**The Aberdeen *Children of the 1950s* cohort study: background, methods, and follow-up information on a new resource for the study of life course and intergenerational influences on health**

G. David Batty[1]
Susan MB Morton[1]
Doris Campbell[2]
Heather Clark[2]
George Davey Smith[3]
Marion Hall[2]
Sally Macintyre[4]
David A. Leon[1]

[1]Epidemiology Unit
London School of Hygiene & Tropical Medicine
Keppel Street
LONDON, WC1E 7HT

[2]Dugald Baird Centre
University of Aberdeen
Aberdeen Maternity Hospital
Cornhill Road
ABERDEEN, AB25 2ZL

[3]Department of Social Medicine
University of Bristol
Canynge Hall
Whiteladies Road
BRISTOL, BS8 2PR

[4]MRC Social and Public Health Sciences Unit
University of Glasgow
4 Lilybank Gardens
GLASGOW, G12 8RZ

Correspondence to Professor David Leon (david.leon@lshtm.ac.uk)
Word count (excluding reference section): 6772

SUMMARY

In this paper we introduce and describe in detail an addition to the UK's population-based resources for the investigation of biological and social influences on health across the life course and between generations: the Aberdeen *Children of the 1950s* study. We also provide an account of post-war Aberdeen when study members were growing up, report on findings of analyses of data from the original survey on which this study is based and its follow-up, assess the strengths and limitations of the study, and outline current and future research directions.

Comprising individuals born in Aberdeen, Scotland (UK) between 1950 and 1956, this cohort is derived from fifteen thousand subjects who took part in the Aberdeen Child Development Survey (ACDS), a cross-sectional study of 'mental sub-normality' (learning disability) in a population of all children who were attending an Aberdeen primary school in December 1962. Data collection included information on birthweight, gestational age, childhood height and weight, tests of cognition and behavioural disorder, and a range of multi-level socio-economic indicators. In 1998 we began the process of revitalising this cohort (now termed the Aberdeen *Children of the 1950s* study). We have been successful in ascertaining the current vital status and whereabouts of 98.5% of a target population of 12,150 subjects (6276 males, 5874 females) with full baseline data. The large majority (81%) of study participants still reside in Scotland and many (73%) have remained in the Grampian region which incorporates Aberdeen. At the present time, a

total of almost five hundred subjects are known to have died. Linkages to hospital admissions and other health endpoints captured through the Scottish Morbidity Records system have been completed. This includes an intergenerational linkage to approximately eight thousand deliveries in Scotland occurring to female members of the study population. A postal questionnaire to all traced surviving cohort members has also been distributed.

## INTRODUCTION

Most of what is known about the aetiology of non-communicable disease is restricted to risk factors measured and operating in adult life, as illustrated by findings from the classic studies of London-based government employees[1] and transport workers,[2] British physicians,[3] and Framingham residents.[4] These investigations were among the first to demonstrate associations between coronary heart disease and serum cholesterol, blood pressure, physical activity and smoking habits when measured in middle age.[5;6] This emphasis on risk factors measured in adult life is, in part, a consequence of the difficulty of obtaining valid information about exposures occurring in pre-adult life for diseases that are typically diagnosed in middle or old-age. Over the past 15 years, however, the work of David Barker and colleagues[7;8] has raised the possibility that circumstances in utero, such as foetal nutrition, may have an effect on disease risk in adult life. To examine these influences, studies are required in which information on earlier life characteristics are obtained, ideally prospectively. Barker's Hertfordshire study[9] is a classic illustration of this approach. This historical cohort was defined in terms of subjects born in the early decades of the 20$^{th}$ Century, with midwife-recorded birthweight, who were then linked to mortality outcomes such as cardiovascular disease and cancer. Other similar examples include the Sheffield,[10] Uppsala,[11] Helsinki,[12] Reykjavik,[13] and Copenhagen[14] cohorts.

