in stress, family hardship, and changes in the quality of the family home,[16] leading to significant differences between children who have experienced a family breakdown and those who have not.[16,17] Because family transitions are linked with other changes, including moving house, school, and/or neighborhood,[16] it is possible that moving home frequently could potentially be a marker of families needing social support.

Moving frequently may therefore increase the likelihood of living in substandard housing with associated hazards. It is likely that some of the effects of moving home, such as accident risk owing to unfamiliar surroundings, are likely to occur in the immediate period after a move and until a child has adapted to their surroundings. It is possible, however, that some outcomes, such as infections and vaccine-preventable conditions, may occur for a longer period after the move because the risks are likely to still be present. It is likely that different risks may present at different childhood developmental stages; for example, during transitions from not moving to crawling and walking, or when routines change, such as when starting nursery or childcare.

Potentially preventable hospitalizations (PPH) are hospitalizations that may be preventable with high quality primary and preventive care. These hospitalizations may be avoided if clinicians effectively diagnose, treat, and educate patients, and if patients actively participate in their care and adopt healthy lifestyle behaviors.[18] If there was a true association between frequently moving home and underutilization of regular primary care services, then this may result in an increase in emergency PPH in children who have moved home frequently during early childhood. No studies to date have examined the association between frequently moving home and emergency PPH.

The ability to measure movement between addresses and link data from different sectors, such as education, work, or crime, produces exciting research opportunities.[19] In this paper, we used the Secure Anonymised Information Linkage (SAIL) databank to examine the association between moving home in the first year of life and emergency PPH in a large population-based cohort of children born in Wales, United Kingdom.

METHODS

Data Sources

This study used data from the Wales Electronic Cohort for Children (WECC) held within the SAIL databank.[20] SAIL is part of the national research infrastructure in

Wales based at Swansea University and is a relational database capable of linking anonymized data at individual and household levels across many health and health-related data sets.[21] The SAIL databank uses a robust array of privacy-protecting techniques to overcome the confidentiality and disclosure issues in health-related warehousing. As part of privacy protection, SAIL does not hold identifiable demographic data (such as names and addresses), but uses anonymized linking fields produced by a National Health Service (NHS)-trusted third party. This means that the information on individuals can be linked together from different datasets by using the anonymized linking fields, and information at the household level can be linked together by using a similarly constructed residential anonymized linking field,[22,23] which is assigned to each child based on their current address by using the Welsh Demographic Service dataset. This is compiled from address changes provided by patients to their general practitioner. This unique set-up enables longitudinal analyses to be undertaken on data for groups of individuals living together in the same household, including the ability to follow movement between residences over time.[19]

Phase 1 of the WECC consists of linked anonymized records for >800 000 children born or living within Wales between January 1, 1990 and December 31, 2008. The individual-level anonymized data on these children that were used for this study were obtained from numerous sources: the Welsh Demographic Service, a continually updated record of children living in Wales; community child health records from the National Community and Child Health Database; births and deaths from the Office for National Statistics; and inpatient data from the Patient Episode Database for Wales.

Cohort Development

We included all children in the WECC born and living in Wales between April 1, 1999 and December 31, 2008 (see Fig 1). We excluded children moving into or out of Wales during the first year of life. Moves out of Wales were recorded, but the outcome data after that time were not used. We also excluded stillbirths, infant deaths, and children born with major congenital anomalies from this analysis. After exclusions, the final cohort size for analysis was 237 842. The total length of follow-up of the cohort was 542 463 person-years, with a mean length of follow-up of 2.28 (SD, 1.31) years for children from age 1 to 5 years old, accounting for differential loss for the end of the cohort (after August, 31, 2008), a house move after age 1 year, or death.

Measure of Exposure

The focus of this study was to explore if moving in the first year of life had an effect on future PPH that were unplanned. In this analysis, we calculated the number of patient-reported residential moves in the first year of life (ie, from birth to age 1 year). We wanted to explore the potential effects of move frequency and ordered them into categories (0, 1, and ≥2 wherever possible) as appropriate and in line with other research that has examined the effects of residential mobility on health and educational outcomes.[1,2] Where numbers were small, residential mobility was limited to 2 categories (0 and ≥1).

