Typologies of Residential Mobility in Childhood and Associations with Sociodemographic Characteristics: a Prospective Birth Cohort Study in Aotearoa New Zealand

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Typologies of Residential Mobility in Childhood and Associations with Sociodemographic Characteristics: a Prospective Birth Cohort Study in Aotearoa New Zealand

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Abstract

Despite documented associations between childhood area-level socioeconomic status (SES), residential mobility and health, studies in this domain rarely use life-course study designs. This study examined temporal patterns of four residential mobility typologies based on area-level SES exposure from birth to 16 years. We devised four main residential mobility typologies: advantaged stayers (remaining in high SES areas), disadvantaged stayers (remaining in low SES areas), advantaged or upward movers (moving between high SES areas or transitioning from low to high SES areas), and disadvantaged or downward movers (moving between low SES areas or transitioning from high to low SES areas). Secondly, the research examined selected sociodemographic characteristics associated with the residential mobility typologies and whether these associations varied by age. Data from the Christchurch Health and Development (CHDS) prospective birth cohort study were used to obtain individual (i.e., gender, ethnic) and family sociodemographic (i.e., family SES) characteristics, and home addresses from birth to 16 years. Geocoded home addresses were linked to area-level SES. Two-level multinomial logistic regression models examined associations between sociodemographic characteristics and residential mobility typologies and their variations by age. Disadvantaged stayers constituted over one-fifth of the cohort during most of childhood. Children with Māori ethnicity, younger mothers, family instability, and childhood adversity are more vulnerable to frequent moves coupled with exposure to low area-level SES. Our study paves the way for the exploration of childhood environmental exposures and later-life health within a spatial lifecourse epidemiology framework.

Keywords Childhood · Residential Mobility · Area-level socioeconomic status · GIS · Health and well-being

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1 Introduction

The impact of area-level socioeconomic status (SES) on health, independent of individual and family factors, has been reported widely in the literature (Elovainio et al., 2020; Shackleton et al., 2018). High SES areas can often provide their residents with a more health-promoting environment, such as better access to nature, physical activity facilities, nutritious food, and healthcare facilities (Lee et al., 2023; Marek et al., 2021a; Schüle et al., 2017). This promotes the development of healthy lifestyles (Hobbs et al., 2022a, b), thereby benefiting a range of health outcomes including physical and mental health (Baranyi et al., 2022; Green et al., 2021; Jokela, 2015). Conversely, low SES areas are often characterised by higher crime rates, and limited access to various health-promoting facilities, making them disadvantageous for the development of healthy lifestyles (Algren et al., 2015; Hobbs et al., 2022b; Marek et al., 2021a; Ortiz et al., 2022). Moreover, area-level SES might interact with individual-level SES to influence health outcomes, as the SES of the broader environment can either amplify or mitigate the effects of an individual's own SES position (Ejlskov et al., 2023; Ribeiro et al., 2022). Despite the associations between area-level SES and health, studies in this domain remain predominantly cross-sectional, with only a limited application of long-term, longitudinal or lifecourse study designs (Jivraj et al., 2020).

Childhood is known to be the most formative period in life, with important physical and psychological development (Halfon et al., 2018). The area-level SES in the context of where children grow up may play an important role in their growth, maturation, and development, as well as subsequent health (Caspi et al., 2020; Zhang et al., 2021). Additionally, individuals who live in socioeconomically disadvantaged areas in childhood are more likely to continue residing in areas of similar SES throughout lifecourse (de Vuijst et al., 2017; Jivraj et al., 2020). Despite the importance of childhood exposure to area-level SES, there is a scarcity of literature comprehensively investigating changes in area-level SES exposure across the entire childhood, which has further hindered the establishment of a robust relationship between childhood area-level SES exposure and subsequent health outcomes over the lifecourse (Pavalko & Caputo, 2013; Simsek et al., 2021).