Work on the foetal origins of adult disease has prompted investigators to hypothesise more broadly about the possible influences on adult health of factors operating across the entire life course and even between generations.[15-17] In the field of inequalities in health, for example, it is clear that an adequate understanding of the processes that generate these variations in adult life requires information about the antecedent biological and social processes that operate in childhood. In the UK, the national birth cohort studies (1946, 1958, 1970 and Millennium) are particularly important resources for attempting to understand the complex interplay of these processes across the life course. These studies differ from the afore mentioned historical cohorts as being essentially nationally representative samples of births. As documented elsewhere,[18-23] they were established prospectively from birth and, in the case of the 1946, 1958 and 1970 cohorts, have had repeated contacts with subjects throughout childhood and adult life. However, it is only in recent years that these cohorts have matured sufficiently for the early life origins of diseases and disabilities of mid-life to be examined.

In this paper we introduce and describe in detail an addition to the UK's resources for the study of early life and childhood influences on adult disease risk. The *Children of the 1950s* study is a large cohort of over twelve thousand individuals born in Aberdeen in the early 1950s for whom information on key early life and childhood characteristics are available. Study participants have been linked to mortality and cancer registers,

hospital admissions, and maternity records (for female members of the cohort). A questionnaire survey has been also completed. The baseline (pre-adult) information for the cohort was collected by investigators on the Aberdeen Child Development Survey conducted between 1962 and 1964, the aim of which was to investigate the determinants of 'mental sub-normality' (learning disability) in a complete community. Although not without its limitations, the revitalisation of this original cohort in the form of the *Children of the 1950s* study has some advantages compared to other cohorts of a similar age and size that will ensure that it will represent an important platform for future research into life course and trans-generational influences on health.

**Post war Aberdeen**

The *Children of the 1950s* study comprises men and women born in Aberdeen between 1950 and 1956 who attended primary schools in the city in 1962. As we will describe in more detail, it is notable that a high proportion of the study population are still resident in Aberdeen or the surrounding area. At the outset, therefore, it is appropriate to provide a brief historical overview of the city in which the cohort members grew up and in which many continue to reside.

Aberdeen is a located on the North East coast of Scotland. With a population in 1961 of 187,000, it was the third largest city in Scotland. Geographically, it is comparatively isolated with the nearest city, Dundee,

being 70 miles to the South. In the 1950s and 60s the Aberdeen economy was dominated by traditional low wage industries that were in decline such as fishing, fish processing, shipbuilding, textiles and papermaking. The post-war housing stock was also in very poor condition – even compared to cities such as Glasgow[24] – due, in part, to the difficulty of modernising the granite built tenement blocks in which many of the more deprived sections of the Aberdeen population lived. As demonstrated by the classic studies of Baird[25;26] and Illsley,[27] socio-economic gradients in birth outcome and adult health were clearly evident in this period which represents the formative years of the Aberdeen study members.

In contrast to the general state of the economy and housing in Aberdeen, the health and educational services had a reputation for excellence. For example, the antenatal services, under the pioneering direction of Dugald Baird, were regarded as being among the best in the world. Additionally, the standard of educational provision and achievement in Aberdeen in the 1960s exceeded that of the rest of Scotland: class sizes were smaller at almost every level of education, particularly in primary schools, and a larger proportion of school leavers went into tertiary education having successfully completed their public examinations.[28]

In 1971 the discovery of oil in the North Sea had a profound effect upon the Aberdeen economy and its population, transforming the city into one of the most affluent in Scotland. Wage levels rose from below the Scottish

average to 10% above.[28] Although the highly skilled jobs required by the oil industry were typically taken by people moving into the area, Aberdonians benefited through the considerable growth of the state and service sector – ranging from schools to restaurants and hotels.

Owing to the rise of the oil industry,[29] the Grampian region, in which the city of Aberdeen is located, currently has the lowest level of deprivation in Scotland. However, socio-economic differences in health have not been eliminated. Studies of birth outcome in Aberdeen in the late 1970s and early 1980s, when this economic transition took place, showed the persistence of variations evident some decades earlier[30] that were as large in relative terms as those seen in South Wales,[31] a markedly more deprived area. Strong effects of current social class on respiratory symptoms in a sub-group of the Aberdeen cohort itself in middle-age have also been reported.[32]

## ABERDEEN CHILD DEVELOPMENT SURVEY (1962-64)

As already noted, the Aberdeen *Children of the 1950s* Study cohort is based on participants in the Aberdeen Child Development Survey (ACDS). As there are no readily accessible descriptions of the ACDS in the literature, we provide a detailed account of this pioneering investigation.