Measurement of Outcome

We analyzed the data based on the emergency PPH outcome measures for a range of acute, chronic, and vaccine-preventable conditions between age 1 and 5 years (see Table 1). We chose the period of up to 5 years to measure outcomes based on the availability of follow-up data. This period allowed us to capture risks that may present at different developmental stages. For example, when babies start to move through crawling and walking, they are likely to be presented with different injury risks (burns, falling, tripping, etc). Also, when babies are weaned from breastfeeding, they may be more at risk for infection or poisoning while their immune system is developing. When children start nursery or school, they are also likely to be more at risk for illnesses, infection, and injury. We identified specific *International Classification of Diseases, 10th Revision* (ICD-10) codes on the basis of previously published research on PPH.[18,24–26] For all codes (with the exception of vaccine-preventable conditions, appendicitis, and injuries), we required the appropriate code to be in the primary diagnostic position in individual-level hospital records.[27] Vaccine-preventable conditions and appendicitis were identified from any coding position according to guidance from previous studies.[14,19–21] Causes of injury codes are usually paired with nature of injury codes, but not always in that order and hence reliance on primary position will not identify all cases.

Confounding Variables

We adjusted for the following predefined confounding variables, which were considered to have a possible effect on our outcomes: gender, parity, gestational age, maternal age at birth, maternal cigarette smoking at booking appointment (first trimester), maternal breast feeding status at birth or 6 to 8 weeks, material deprivation measured by the Townsend score[28] of registered lower super output area at birth, multiple births, congenital anomalies, being small for gestational age (ie, <10th percentile), and birth by cesarean delivery. Variables other than breastfeeding status (16.3% missing) and maternal cigarette

smoking (62.2% missing) had few missing values, and therefore only subjects with complete records for those variables were included. We imputed the breastfeeding status and maternal cigarette smoking data by using multiple imputation based on chained equations using the variables listed.[29] Estimates from 20 different imputations were combined by using Rubin's rules.[30]

Statistical Analysis

We analyzed the data by using Stata version 13 (Stata Corp, College Station, TX). To examine PPH, we fitted negative binomial regression models to the data (to account for differential loss to follow-up of the outcome measure from end of cohort [after August 31, 2008], a house move after age 1 year, or death) to calculate person-years incidence risk ratios (IRR) (with 95% confidence intervals [CIs])]. House moves and PPH categories (Table 1) were considered in univariate analysis. When a significant association ($P \leq .05$) was found, categories were grouped as an "All PPH" variable (Table 2) and in individual categories (Table 3) for multivariate analysis. To avoid making assumptions of linearity, we categorized those variables that could take many values and treated them as categorical variables. Maternal age was divided into 5-year bands, with the exception of teenage mothers and those aged at least 40. Townsend deprivation scores were divided into quintiles.

Ethical Approval

National Research Ethics Service guidance does not require ethical review for anonymized databank studies. We obtained approval from the independent Information Governance Review Panel, whose membership includes Caldicott Guardians and other Information Governance professionals, lay people, and representatives from the National Research Ethics Service to use SAIL to answer the specific house moves research question.[20,21]

