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Challenges in examining area effects across the life course on physical capability in mid-life: Findings from the 1946 British Birth Cohort

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ABSTRACT

A major limitation of past work linking area socioeconomic conditions to health in mid-life has been the reliance on single point in time measurement of area. Using the MRC National Survey of Health and Development, this study for the first time linked place of residence at three major life periods of childhood (1950), young adulthood (1972), and mid-life (1999) to area-socioeconomic data from the nearest census years. Using objective measures of physical capability as the outcome, the purpose of this study was to highlight four methodological challenges of attrition bias, secular changes in socio-economic measures, historical data availability, and changing reporting units over time. In general, standing balance and chair rise time showed clear cross-sectional associations with residing in areas with high deprivation. However, it was the process of overcoming the methodological challenges, which led to the conclusion that in this example percent low social class occupations was the most appropriate measure to use when extending cross-sectional analysis of standing balance and chair rise to life course investigation.

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1. Background

There is a large and growing body of literature showing that persons who live in socioeconomically 'deprived' areas have worse health than those who live in better areas, even after adjustment for their own socioeconomic position (Diez-Roux and Mair, 2010). But most studies focus on specific illnesses, such as cardio-vascular disease, not overall physical ability. A few studies have documented that living in a more deprived area in adulthood is associated with higher self-rated functional limitations (Basta et al., 2007), mobility disability (Lang et al., 2008), and general disability (Beard et al., 2009; Freedman et al., 2008) in late adulthood. Only one study of which we are aware (Lang et al., 2008) has investigated area effects on an objective measure of physical capability, walking speed, which is only one of a series of measures that can be used to test the ability of an individual to undertake the tasks of daily living.

Most existing studies of area effects on health rely on measures of areas assessed at a single point in time in adulthood (Diez-Roux and Mair, 2010). If over time persons move to better or worse areas or the areas in which they live change, using a single measure of residence could underestimate the effects of areas on physical capability. There is mounting evidence that physical capability in later life is a reflection of factors occurring across the life course, including growth and motor coordination in childhood (Kuh et al., 2006). In addition, numerous studies have shown that higher area deprivation is related to less availability of healthy foods and physical activity resources (Lakshman et al., 2010; Larson et al., 2009; Lovasi et al., 2009; Sallis and Glanz, 2009), higher rates of smoking (Lakshman et al., 2010; Matheson et al., 2011), and alcohol consumption (Lakshman et al., 2010; Matheson et al., 2011; Pollack et al., 2005), all of which are major risk factors for lower body functional limitations (LaCroix et al., 1993). Hence, the socioeconomic environment in which individuals live at multiple points in the life course may be associated with physical capability in later life.

Investigating the impact of area socioeconomic conditions over the life course on health in later life is complex, requiring residential addresses for each study member at multiple dates over a long period, plus corresponding area level data for each date. Any such analysis must address a number of methodological challenges.

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First, in longitudinal studies drop-out inevitably occurs due to death, emigration, and refusal to participate. Some further cases are lost because old addresses cannot be located or linked to exposure data. Consequently, it is important to compare the area socioeconomic characteristics of those included and those excluded from analysis to examine if attrition bias may have occurred.

Second, the UK has experienced extensive social change over the last fifty years, including large increases in standards of living (Hicks and Allen, 1999). If we are to disentangle effects of areas at different stages of the life course, there must be enough variation in deprivation measures across areas in all years, and there need to be enough individuals moving between areas with different characteristics.

Third, consistent area level information at different points of the life course, including childhood, is required. Assessment of area deprivation in cross-sectional studies is either by direct assessment of areas by survey teams (Raudenbush and Sampson, 1999; Diez-Roux and Mair, 2010), surveys of residents (Mujahid et al., 2007; Mujahid et al., 2008; Auchincloss et al., 2009) or aggregate data, notably from the census (Riva et al., 2007; Diez-Roux and Mair, 2010). Surveys are impractical in longitudinal studies, so we must rely on census data and other official statistics. Area deprivation is often defined using indices such as the Index of Multiple Deprivation (IMD) (ODPM, 2004), Townsend deprivation index (Townsend et al., 1988), or the Carstairs deprivation index (Carstairs, 1995), which are comprised of items from the census. However, only 5 of the 7 census variables used in the Townsend or Carstairs indices were collected for census years earlier than 1971. It is therefore necessary to investigate whether single area deprivation measures, which are available at all time points, or new indices based on measures available at all time points, are associated with physical capability in the same way.