Childhood residential mobility has been linked to various adverse health outcomes in both current and later life (Jelleyman & Spencer, 2008; Simsek et al., 2021). However, not all moves have negative effects (Morris et al., 2018). The health implications of childhood residential mobility can differ depending on the SES of the areas to which children move, although this is often overlooked (Jelleyman & Spencer, 2008). Evidence suggests that individuals who move from low to high SES areas are healthier than those who move in the opposite direction (Norman et al., 2005). However, a minimal percentage (0.3%) of individuals who frequently changed residential addresses in New Zealand (NZ) were relocating towards higher SES areas (Marek et al., 2021b). The opportunity for residential mobility with improved area-level SES may be further unevenly distributed among children from different family backgrounds. Māori and Pacific children were less likely to move to, or remain in low SES areas and were also less likely to transition to high SES areas compared to the total NZ population (Robertson et al., 2021). Additionally, families with unstable partner-

ships and unemployment are more prone to downward residential mobility from high to low SES areas (Gambaro et al., 2017). Understanding how children move between areas with different SES throughout childhood has important implications in clarifying the associations between early exposure to area-level SES on health outcomes in later life (Baranyi et al., 2022; Pavalko & Caputo, 2013). Moreover, identifying the sociodemographic characteristics of children with different residential mobility patterns can inform policies aimed at reducing health inequalities related to area-level SES (Pavalko & Caputo, 2013; Robertson et al., 2021).

The spatial lifecourse epidemiology framework has emerged as a promising approach to investigate the associations between the environment and health over the lifecourse (Desjardins et al., 2023; Jia, 2019; Jia et al., 2019, 2020; Pearce, 2018), with residential mobility being a key yet often overlooked component of this framework. Residential mobility fits well within this framework for three primary reasons. First, it represents a sequence of evolving events that can directly impact health potentially confounding the relationship between the environment and health outcomes (Mok et al., 2016; Price et al., 2018). Second, capturing residential mobility improves measurement of the sum of an individual's environmental exposures over their lifecourse, which has important implications in chronic disease studies and infectious disease research (Jia et al., 2020). Exposure misclassification may be an important bias by not including residential mobility (Hedman, 2011; Hodgson et al., 2015; Saucy et al., 2023) or using inaccurate residential history data (Harari-Kremer et al., 2022) when examining the environmental impact on health. Third, residential mobility plays an important role in addressing selective migration bias (Hedman, 2011; Morris et al., 2018). This bias may arise when healthier individuals actively choose to reside in neighbourhoods with specific environmental characteristics such as being less deprived or with greater greenspace (Norman et al., 2005). This thereby introduces uncertainties into the relationship between any environment health association (Hedman, 2011). While efforts have been made in recent research to incorporate residential mobility into study design (Hobbs et al., 2023; Mouly et al., 2023), residential mobility over the lifecourse is still absent in most studies in this area due to the lack of high-quality prospectively collected data over the lifecourse.

The evidence on understanding childhood patterns of residential mobility and area-level SES exposure and the associations between these patterns and children's and families' sociodemographic characteristics have the following gaps. First, childhood patterns of residential mobility based on area-level SES across the whole childhood are rarely fully investigated in the literature with most studies focusing predominantly on specific childhood segments, particularly early childhood under age five (Gambaro et al., 2017; Nathan, 2021; Robertson et al., 2021). Second, many studies usually conceptualised residential mobility as an aggregated count or a dichotomous variable (Anderson et al., 2014b; Coley & Kull, 2016), ignoring the SES of the areas where children lived. Third, many studies in this area rely on administrative data (Marek et al., 2023; Nathan, 2021; Robertson et al., 2021) lacking the capacity to provide detailed personal information, such as maternal education level. Fourth, the associations between patterns and directions of residential mobility based on area-level SES might differ at different ages in childhood (Anderson et al., 2014b). This paper aimed to address these knowledge gaps by using prospectively collected birth

cohort data to examine typologies of residential mobility based on area-level SES exposure from a lifecourse perspective including advantaged stayers (remaining in high SES areas), disadvantaged stayers (remaining in low SES areas), advantaged or upward movers (moving between high SES areas or transitioning from low to high SES areas), and disadvantaged or downward movers (moving between low SES areas or transitioning from high to low SES areas). Specifically, this study aims to (i) examine temporal patterns of the four residential mobility typologies across childhood from birth to 16 years; (ii) examine what sociodemographic and individual characteristics are associated with the typologies of residential mobility; and (iii) examine whether these associations vary by age in childhood. We hypothesis that the disadvantaged or downward movers are associated with the most disadvantageous sociodemographic and individual characteristics, and these associations do not vary by age in childhood. This study paves the way for future studies to examine the lifecourse associations between environment and health within a spatial lifecourse epidemiology framework.