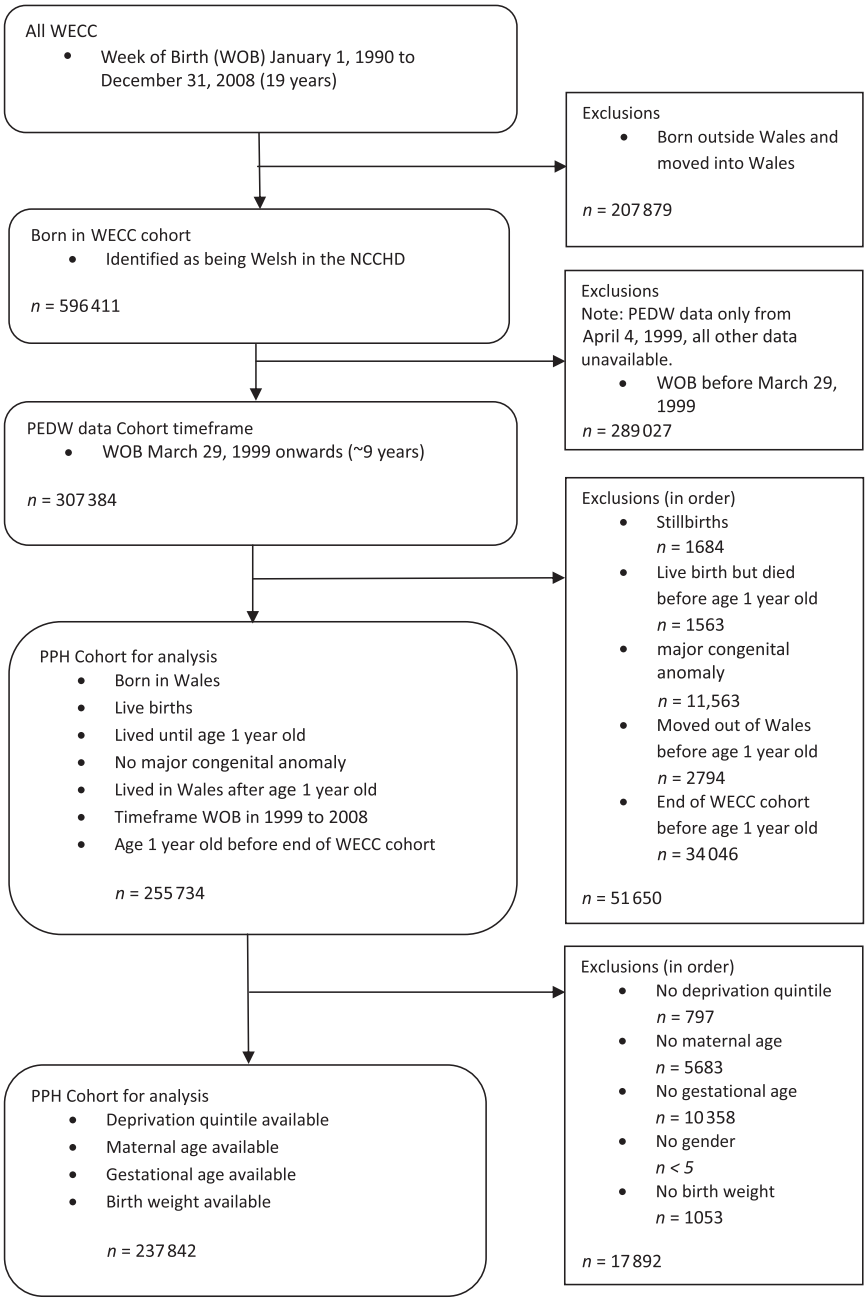

FIGURE 1
Selection of cohort for analysis. NCCHD, National Community and Child Health Database; PEDW, Patient Episode Database for Wales.

RESULTS

Of the 237 842 children included in the cohort: 201 114 (84.6%) never moved; 31 735 (13.3%) moved once; and 4993 (2.1%) moved ≥2 in their first year of life. Emergency PPH were associated with increasing numbers of residential moves for several confounders (Table 2). Table 4 illustrates the frequency of emergency PPH in each year for the period of follow-up. The greatest rate of PPH was between the ages of 1 and 2 years, with decreasing frequency of PPH up to age 5 years. Nonmovers showed

TABLE 1 ICD-10 Codes for PPH[18,24–26]