**Rationale and funding of the ACDS**

In the decades following the end of the second world war there was considerable interest in the foetal and obstetric determinants of 'mental disorders' and 'mental retardation' in particular.[33] This issue was one of the funding priorities of the charity the American Association for Aid to the Crippled Child (AAACC). Their mode of operation at the time was to actively identify and then fund scientists to examine questions that they considered to be of importance. Following informal contact between the AAACC and Raymond Illsley of Aberdeen University, plans were made to conduct the first systematic survey of the prevalence of mental disability in children in a defined population. Aberdeen was selected as it had a number of particular strengths in comparison to alternative locations. Foremost was the world-renowned obstetric database – the Aberdeen Maternal and Neonatal Databank – established by Dugald Baird in 1948. Since its inception, this depository had collected research-standard data on the course of pregnancy and birth outcomes for at least 85% of women delivering their babies in the city of Aberdeen.[34;35] Under the direction of Dugald Baird, the Medical Research Council's (MRC) Obstetric Medicine Research Unit based at the Aberdeen Maternity Hospital used these and other data to conduct wide-ranging medical investigations to elucidate factors influencing the course and outcome of pregnancy. There was also a Scandinavian-like tradition in the city of recording and archiving information on its inhabitants, including home visitor and school records which contained data on childhood growth, illness, immunisation, and social background (Alistair

Cross – personal communication). These records, allied to a stable population – approximately 80% of children born in Aberdeen in the 1950s were still residing there 5 years later[36] – made Aberdeen an optimal environment in which to conduct health-orientated research.

**Objectives, Design and Conduct of the ACDS**

The ACDS had several objectives. The first was to determine the prevalence of clinically verified 'mental sub-normality' and its subtypes in the complete population of all Aberdeen primary school children. The second was to investigate the association of obstetric, perinatal and social factors with (i) these pathological outcomes and, (ii) physical growth and intellectual development. The design of the study involved the administration of a series of reading tests, extraction of retrospective routinely collected educational (e.g., intelligence quotient test results) and medical (e.g., height, weight) data, and linkage to obstetric and perinatal records held at the Aberdeen Maternity Hospital where the large majority of births in the city took place. The field work, which was undertaken by a multidisciplinary team of investigators and required the co-operation of city health and education officials, was co-ordinated in Aberdeen by Raymond Illsley based in the MRC's Obstetric Medical Research Unit. Upon Baird's retirement, responsibility for completion of the data set and its computerisation became that of the MRC's Medical Sociology Unit (latterly the MRC Social and Public Health Research Unit, Glasgow), then directed by Illsley.

*Study population*

The ACDS population comprised five complete school years: primary III (approximately 7 years of age) to primary VII (approximately 11 years of age); however, because some children were held back a year due to below average educational performance while others advanced more rapidly, the full age range was in fact 6 to 13 years. This population therefore comprised children born in Aberdeen between 1950 and 1956, who attended primary school in Aberdeen when the survey was conducted (between December 13th 1962 and March 11th 1964), plus any in-migrants during this period. A total of 14,939 children participated in the survey, although complete data are not available for all. The ACDS comprised three distinct phases.

*Phase 1*

A range of US- and UK-orientated reading tests, selected to facilitate between-country comparison, were piloted at primary schools in Edinburgh and those outside Aberdeen city boundaries among pupils felt to represent a range of learning abilities. Following this work, some tests were discarded and the structure of an accompanying questionnaire which made enquiries about the child's personal details – used to facilitate linkage to birth records – was simplified.

With the exception of the youngest group (primary III) for whom testing took place over two days, all other school years were administered age-

appropriate reading tests (table 1) by their class-teachers during a single three hour period on, or soon after, December 13th 1962. Children with learning disabilities were given tests appropriate to the youngest group (primary III) and, if successfully completed, were then administered class-appropriate tests. Coverage stood at almost 100%. The completed tests were assessed by university students and the research team, with steps taken to ensure consistent marking. Irrespective of whether or not they were administered the reading tests, each child was given *form A* in which they were requested to provide their own (e.g., name, date of birth, class, address) and their parents' (e.g., father's occupation) personal and demographic details. This information was subsequently used to link 86% of children to records from the Aberdeen Maternity and Neonatal Database (AMND) where perinatal and social information were collated throughout the course of their mother's pregnancy and their own birth. Links with obstetric data were not made to the remaining children largely because they were not born in Aberdeen. A description of these data is given in table 2.