2 Methods

2.1 Settings and Participants

This study used data from the Christchurch Health and Development Study (CHDS). The CHDS is a birth cohort study of 1,265 children (630 females) born in the Christchurch (NZ) urban region over four months in 1977 comprising 97% of all births occurring during that period (Fergusson & Horwood, 2001). CHDS cohort members' information has been collected using diverse methods including interviews with parents (birth to age 16); interviews directly with the cohort members (from age 8 onwards); reports from teachers and standardised tests (age 6 to 13); official records from medical (birth to age 16); police record data (age 14 to 21) (Fergusson & Horwood, 2001). The CHDS data have been used to research a wide range of topics including mental health (Fergusson et al., 1995; McLeod et al., 2016), substance use (Boden et al., 2016, 2017), exposure to abuse and trauma (Boden et al., 2007; Friesen et al., 2010), and many related topics. More details about this study can be found elsewhere (Fergusson et al., 1989; Fergusson & Horwood, 2001, 2013). This paper uses the first 18 waves of CHDS data which includes birth (1977), four months (1977), and annual assessments from one-year-old (1978) to 16 years old (1993) (Fergusson & Horwood, 2013). All phases of the CHDS were approved by the Southern Health and Disabilities Ethics Committee with the signed consent of the cohort members. Cohort members' addresses at each wave were geocoded at the address level, more details on the geocoding process were provided in Online Resource Sect. 1.

2.2 Individual and Family Sociodemographic Characteristics

CHDS collected data from both individual and family sociodemographic characteristics (detailed information about the definition of each factor is provided in Online

Resource Sect. 2). At the birth interview, mothers were asked a series of questions related to the cohort members' individual and family backgrounds, including gender (0 = male, 1 = female), ethnicity (0 = European, 1 = Māori), maternal education (1 = low, 2 = moderate, 3 = high), maternal age (1 = young, 2 = moderate, 3 = mature), family type (0 = two-parent family, 1 = single-parent family), family SES (1 = low, 2 = moderate, 3 = high). Additionally, two variables were tracked throughout the cohort members' development: family instability from birth to age 16 (0 = no changes in parental figures; 1 = at least one change in parental figures) and cumulate childhood adversity level from birth to age 16 (1 = the least, 2, 3, 4, 5 = the highest).

2.3 Typologies of Residential Mobility Based on area-level SES in Childhood

Four typologies of residential mobility including area-level SES in childhood over 16 years were defined. Their construction involved three steps. First, cohort members' home coordinates at each wave were compared with the previous wave, resulting in 17 dichotomous variables representing whether they moved between consecutive waves. Secondly, the area-level SES at cohort members' home locations at each wave was measured using a recently developed historical time-series area-level deprivation metric (Deng et al., 2024). This metric was constructed for the years 1981, 1986, and 1991 at the Census Area Unit (CAU) level based on unemployment and non-home-ownership. The metric has been validated in previous research and can be regarded as a reliable proxy for area-level SES in NZ from 1981 to 1991 (Deng et al., 2024). The visualisation of the metric was provided in Online Resource Fig S1. The metric was linked to home coordinates at the temporally closest wave, with areas categorised into high SES (quintiles 1–3) or low SES (quintiles 4–5). This categorisation of high and low SES areas ensures that each typology of residential mobility has a sufficient sample size to support subsequent statistical analysis and provides a clear distinction between lowest SES areas and other SES areas. Cohort members' area-level SES exposure at each wave was compared with the previous wave. This generated 17 categorical variables reflecting four SES exposure combinations between adjacent waves: (1) high and high, (2) low and low, (3) high and low, and (4) low and high. Thirdly, the four typologies were constructed by combining residential moves and area-level SES changes: (1) advantaged stayers - cohort members who lived in high SES areas and did not move; (2) disadvantaged stayers - cohort members who lived in low SES areas and did not move; (3) advantaged or upward movers - cohort members who either moved between high SES areas or who moved from low SES areas to high SES areas; (4) disadvantaged or downward movers - cohort members who either moved between low SES areas or moved from high SES areas to low SES areas. If there are missing values in residential moves or area-level SES changes between consecutive waves, the cohort member is classified as missing. This process generated 17 categorical variables representing typologies of residential mobility from birth to age 16.