Category	ICD-10 Code	Additional Information
Vaccine-preventable conditions		
Influenza and pneumonia	J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8	In any diagnosis field; exclude people <2 mo; ICD-10; exclude cases with secondary diagnosis of D57 (sickle-cell disorders)
Other vaccine-preventable conditions	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field
Asthma	J45, J46	Principal diagnosis only
Dehydration and gastroenteritis	A09.9, E86, K52.2, K52.8, K52.9	Principal diagnosis only
Ear, nose, and throat infections	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only
Dental conditions	A69.0, K02, K03, K04, K05, K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only
Appendicitis with generalized peritonitis	K35	In any diagnosis field
Convulsions and epilepsy	G40, G41, O15, R56	Principal diagnosis only
Injuries and poisoning		
All injuries (falls, fire/hot object or substance; MVTC); MVTC–pedestrian only; poisoning)	V01-Y36	In any diagnosis field

MVTC, motor vehicle traffic collision.

a reduction in admissions over time, whereas movers had an increase in admissions for some PPH (asthma, dental conditions, vaccine-preventable conditions, and appendicitis). For the majority of time points and PPH, the movers had more PPH than the nonmovers.

The percentage of children having ≥1 emergency PPH between the age of 1 and 5 years increased with increasing frequency of residential moves (13.9% for children who did not move between age 0 and 1 years compared with 16.4% for children who had moved ≥2 times). Compared with no moves, for children with 1 move in the first year of life, the risk of a PPH between the ages of 1 and 5 years increased by 14%, and for ≥2 moves, the risk of PPH increased by 45% after adjusting for confounders. In the adjusted model, children of a younger mother, gestational age at birth, boys, a minor congenital anomaly, or born by cesarean delivery were all independently associated with increased risk of emergency PPH. Regression analysis on the dataset, without imputation of breastfeeding and maternal cigarette smoking missing data (complete case analysis), gave similar results.

Increased frequency of residential moves in the first year of life resulted in an increased risk of all PPH (Table 3). We identified a significantly increased risk after controlling for confounders for: ear, nose, and throat infections; convulsions and epilepsy; injuries; dehydration/gastroenteritis; asthma; influenza/pneumonia; and dental conditions between the age of 1 and 5 years. In all cases, the IRR was higher for ≥2 moves than for a single move. House moves in the first year of life were not shown to significantly increase the risk of PPH for acute appendicitis with generalized peritonitis, or other vaccine-preventable conditions.

DISCUSSION

Our study, in which we examined the effect of moving home on emergency PPH within early childhood, demonstrated that even a small number of moves appear to have a detrimental effect on subsequent health. We showed that residential moves are associated with an increased risk of being admitted to hospital for: ear, nose, and throat infections; convulsions and epilepsy; injuries; dehydration/gastroenteritis; chronic asthma; influenza/pneumonia; and dental conditions between the age of 1 and 5 years. We also found similar associations for non-PPH as those found for PPH.[31] Our findings concur with US studies that have reported increased use of emergency healthcare services and lack of engagement with primary care providers.[32–34] A key issue is whether these relationships are causal or reflect unmeasured residual confounding, the latter of which is almost impossible to rule out in observational studies. Some factors, such as a failure of families to engage with early years healthcare providers or the stress of moving, may result in a causal pathway leading to an increased use of emergency departments. In addition, the decision of whether to hospitalize may be influenced by the level of primary care and social support, which may lead to more hospitalizations in the highly mobile group. Other factors are more likely to be due to confounding, such as deprivation and family structure. Comparison of our findings with existing theories and empirical literature helps to shed light on this difficult question.

Most injuries to preschool children happen at home,[14] with well-known risk factors documented, including: low social class, psychosocial stress, an unsafe environment, and child development disorders.[35] The findings from our study illustrated that residential mobility in the first year of life was associated with an increased risk of emergency PPH from injury or poisoning. It is possible that this increased injury risk could be the result of moving to a new house and unfamiliar surroundings; less safe environments

TABLE 2 Negative Binomial Model of the Frequency of Moving Home From Age 0 to < 1 y and All Emergency PPH Between the Ages of 1 and 5 y (n = 237 842)

