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Are the differences in adulthood ill-health across the north-south divide and between Scotland and England also evident in early childhood health indicators?

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ABSTRACT

Regional differences in adult morbidity and mortality within England (i.e., north-south divide or gradient) and between England and Scotland (i.e., Scottish effect) are only partly explained by adult levels of socioeconomic status or risk factors. This suggests variation in early life, and is supported by the foetal origins and life-course literature which posits that birth outcomes and subsequent, cumulative exposures influence adult health. However, no studies have examined the north-south gradient or Scottish effect in health in the earliest years of life. The aims of the study were: i) to examine health indicators in English and Scottish children at birth and age three to establish whether regional differences exist; and ii) to establish whether observed changes in child health at age three were attributable to birth and/or early life environmental exposures. Respondents included 10,639 biological Caucasian mothers of singleton children recruited to the Millennium Cohort Study (MCS) in the year 2000. Outcome variables were: gestational age and birth weight, and height, body mass index (BMI), and externalising behavioural problems at age three. Region/country was categorised as: South (reference), Midlands, North (England), and Scotland. Respondents provided information on child, maternal, household, and socioeconomic characteristics. Results indicated no significant regional variations for gestational age or birth weight. At age three there was a north-south gradient for externalising behaviour and a north-south divide in BMI which attenuated on adjustment. However, a north-south divide in height was not fully explained by adjustment. There was also evidence of a 'Midlands effect', with increased likelihood of shorter stature and behaviour problems. Results showed a Scottish effect for height and BMI in the unadjusted models, and height in the adjusted model, but a decreased likelihood of behaviour problems. Findings indicated no regional differences in health at birth, but some regional variation at age three supports the cumulative life-course model.

1. Introduction

The north-south divide in adult health within England is a well documented, persistent phenomena of worse health outcomes for those living in the north of England compared to those in the south, and has also been observed as a *gradient* of increasingly worse health from the south, through the midlands, to the north of England (Doran et al., 2004; Hacking et al., 2011; Leyland, 2004; Wells and Gordon, 2008). These differences are somewhat, but not entirely explained by variations in socioeconomic status or other factors such as lifestyle or social composition within regions (Doran et al., 2004; Hacking et al., 2011).

Similarly, Scotland exhibits higher mortality rates than England that go back to at least 1925, and have been increasing since the middle of the 20th century, especially for men (Campbell et al., 2013). Even compared to similarly deprived areas in other parts of Britain, Scotland has a history of higher mortality rates (Hanlon et al., 2005). These findings have led to the term 'the Scottish effect', and as with the north-south divide in England, the higher mortality

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risk in Scotland is only partially explained by differences in deprivation levels (Hanlon et al., 2005) or variations in lifestyle or risk factor levels (Mitchell et al., 2005). More recently, Shelton (2009) has also identified evidence of a Scottish effect in the prevalence of risk factors for cardiovascular disease in a comparison of Scottish and English regions. However, the relationship between area and risk factor was complex, and varied in strength and direction according to gender and risk factor.

Research investigating the north-south divide and the Scottish effect has typically focused on *adult* mortality and morbidity. However, it seems plausible to examine patterns of regional differences in early life health indicators as these may be the precursors to regional differences in later life health outcomes. We know from the foetal origins and life-course literature (Barker, 1992; Ben-Shlomo and Kuh, 2002; Power and Hertzman, 1997) that birth and early life outcomes are associated with a range of adverse health outcomes in the adult years. For example, associations that are independent of the effects of birth weight have been established between preterm birth and cardiovascular disease, hypertension, and glycaemic dysregulation (Dalziel et al., 2007; Doyle, 2008). Similarly, substantive literature has documented relationships between low birth weight and cardiovascular disease (Eriksson et al., 2001; Kaijser et al., 2008; Rich-Edwards et al., 2005), hypertension (Eriksson et al., 2000; Ramadhani et al., 2006), and metabolic syndrome (Eriksson et al., 2000; Newsome et al., 2003; Ramadhani et al., 2006) in adulthood. Evidence suggests an inverse association between height and cardiovascular disease (Paajanen et al., 2010; The Emerging Risk Factors Collaboration, 2012), height and cardiorespiratory disease (Davey Smith et al., 2000; McCarron et al., 2002), and an association between high body mass index (BMI) in childhood and the development of type 2 diabetes, hypertension, and coronary heart disease in adulthood (Park et al., 2012; Reilly and Kelly, 2011). Finally, evidence indicates that behavioural problems in childhood are associated with increased risks in a number of health-related areas in adulthood including: obesity (von Stumm et al., 2011), substance misuse (von Stumm et al., 2011; Fergusson et al., 2005), risky sexual behaviour (e.g., multiple partners; teen pregnancy/parenthood) (Fergusson et al., 2005), injury (Jokela et al., 2009b), hospitalisation due to road traffic accidents (Redelmeier et al., 2010), chronic widespread pain (Pang et al., 2010), long-term illness (von Stumm et al., 2011), psychological ill health (Fergusson et al., 2005; Clark et al., 2007), mortality (by midlife) (Jokela et al., 2009a), and criminal behaviour (Fergusson et al., 2005; Murray et al., 2010).