2.4 Statistical Methods

Descriptive statistics are presented as counts and percentages. Individual and family sociodemographic characteristics were stratified by the four typologies of residential mobility at each wave; mean values were calculated for each characteristic within each group, allowing for a comparison of the differences between groups for each specific characteristic.

A two-level multinomial logistic regression model with repeated observations over time nested within individuals was fitted to investigate the association between individual and family sociodemographic characteristics and the four typologies of residential mobility. By incorporating interaction terms of age and each sociodemographic variable, this model also examined how the relationships between characteristic variables and typologies of residential mobility might differ as age progresses. Both fixed effects and random effects on the individual level were included in the model and advantaged stayers were treated as the reference category. The Relative Risk Ratio (RRR) and 95% confidence intervals (CIs) were estimated from the model. The dependent variable (typologies) was modelled as a categorical variable while independent variables were included as continuous variables in the model, which is in line with previous CHDS analytical procedures (Boden et al., 2023). By this we assume that within-variable group differences are constant. All analysis was conducted in Stata 17.

3 Results

3.1 Temporal Patterns of Residential Mobility Typologies in Childhood

Figure 1 illustrates the patterns of residential mobility typologies of the cohort birth (1977) to age 16 by classifying the cohort members as advantaged stayers, disadvantaged stayers, advantaged or upward movers, disadvantaged or downward movers, and missing data. Throughout childhood, advantaged stayers consistently constituted the majority, ranging from 44 to 52%. Disadvantaged stayers represented approximately 28% of the cohort at four months, and then gradually decreased to around 16% by the age of 16. Advantaged or upward movers represented 8% of the cohort throughout most of childhood, with a slightly elevated proportion of 12% at ages one, two, and four, and a slightly reduced proportion of 4% at ages 11 and 15. Disadvantaged or downward movers were the smallest among the four categories, constituting approximately 8% before the age of four and maintaining a steady 4% between ages four and 16. Missing data accounted for about 8% at four months, reaching a peak of around 28% at age 12, and subsequently decreasing slightly to 24% at age 16.

3.2 Sociodemographic Characteristics by Typologies of Residential Mobility

The characteristics of original CHDS data ($n=1,265$) are provided in the Online Resource Sect. 3. Among the original CHDS data, 49.8% were female, 85.8% were European, and 14.2% were Māori or Pacific. At the time of birth of the members,
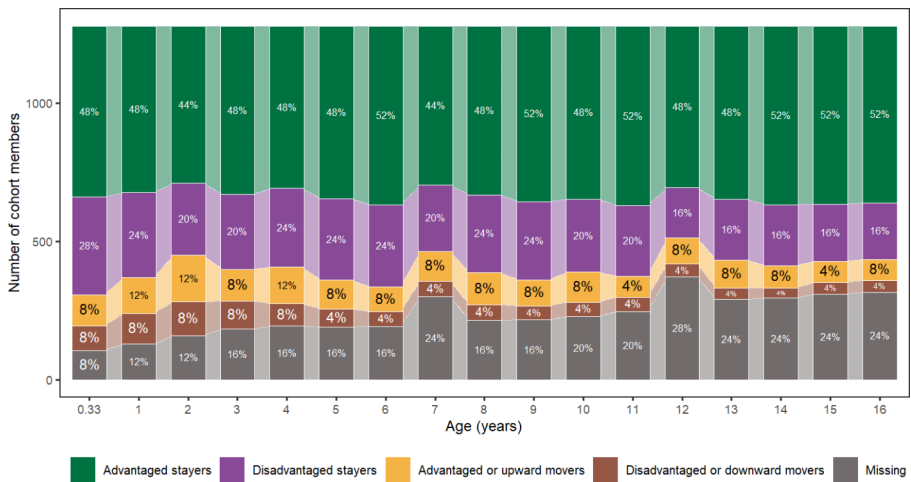
Fig. 1 Temporal patterns of residential mobility typologies from 4-month-old to the age of 16

51.1% of mothers possessed a low educational level, while 18.6% had a high educational level. Further, 14.1% of mothers were below 20 years of age, whereas 20.6% were above 30 years old. Most members (92.3%) were born into a two-parent family, while more than one-third of cohort members (34.1%) saw at least one change in parental relationship in childhood. Additionally, 27% and 20.2% of members were born into families with lower and higher SES, respectively. Moreover, 3.2% of the members experienced a very high level of childhood adversity.