Characteristics	All Emergency PPH Age 1 to <5 y old[a]						
	Total	≥1 Admission		Negative Binomial Regression[b] Univariate		Negative Binomial Regression[b] Adjusted[c] and Imputed[d]	
	N	*n*	(%)	IRR[e]	95% CI	IRR[e]	95% CI
Frequency of moving home age 0–<1 y							
0	201 114	26 984	(13.4)	1.00	—	1.00	—
1	31 735	4792	(15.1)	1.19	1.15–1.23	1.10	1.07–1.14
≥2	4993	800	(16.0)	1.44	1.34–1.55	1.28	1.19–1.38
Gender[f]							
Boy	121 843	18 298	(15.0)	1.00	—	1.00	—
Girl	115 999	14 278	(12.3)	0.79	0.78–0.81	0.80	0.78–0.82
Parity							
0	57 849	7975	(13.8)	1.00	—	1.00	—
≥1	179 993	24 601	(13.7)	1.00	0.97–1.02	1.00	0.97–1.02
Maternal age at birth, y							
<20	22 874	4157	(18.2)	1.39	1.33–1.44	1.27	1.22–1.32
20–24	52 098	8204	(15.7)	1.22	1.18–1.26	1.16	1.12–1.20
25–29	63 877	8586	(13.4)	1.00	—	1.00	—
30–34	62 896	7535	(12.0)	0.87	0.84–0.90	0.90	0.87–0.93
35–39	30 328	3460	(11.4)	0.86	0.82–0.89	0.88	0.85–0.92
≥40	5769	634	(11.0)	0.84	0.78–0.91	0.86	0.79–0.93
Gestational age at birth, wk							
24–32	3070	639	(20.8)	1.84	1.69–2.01	1.74	1.59–1.90
33–36	12 913	2039	(15.8)	1.24	1.18–1.30	1.22	1.16–1.28
37–≥40	221 859	29 898	(13.5)	1.00	—	1.00	—
Maternal cigarette smoking							
No	68 232	9140	(13.4)	1.00	—	1.00	—
Yes	21 765	3666	(16.8)	1.25	1.20–1.31	1.12	1.07–1.18
No answer[g]	147 845	19 770	(13.4)	0.98	0.96–1.00	—	—
Breast feeding at birth/at 6–8 wk							
No	87 312	13 059	(15.0)	1.00	—	1.00	—
Yes	111 823	14 135	(12.6)	0.84	0.82–0.86	0.92	0.90–0.95
No answer[g]	38 707	5382	(13.9)	0.83	0.80–0.85	—	—
Townsend quintile of LSOA at birth/first 4 mo[h]							
1	41 060	4867	(11.9)	1.00	—	1.00	—
2	41 544	5174	(12.5)	1.05	1.00–1.09	1.01	0.97–1.05
3	45 718	6270	(13.7)	1.19	1.15–1.24	1.09	1.05–1.14
4	49 142	7026	(14.3)	1.26	1.21–1.31	1.12	1.08–1.17
5	60 378	9239	(15.3)	1.35	1.30–1.40	1.14	1.09–1.18
Multiple births (eg, twins)							
No	231 699	31 776	(13.7)	1.00	—	1.00	—
Yes	6143	800	(13.0)	0.98	0.91–1.05	0.86	0.79–0.93
Congenital anomaly							
None	232 454	31 648	(13.6)	1.00	—	1.00	—
Minor	5388	928	(17.2)	1.35	1.26–1.45	1.27	1.19–1.36
Small for gestational age (<10%)							
No	214 812	29 155	(13.6)	1.00	—	1.00	—
Yes	23030	3421	(14.9)	1.11	1.06–1.15	1.04	1.00–1.08
Cesarean delivery							
No	183 231	24 767	(13.5)	1.00	—	1.00	—
Yes	54 611	7809	(14.3)	1.09	1.06–1.12	1.12	1.09–1.15

—, denotes reference category.

[a] All avoidable admissions statistically significant $P \leq .05$ in χ^2 or univariate analysis. LSOA, lower super output area.

[b] Negative binomial model used with person-years to account for differential loss to follow-up of the outcome measure from end of cohort (after August 31, 2008), house move out of Wales, and death.

[c] Adjusted for all variables in the table.

[d] Breastfeeding and maternal cigarette smoking imputed.