Therefore, there is a rationale for examining early life health indicators in order to understand patterns of regional differences that may be present at birth, or that may emerge during the first few years of life. Moreover, if regional differences in health are present at birth and in the early years, important policy implications are imminent. For example, if the origins of chronic disease are largely determined in the foetal and early life periods, public health interventions should target this important life-stage. Moreover, whilst the impact of birth characteristics (Barker, 1992; Gluckman et al., 2005) and the accumulation of subsequent and varied early life environmental exposures on adult health is well-established (Power and Hertzman, 1997), there is little research focused directly towards the impact of such variables on health outcomes in the shorter term (i.e., during the first few years of life).

To date, there are no studies that have explicitly examined the north-south divide (or gradient) or the Scottish effect in health in the earliest years of life. Therefore, the aims of this study were twofold. First, we aimed to examine health indicators in English and Scottish children at birth and at three years of age in order to establish whether regional differences exist – it was hypothesised that if the antecedents of regional variations in adult health are determined at an early stage then similar variations should be present, and will be evident as markedly worse health at birth or during the infancy/early childhood period for those living in the north of England (compared to the south of England), and for those living in Scotland (compared to the south of England). The five health indicators examined were: gestational age and weight at birth, and height, BMI, and externalising behaviour problems at three years of age. The second aim of the present study was to establish whether observed changes in health at age three were attributable to birth characteristics and/or early life environmental factors.

2. Methods

2.1. Sample population

Respondents were the biological mothers of singleton children enrolled in the Millennium Cohort Study (MCS), a nationally representative birth cohort study of children born across the UK in the year 2000 (see cohort profile by Connelly and Platt, 2014). The present study is concerned with data collected in waves 1 (baseline) and 2 (second stage of data collection) of the MCS in England and Scotland when the cohort child was aged nine months and three years respectively. It should be noted that attrition rates at wave 2 for families with lower (or no) education was higher in Scotland than in England, thus affecting the representativeness of the Scottish sample at wave 2. Children of non-biological mothers (1.8% of total sample), and from non-singleton pregnancies (1.4% of total sample) were excluded because of their potential to confound results. There were also a small number of cases that had incomplete data for maternal age, maternal ethnicity, mother's employment, number of siblings, tenure, and car availability (N = 20) which were also excluded from analysis. These exclusions left a sample size of 13,365. Frequency analysis showed the proportion of non-white ethnicities in Scotland was small (2.2%) compared to the other regions (see Table 1), therefore, children of non-white/non-Caucasian mothers were excluded from further analysis. The final sample sizes for analysis with valid data on each of the five outcome variables were as follows: gestational age, N = 10,575; birth weight, N = 10,512; height, N = 8233; BMI, N = 8143; and externalising behaviour N = 8576. Ethical approvals for the MCS waves 1 and 2 were granted by the South West Multicentre Research Ethics Committee (MREC) and London MREC respectively.

3. Measurements

3.1. Outcome variables

All outcome variables were coded as binary. Gestational age comprised a preterm (25^{+0}–37^{+0} weeks) versus term group (37^{+1}–43^{+0} weeks). Birth weight comprised a low birth weight (LBW) (0.500–2.500 kgs) versus normal group (>2.500 kgs). Height comprised a 'short for age and gender' (at age three) versus normal group. The Center for Disease Control (CDC) standardised (z-scores) norms for height (by age and gender) were used as a reference (Kuczmarski et al., 2002), with a height of ≥1 standard deviation below the mean being the cut-off. Child BMI was available as a 4-category derived variable; for the purpose of the present analysis this variable was further aggregated to comprise an 'overweight/obese' versus an 'underweight/normal' group (at age three). Externalising behaviour comprised two groups; 'behaviour problems' and 'no behaviour problems' (at age three) which was derived by summing scores on the hyperactivity and conduct disorders scales of the parent-completed Strengths and Difficulties Questionnaire (SDQ; Goodman et al., 2000a, b; Goodman et al., 2010).