Table 1 summarises the individual and family sociodemographic characteristics of cohort members by typologies of residential mobility defined during the interval from birth to four months of age. Characteristics of cohort members by typologies of residential mobility defined for other childhood age intervals were provided in Online Resource Sect. 4. Advantaged stayers had the highest proportions of European ethnicity, high educational level of the mother at birth, age maturity of the mother at birth, two-parent families, no parental relationship changes, high family SES at birth, and the lowest level of childhood adversity compared to the other three typologies. On the other hand, disadvantaged or downward movers had the highest proportion of males, Māori ethnic groups, low educational level of the mother at birth, young maternal age at birth, single-parent families, at least one parental relationship change, low family SES at birth, and the second highest level of childhood adversity. These patterns found between birth and four months remained consistently similar for other childhood ages (see Online Resource Sect. 4).

3.3 Associations between Sociodemographic Characteristics and Typologies of Residential Mobility

Table 2 presents the results of the two-level multinomial logistic regression model examining the relationships between various individual and family sociodemo-

Table 1 Individual and family sociodemographic characteristics by the typologies of residential mobility from birth to 4-month-old

	Advantaged stayers n=617	Disadvantaged stayers n=353	Advantaged or upward movers n=113	Disadvantaged or downward movers n=89
Gender				
Male	304 (49.3%)	181 (51.3%)	52 (46.0%)	51 (57.3%)
Female	313 (50.7%)	172 (48.7%)	61 (54.0%)	38 (42.7%)
Ethnicity				
European	570 (92.4%)	290 (82.2%)	89 (78.8%)	55 (61.8%)
Māori	47 (7.6%)	63 (17.8%)	24 (21.2%)	34 (38.2%)
Maternal education at birth				
Low	287 (46.5%)	186 (52.7%)	70 (61.9%)	58 (65.2%)
Moderate	187 (30.3%)	107 (30.3%)	29 (25.7%)	22 (24.7%)
High	143 (23.2%)	60 (17.0%)	14 (12.4%)	9 (10.1%)
Maternal age at birth				
Young	38 (6.2%)	52 (14.7%)	34 (30.1%)	38 (42.7%)
Moderate	423 (68.6%)	234 (66.3%)	66 (58.4%)	41 (46.1%)
Mature	156 (25.3%)	67 (19.0%)	13 (11.5%)	10 (11.2%)
Family type at birth				
Two-parent family	594 (96.3%)	332 (94.1%)	97 (85.8%)	63 (70.8%)
Single-parent family	23 (3.7%)	21 (5.9%)	16 (14.2%)	26 (29.2%)
Family instability				
No changes in parental figures	448 (72.6%)	200 (56.7%)	59 (52.2%)	44 (49.4%)
At least one change in parental figures	169 (27.4%)	153 (43.3%)	54 (47.8%)	45 (50.6%)
Family socioeconomic status at birth				
Low	118 (19.1%)	105 (29.7%)	43 (38.1%)	40 (44.9%)
Moderate	339 (54.9%)	189 (53.5%)	50 (44.2%)	41 (46.1%)
High	160 (25.9%)	59 (16.7%)	20 (17.7%)	8 (9.0%)
Adversity level				
Level 1– the lowest	172 (34.1%)	69 (24.3%)	12 (13.5%)	6 (9.2%)
Level 2	159 (31.5%)	75 (26.4%)	23 (25.8%)	16 (24.6%)
Level 3	111 (22.0%)	69 (24.3%)	27 (30.3%)	16 (24.6%)
Level 4	53 (10.5%)	55 (19.4%)	16 (18.0%)	23 (35.4%)
Level 5– the highest	10 (2.0%)	16 (5.6%)	11 (12.4%)	4 (6.2%)
Missing	112	69	24	24

Data are presented as n (%)

graphic characteristics and the typologies of residential mobility across childhood. Advantaged stayers were the reference group for all subsequent findings.