[e] Person-years IRR.

[f] One no-answer case excluded.

[g] Included as high levels of missing data.

[h] The first quintile denoted the least deprived group through to the fifth denoting the most deprived.

TABLE 3 Negative Binomial Model of the Frequency of Moving Home From Age 0 to < 1 y and All Emergency PPH Between the Ages of 1 and 5 y (n = 237 842)

Characteristics	Total	≥1 Admission		PPH Univariate[a]		PPH Adjusted[a,b]	
	N	*n*	(%)	IRR[c]	95% CI	IRR[c]	95% CI
All PPH[d]							
Frequency of moving home age 0–<1, y							
0	201 114	26 984	(13.4)	1.00	—	1.00	—
1	31 735	4792	(15.1)	1.29	1.24–1.33	1.14	1.10–1.18
≥2	4993	800	(16.0)	1.74	1.61–1.88	1.45	1.34–1.57
All PPH for acute ear, nose, and throat infections							
Frequency of moving home age 0–< 1 y							
0	201 114	13 035	(6.5)	1.00	—	1.00	—
1	31 735	2319	(7.3)	1.28	1.22–1.34	1.16	1.10–1.21
≥2	4993	386	(7.7)	1.67	1.50–1.86	1.44	1.29–1.61
All PPH for acute convulsions/epilepsy							
Frequency of moving home age 0–< 1 y							
0	201 114	3105	(1.5)	1.00	—	1.00	—
1	31 735	547	(1.7)	1.23	1.10–1.38	1.10	0.98–1.23
≥2	4993	97	(1.9)	1.94	1.50–2.49	1.58	1.23–2.04
All PPH for all injuries							
Frequency of moving home age 0–< 1 y							
0	201 114	8935	(4.4)	1.00	—	1.00	—
1	31 735	1616	(5.1)	1.27	1.21–1.35	1.10	1.05–1.17
≥2	4993	277	(5.5)	1.65	1.46–1.86	1.33	1.18–1.51
All PPH for acute dehydration/ gastroenteritis							
Frequency of moving home age 0–< 1 y							
0	201 114	2789	(1.4)	1.00	—	1.00	—
1	31 735	511	(1.6)	1.31	1.19–1.45	1.16	1.05–1.28
≥2	4993	96	(1.9)	1.84	1.48–2.29	1.51	1.21–1.88
All PPH for chronic asthma							
Frequency of moving home age 0–< 1 y							
0	201 114	2427	(1.2)	1.00	—	1.00	—
1	31 735	404	(1.3)	1.26	1.11–1.44	1.16	1.02–1.32
≥2	4993	84	(1.7)	1.85	1.37–2.50	1.61	1.19–2.16
All PPH for influenza/pneumonia							
Frequency of moving home age 0–< 1 y[e]							
0	201 114	1371	(0.7)	1.00	—	1.00	—
≥1	36 728	264	(0.7)	1.17	1.02–1.34	1.15	1.00–1.32
All PPH for acute dental conditions[f]							
Frequency of moving home age 0–< 1 y							
0	201 114	395	(0.2)	1.00	—	1.00	—
≥1	36 728	101	(0.3)	1.55	1.23–1.95	1.30	1.03–1.64
All PPH for acute appendicitis with generalized peritonitis							
Frequency of moving home age 0–< 1 y							
0	201 114	52	(0.03)	1.00	—	—	—
≥1	36 728	14	(0.04)	1.66	0.90–3.07	—	—
All PPH for other vaccine preventable conditions							
Frequency of moving home age 0–< 1 y							
0	201 114	71	(0.04)	1.00	—	—	—
≥1	36 728	10	(0.03)	0.86	0.44–1.69	—	—

—, denotes reference category.

TABLE 3 Continued

[a] Negative binomial model used with person-years to account for differential loss to follow-up of the outcome measure from end of cohort (after August 31, 2008), a house move after age 1 y, or death.

[b] Adjusted for all variables in the main model, but without imputation because of small counts.

[c] Person-years IRR.