Fourth, the area measures need to be available for equivalent geographical units over time. The smallest geographical unit for which area socioeconomic data are available before 1971 is the local government district, although their average size was substantially smaller than modern districts and unitary authorities. Smaller ward units as well as local government district areas are available for more recent years. An understanding of the extent, if any, of the underestimation of area effects on physical capability when using the larger geographic boundary of local government district is required.

This research forms part of the Healthy Ageing across the Life Course (HALCyon) collaborative research programme funded by the New Dynamics of Ageing programme (www.halcyon.ac.uk). This component aims to understand how healthy ageing, as measured by physical and cognitive capability, is affected by where people live across whole of their lives. This paper uses data from the Medical Research Council (MRC) National Survey of Health and Development (NSHD), a birth cohort of men and women born in 1946, with prospectively collected residential addresses available across the whole of the life course. We link addresses collected at ages 4, 26, and 53 years to census area socioeconomic data in 1951, 1971, and 2001, respectively, to investigate the impact of four methodological challenges on moving from cross-sectional to longitudinal analyses of area effects on health in later life.

2. Methods

2.1. Study participants

The MRC NSHD is a socioeconomically stratified sample of 5362 singleton births during one week in March 1946. Cohort members have been followed up to 23 times since birth and a wealth of medical and socioeconomic data has been collected throughout the life course (Wadsworth et al., 1992). At 53 years, 3035 men and women still alive and residing in England, Scotland, and Wales were interviewed in their own homes by a team of trained nurses. The sample remains representative, in most respects, of the British-born population of the same age (Wadsworth et al., 1992, 2003).

2.2. Linkage of historical census data to the National Survey of Health and Development

At every data collection, the address of the current place of residence was recorded for each survey member. Three ages were chosen to represent area in childhood (1950—aged 4 years), early adulthood (1972—aged 26 years), and midlife (1999—aged 53 years). Of the 2973 cohort members who had an address collected at age 53 years (1999), 2954 could be assigned a 2001 local government district (LGD) and ward (ONS, 2001a) using the UK Office for National Statistics' (ONS) all-fields postal directory (ONS, 2001b) (Fig. 1).

For the 1972 study year, 3626 postcodes were assigned LGD units for the 1971 census (RG for England and Wales, 1971; RG for Scotland, 1971). As the postcode system was only first introduced in 1959, the full addresses from 1950 ($n=4707$) were utilized for 1951 census year LGD units (RG for England and Wales, 1956a; RG for Scotland, 1956b). Initially, Imperial College London's Small Area Health Statistics Unit (SAHSU) matched residential data against the Ordnance Survey's Address-Point database (2010a) to create grid coordinates for 2551 of the 1950 addresses (54.2%) and 3586 of the 1972 postcodes (98.9%). Then, coordinates were linked to LGD units by University of Portsmouth's Great Britain Historical GIS Project based on county administrative diagrams published by the Ordnance Survey (Gregory and Southall, 1998; Gregory et al., 2002).

For the 2154 addresses from 1950 (45.8%) and 40 postcodes from 1972 (1.1%) that could not be matched at SAHSU, the GB Historical GIS team employed manual methods of LGD assignment. First, the Ordnance Survey's 1:50,000 Scale Gazetteer was used to identify addresses (Ordnance Survey, 2010b), which was successful in matching all remaining 1972 postcodes and 1432 of the 1950 addresses. For the remaining unmatched 1950 addresses, 558 were matched by Ordnance Survey County Series: 1:10,560, 1:2500, and 1:2250 sheets from the 1940s and 1950s (RG for EW, 1932–3; RG for EW, 1954) through EDINA Digimap service, then 140 modern equivalent addresses were identified in Google and matched against Ordnance Survey's Code-Point database (Ordnance Survey, 2010c). In the 23 remaining cases, previously assigned approximate 10 km grid references were used to assign an LGD. Overall for years 1950, 1972, and 1999, $>99\%$ were linked to an appropriate LGD area. This resulted in 2697 cohort members with an area assignment for all three years.

2.3. Life course area deprivation measures

Seven area socioeconomic measures were considered as potential proxies for area deprivation: five of which had previously been used in either the Townsend or Carstairs indexes (low social class, unemployment, overcrowding, renters, and no car) (Carstairs, 1995; Townsend et al., 1988) and two of which had been found in previous literature to be associated with functional impairment in later adulthood (lacking household amenities and higher education) (Basta et al., 2007; Freedman et al., 2008). For each defined geographic area, 'low social class' was defined as the percentage of all occupied persons (among males only in 1951 and 1971) in the geographic area with occupation classes 4 (partly skilled) or 5 (unskilled); 'unemployment' as the percentage of all