Compared to advantaged stayers, being of Māori ethnicity was statistically significantly associated with a 6.09 times higher risk of belonging to disadvantaged or downward movers (CI = [3.51, 10.57]), a 4.31 times higher risk of belonging to disadvantaged stayers (CI = [2.61, 7.14]), and a 3.41 times higher risk of belonging to advantaged or upward movers. Additionally, being born to mature mothers was statistically significantly associated with 19% less likely to belong to disadvantaged or downward movers (RRR = 0.81 [0.78, 0.86]), 14% less likely to belong to advantaged

Table 2 Results from the two-level multinomial logistic regression model investigating the associations between individual and family sociodemographic characteristics and typologies of residential mobility

The reference group is advantaged stayers	Disadvantaged stayers	Advantaged or upward movers	Disadvantaged or downward movers
Gender	0.83 [0.59, 1.15]	0.85 [0.59, 1.22]	0.77 [0.52, 1.14]
Ethnicity	**4.31 [2.61, 7.14] *** **	**3.41 [1.97, 5.92] *** **	**6.09 [3.51, 10.57] *** **
Maternal education at birth	1.00 [0.79, 1.26]	1.11 [0.86, 1.43]	0.94 [0.70, 1.25]
Maternal age at birth	**0.91 [0.88, 0.95] *** **	**0.86 [0.83, 0.90] *** **	**0.81 [0.78, 0.86] *** **
Family type at birth	0.99 [0.49, 2.01]	1.33 [0.63, 2.80]	1.84 [0.88, 3.89]
Family instability	1.01 [0.94, 1.10]	**1.10 [1.01, 1.20] ***	**1.10 [1.01, 1.20] ***
Family socioeconomic status at birth	0.79 [0.60, 1.04]	1.05 [0.77, 1.42]	0.85 [0.61, 1.19]
Adversity level	**1.44 [1.21, 1.71] *** **	**1.33 [1.10, 1.61] *** **	**1.43 [1.16, 1.75] *** **
Age	**0.85 [0.79, 0.92] *** **	**0.84 [0.76, 0.93] *** **	**0.71 [0.63, 0.81] *** **
Age × gender	1.02 [1.00, 1.04]	1.02 [0.99, 1.04]	1.03 [0.99, 1.06]
Age × ethnicity	**0.96 [0.94, 0.99] ***	**0.92 [0.89, 0.96] *** **	**0.93 [0.90, 0.97] *** **
Age × maternal education at birth	**0.98 [0.96, 0.99] *** **	**0.98 [0.96, 1.00] ***	**0.96 [0.94, 0.99] *** **
Age × maternal age at birth	**1.00 [1.00, 1.01] *** **	**1.01 [1.00, 1.01] *** **	**1.01 [1.01, 1.02] *** **
Age × family type at birth	1.01 [0.97, 1.06]	1.00 [0.95, 1.05]	0.96 [0.91, 1.01]
Age × family instability	0.99 [0.99, 1.01]	**1.01 [1.00, 1.01] ***	**1.01 [1.00, 1.01] ***
Age × socioeconomic status at birth	1.00 [0.99, 1.02]	0.99 [0.97, 1.01]	0.98 [0.95, 1.01]
Age × Adversity level	1.00 [0.99, 1.01]	1.00 [0.98, 1.01]	1.01 [0.99, 1.02]

Data are presented as Relative Risk Ratio [Confidence Intervals]

* $p \leq 0.05$, ** denotes $p \leq 0.01$, *** denotes $p \leq 0.001$

Log likelihood = -12963.47, pseudo-R^2 = 0.312, Akaike information criterion (AIC) = 26036.94, Bayesian Information Criterion (BIC) = 26458.47

or upward movers (RRR=0.86 [0.83, 0.90]), and 9% less likely to belong to disadvantaged or downward movers (RRR=0.91 [0.88, 0.95]). Compared to advantaged stayers, members who experienced changes in parental relationships had a statistically significant slightly higher relative risk of belonging to advantaged or upward movers and disadvantaged or downward movers (RRR=1.10 [1.01, 1.20] for both). Furthermore, members experiencing an increased level of childhood adversity had a statistically significant higher relative risk of belonging to disadvantaged stayers, advantaged or upward movers, and disadvantaged or downward movers (RRR=1.44 [1.21, 1.71], 1.33 [1.10, 1.61] and 1.43 [1.16, 1.75] respectively for every adversity level). There were no statistically significant associations between gender, maternal education at birth, family type at birth, and family SES at birth and any of the residential mobility typologies.