[d] All avoidable admissions significant $P \leq .05$ in χ^2 or univariate analysis.

[e] Adjusted IRR for PPH for influenza/pneumonia ≥ 1 house move in first year of life has $P = .055$.

[f] Dental model adjusted only for parity, maternal age, Townsend quintiles at birth/4 mo, and cigarette smoking because of small numbers of PPH for acute dental conditions.

may be characterized by rental housing stock or indicate a more chaotic lifestyle, not captured by the use of a coarse area-based deprivation measure and other predictors used in the analysis. Our findings are similar to those from the Millennium Cohort Study; mobile families had more infant injuries and individual measures of deprivation and social class were included in the analysis.[10] Other researchers showed that in preschool children, frequent home moves were more strongly associated with overall accident rates than family type.[14] Findings from a US study suggest that the stress of a family move may be a precipitating factor in the etiology of unintentional burns, with moving children having ~3 times the rate of burns than those from the general population.[13]

A number of researchers have suggested a link between the frequency of home moves and the development of respiratory conditions or infections.[15,36,37] Our findings reinforce previous work in illustrating that moving home frequently presents an increased risk of PPH for asthma and ear, nose, and throat infections. We also found that increased residential mobility resulted in an increased risk of PPH for convulsions and epilepsy, dehydration and gastroenteritis, and influenza/pneumonia. A case-control study in which researchers examined whether house moves were a risk factor for the development of childhood asthma found a nonsignificant association between early home moves and the subsequent development of asthma.[38] Other studies have also shown strong associations between home moves in families with young children to previously inhabited, centrally heated dwellings and the subsequent development of childhood asthma.[39,40] It is suggested that moving home at an early age increases the risk of developing asthma, or is associated with other more important risk factors, such as increased general mobility and hence exposure to viral infections.[38] Similarly, it is thought that an increase in residential mobility, as an indicator of deprivation and living in a damp home, may be more important in the etiology of asthma than exposure to any 1 individual allergen or pollutant[40]. Our study examined the number of residential moves only; we did not have information regarding the condition of residential properties.

We conducted this study using a large, retrospective population-based cohort. By using SAIL, we previously demonstrated the effects of moving home on school and educational attainment as a prelude to studying the complex interrelationship between education and health.[2] A strength of this research was that the large size of the cohort and 5-year follow-up included sufficient frequencies for the outcomes of interest. Outcomes were collected in a standardized way, blinded to exposure status, thus facilitating rigorous comparison of the data.

A limitation of our study was that we had no information regarding the reasons for moving.[41] Not all children may be detrimentally affected by a move. For some, it could represent a move into a more affluent area with better facilities and housing, and therefore it would be expected to have a beneficial effect on their future health. It would be useful to examine whether individual moves were to a higher or lower level of deprivation and whether this influences the outcome. In addition, in our study, a residential move was defined as the change of address registered with the NHS. We also know that short-term moves and individuals not engaging with health service providers may result in moves not being registered with the NHS. This would lead to a misclassification of the number of moves and is likely to lead to an underestimation of the effect of moving home. We did not examine details regarding the distance involved in moves, only their frequency in the first year of life. We recognize that moves may only be to next door or to quite a distance. However, other research recently completed by the team using the same dataset found that moving between deprivation quintiles was not a significant predictor of hospital admissions (S.E.R., personal communication). Family structure is known to have strong influences on childhood outcomes.[16,17] We did not include details regarding the family structure in our analysis and would recommend further research to examine whether differences in

TABLE 4 Potentially Preventable Emergency Hospitalization Incidence Rates by Year of Follow-up and House Move (n = 237 842)