With age progression, CHDS cohort members were less likely to be in the other three typologies compared to the advantaged stayers. Over time, there was a statistically significant but minor reduction in the strength of associations between ethnicity or maternal education at birth and the four typologies of residential mobility. Con-

versely, the associations between maternal education at birth or family instability and the four typologies of residential mobility showed a marginal but statistically significant increase over time.

4 Discussion

Using a prospective birth cohort study design, we examined the temporal patterns of four residential mobility typologies (advantaged stayers, disadvantaged stayers, advantaged or upward movers, and disadvantaged or downward movers) across childhood from birth to 16 years. We then examined what sociodemographic characteristics were associated with the four typologies of residential mobility and whether these associations varied by age in childhood. Our findings showed that while advantaged stayers were consistently in the majority, disadvantaged stayers constituted more than one-fifth of the cohort before the age of 11 and 16% thereafter. Being of Māori ethnicity, being born to younger mothers, and having elevated childhood adversity levels were associated with a higher likelihood of being in the other three typologies compared to being the advantaged stayers. Additionally, experiencing changes in parental relationships had a slightly higher likelihood of being advantaged or upward movers and disadvantaged or downward movers. Over time, associations between characteristics and residential mobility typologies varied marginally in effect size, suggesting that the characteristics of the residential mobility typologies are persistent during childhood. These results partially support our hypotheses that disadvantaged or downward movers are associated with more disadvantageous characteristics, with slight changes in the extend of some associations over time. Our findings are useful for policy as they identify underserved populations that may benefit from targeted interventions aimed at early prevention of residential instability and improvement of residential area SES conditions during childhood in New Zealand.

In terms of the temporal trend of residential mobility, this study found that residential mobility was a more prevalent phenomenon in early childhood (0 to 4 years old) than in middle (5 to 10 years old) and to a lesser extent late childhood (11 to 16 years old) among the CHDS population. These findings align with the findings from other studies focused on childhood residential mobility in NZ which found children under age five showed high residential mobility (Morton et al., 2017, 2020; Nathan, 2021; Robertson et al., 2021). It is suggested that families with young children tend to move more, possibly due to the need of a bigger accommodation that accommodates an extra family member, and that voluntary moving reduces once children go to primary school (Morton et al., 2020).

Drawing on typologies that encompass both the attributes of residential movement and the residential area context, we have gained novel and distinctive insights into childhood residential mobility in NZ. Traditionally, studies have tended to consider residential mobility and area-level SES separately (Brown et al., 2012; Nathan et al., 2019), inadvertently overlooking the chance to illuminate the subgroup of children facing a potential dual disadvantage. We found that children exposed to both residential mobility and low area-level SES constitute a group with the highest likelihood of coming from the most disadvantaged backgrounds including Māori ethnic-

ity, younger maternal age at birth, higher family instability, and higher childhood adversity level. These findings are broadly consistent with those of the Growing Up in New Zealand (GUINZ) study, another more contemporary birth cohort study in NZ, which found that experiencing any residential mobility and persistent exposure to low area-level SES was more common among children born to younger mothers and those identifying as Māori or Pacific (Morton et al., 2020). However, the GUINZ also found associations between residential mobility and exposure to low area-level SES with maternal educational attainment, which were not found in the present study potentially due to the differences in study design.

This study revealed a disproportionate concentration of Māori individuals classified as disadvantaged or downward movers, who are exposed to higher levels of residential mobility and low area-level SES. Similar results were found by Robertson et al. (2021), who found that moves are predominantly occurring in low SES areas for both Māori and Pacific children. This disparity could be attributed to the historical injustices and the enduring impacts of colonisation, which began in the 19th century (Bécares et al., 2013; Hobbs, 2019). These historical factors have resulted in widespread deprivation and marginalisation of the Māori community, leading to their forced separation from vital social, cultural, and economic resources, including their ancestral lands (Bécares et al., 2013). Although this study has shown that the strength of the association between ethnicity and residential mobility typologies decreases with age, the magnitude of the decrease is considered small given the magnitude of the initial association. In addition, this study also revealed that family instability (i.e., divorce) was found to be only significantly associated with the movers, no matter whether advantaged or upward movers or disadvantaged or downward movers. This implies that the instability of parental relationships, such as parental separation or divorce, plays a role in the decision to relocate children (Anderson et al., 2014b) but perhaps not the SES characteristics of areas.

To our knowledge, this is one of the largest analyses of residential mobility based on residential area-level SES patterns in Oceania, spanning birth to 16 years in a birth cohort study. Two major strengths of this study are firstly the availability of detailed residential history data at the address level and secondly linking the residential mobility data to historical measures of area-level SES from the birth year 1977 (Deng et al., 2024). Despite this, the moves reported in this study were an undercount of the actual number of moves as addresses were only captured at interview alongside longitudinal data collection. Consequently, moves that occurred between interviews may be missing. Additionally, owing to the nature of a longitudinal study, the withdrawal and re-entry of members as well as sample attrition were responsible for most missing data. Other factors such as incomplete addresses, failures in geocoding, and missing values in area SES data were also attributed to a part of the missing data. Nevertheless, the problem of missing data was addressed by using multilevel models in the analysis.

The sample size of this study limited our ability to incorporate additional important characteristics of residential mobility other than area-level SES, such as the distance moved (Nathan, 2021) and the urban/rural setting of moves (Marek et al., 2023). This is because doing so would result in smaller sample sizes within certain categories of residential mobility compromising the statistical power of the analysis. In addition, we acknowledge that the categorisation of area-level SES into low and high are

arbitrary and may lack of comparability with other studies (Lamb & White, 2015). Despite this, our chosen method of classification still effectively incorporated the unique characteristics of cohort members in terms of residential mobility and areas where the cohort members lived, making optimal and meaningful use of this data.

This study used the cohort data that was born in 1977, the evidence from this study may not apply to the generations born in the 21st century. The cohort members in this study were largely from two ethnic groups: European and Māori groups, which can be different from the current composition of ethnic groups in NZ. Nevertheless, this study is still valuable in providing insights into the residential mobility patterns in the current middle–aged generation and will provide the potential to study the longitudinal relationship between residential mobility and health, as well as link environmental exposures in childhood to health in adulthood for future study.

In the future, researchers can delve deeper into understanding the long-term effects of residential mobility and area-level SES on health and explore the cumulative nature of these effects by capitalising on the high-quality birth cohort data. Moreover, by incorporating the spatial lifecourse epidemiology approaches, it becomes possible to investigate the complex relationships between environmental exposures and health outcomes for future studies. For instance, examining how exposure to different environmental factors evolves and how these exposures influence health can provide valuable insights into establishing causal relationships.

5 Conclusion

Using data from a prospective birth cohort study, we examined patterns of residential mobility based on area-level SES exposure during childhood and examined the relationships between individual and family sociodemographic characteristics and residential mobility typologies. Children with Māori ethnicity, younger mothers, family instability, and childhood adversity are more vulnerable to frequent moves coupled with exposure to low area-level SES during childhood. Within a spatial lifecourse epidemiology framework, our study provides a unique perspective that contributes to the understanding of childhood residential mobility typologies. This study also lays the groundwork for subsequent research on the relationships between environmental exposures during childhood and health effects later in life.

Data availability The Christchurch Health and Development Study (CHDS) data are not freely available as we do not currently have ethical approval to upload these data to any repository and this prevents us from sharing this data in this way. However, data are available on request, subject to approval by the CHDS Director: chds.uoc@otago.ac.nz.

Declarations

All aspects of the CHDS received ethical approval by the Southern Health and Disabilities Ethics Committee and the approval number is 16_STH_144. All data were collected with the explicit written consent of the cohort members.

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