Year of Follow-up	Mean No. of All PPH[a] per 1000 Child-Years		Mean No. of All PPH for Acute Ear, Nose, and Throat Infections per 1000 Child-Years		Mean No. of All PPH for Acute Convulsions/ Epilepsy per 1000 Child-Years		Mean No. of all PPH for All Injuries per 1000 Child-Years		Mean No. of all PPH for Acute Dehydration/ Gastroenteritis per 1000 Child-Years		Total No. of Children per Year of Follow-up (n)	
	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–<1 y	1+ move age 0–<1 y	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–<1 y	≥1 move age 0–<1 y
Age 1–<2 y	87.0	108.0	40.6	49.3	11.7	14.4	16.8	22.2	9.0	11.2	201 114	36 728
Age 2–<3 y	54.8	64.8	20.3	23.2	6.0	7.1	15.6	18.7	3.8	4.2	146 295	24 038
Age 3–<4 y	39.4	45.1	12.8	15.3	3.8	4.8	12.1	12.2	2.0	2.6	109 059	16 177
Age 4–<5 y	29.6	33.0	9.0	10.4	2.2	2.1	10.3	10.7	1.3	1.6	81 262	11 232

Year of Follow-up	Mean No. of All PPH for Chronic Asthma per 1000 Child-Years		Mean No. of All PPH for Acute Dental Conditions per 1000 Child-Years		Mean No. of All PPH for Acute Appendicitis With Generalized Peritonitis per 1000 Child-Years		Mean No. of all PPH for Influenza/ Pneumonia per 1000 Child-Years		Mean No. of All PPH for Other Vaccine-Preventable Conditions per 1000 Child-Years		Total No. of Children per Year of Follow-up (n)	
	No move age 0–<1 y	≥1 move age 0–1 y	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–<1 y	≥1 move age 0–<1 y	No move age 0–< 1 y	≥1 move age 0–< 1 y	No move age 0–< 1 y	≥1 move age 0–<1 y
Age 1–<2 y	4.8	6.4	0.8	1.0	0.0	0.0	3.3	3.5	0.2	0.1	201 114	36 728
Age 2–<3 y	6.3	7.9	0.7	1.2	0.1	0.0	2.2	2.5	0.1	0.2	146 295	24 038
Age 3–<4 y	6.6	7.1	0.4	0.9	0.1	0.4	1.7	2.3	0.0	0.1	109 059	16 177
Age 4–<5 y	4.8	6.6	0.3	0.4	0.1	0.2	1.6	1.2	0.0	0.1	81 262	11 232

[a] All avoidable admissions statistically significant $P \leq .05$ in χ^2 or univariate analysis.

family structure influence the outcome over and above moving home.

Further research is needed to determine whether the effects of residential mobility in early childhood on PPH persist in later childhood and adolescence and whether moves beyond the first year of life have similar effects. In addition, further sensitivity analysis to explore the type and timing of PPH could determine whether certain hospitalizations are linked to different childhood developmental stages. We found that children who move home had increased risk of PPH compared with those who are more residentially stable. Whether this effect is primarily owing to the move, residual confounding for socioeconomic status, or a mixture of both is difficult to ascertain completely. Some of the other published literature that adjusted for confounders, albeit in smaller studies, such as the Millennium Cohort Study (n =18 000), demonstrate similar findings.

The question is what to do about such findings? The PPH caused by moving home represent a systems failure and can be considered a safe-guarding issue. Our findings also have wider implications for policy makers both nationally and internationally. Consideration needs to be given to welfare reforms which may, for example, result in moves by claimants. Policy makers need to be aware of the potential detrimental health effect that moving may have on families.

We found sizeable effects sizes worthy of developing a targeted intervention. These interventions would be based on likely causal factors, such as improving links with health care professionals and supporting parents who move. However, potential interventions

aiming to help educate, support, and monitor highly mobile families should be tested using rigorous designs before being completely rolled out. Further research including qualitative work is needed to understand the reasons behind residential mobility in early childhood and these causal factors. This could help identify families potentially at risk who should be offered additional support. Once we have a robust understanding of these factors, we can develop interventions for randomized controlled trials.

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ABBREVIATIONS

CI: confidence interval
ICD-10: *International Classification of Diseases, 10th Revision*
IRR: incidence risk ratio
NHS: National Health Service
PPH: potentially preventable hospitalization
SAIL: Secure Anonymised Information Linkage
WECC: Welsh Electronic Cohort for Children

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