Throughout the 1950s in Aberdeen, tests of intelligence quotient (cognition) were routinely administered to children at 7, 9 and 11 years of age (table 3). In addition to performance on attainment tests, cognition scores at 11 years of age (the so called '11 plus') were used to determine the type of secondary school the child was to attend; that is, junior or senior secondary. In the present study, cognition scores were abstracted for participants in the

ACDS. Results of tests taken after December 1962 were obtained as they became available up until 1964.

*Phase 2*

Conducted in July 1963, the same school year as phase one, this phase involved the abstraction of medical data routinely collected by the schools. During the period of the study, Aberdonian children underwent a medical examination on entering school, typically at 5 years of age and, in those cases identified as a cause for concern, perhaps because of sub-optimal growth or impaired vision, again at around 9 and 12 years of age. The data included height, weight, visual and hearing acuity, history of previous illnesses, and, where applicable, details of other schools attended.

*Phase 3*

This final stage of the ACDS was conducted on or around 11th March 1964 – approximately 15 months following the first phase – by which time some study participants had progressed to secondary school. In this phase, sociometric and behavioural data were collected. For the sociometric data, an inventory of the children in each school class was given to each student and they identified three of their peers they favoured most by highlighting the relevant names. Teachers completed the Rutter scale B of minor behavioural disorder[37] for each child. This was the first occasion the scale was used in the context of a population-based investigation, and the experiences gained were applied to the Isle of Wight study some years

later.[38] Subsequently, the Rutter scale B was widely employed in a series of surveys[39-41] and is now established as a routine screening measure for psychological disturbance in children.[42] Inter-tester and test-retest reliability studies of this questionnaire were conducted in a sub-group of teachers in the ACDS.[38]

*Family survey*

Following pilot interviews in a group of approximately 80 children, the mothers of a simple, random 1 in 5 sample of the survey population were contacted to ascertain their willingness to participate in an in-depth interview survey within the home; 90% (N=2510) consented. Enquiries were made regarding a range of topics, including the child's medical history, mother's attitude towards their child's education and their aspirations for them, leisure activities of the child and parent, and housing conditions and social background of the parents. Additionally, the mother/carer was requested to complete Rutter *Scale A*, the parental version of the teacher-administered scale B described above.

**Findings from the ACDS**

Although relatively unexplored given its diversity and depth, some publications have resulted from the ACDS data set. In addition to a summary of the methods and major findings,[43] the principal publication from the study describes at length the prevalence and correlates of 'mental sub-normality' in participants in the ACDS.[44] Using a definition of mental

sub-normality which incorporated children who had been clinically assessed as such by the medical services, and/or children with a cognition scores of below 75 (a score of 100 was the mean), the prevalence was 2.7%. Prevalence of mental sub-normality was strongly related to social background with the highest levels seen in children from the least affluent households. Complications of pregnancy and delivery were also associated with this disorder such that pre-eclamptic toxemia, antepartum haemorrhage, breech delivery, low birthweight and short gestation were all more common in children with a mental sub-normality in comparison to those without.

The results of work examining the relation of a range of social factors in childhood at the level of the individual (paternal social class, family size, maternal age) and group (area of residence) with scores on tests of cognition and educational achievement have been published.[45-48] Most recently, Illsley[47] has reported higher scores on cognition and English language tests of word knowledge, discrimination and reading in children from higher social strata – findings that have been supported elsewhere.[49] The association between classroom peer status, as assessed using a sociometric questionnaire, and psychological disorder, as indexed by the Rutter scale, has also recently been described,[50] with a child held in higher status by their peers at lower risk of such malaise than their lower-ranked contemporaries. In addition, we have recently shown that growth in utero, and childhood and

paternal occupational social class are predictive of reduced distant visual acuity in this group.[51]

Some years after the completion of the ACDS, study members who had been recipients of services for people with an intellectual disability up to the age of 16 years (N=221) were traced in the 1970s by one of the principal investigators on the original survey team – Stephen Richardson – and, along with their carers, interviewed at 22 years to construct a detailed individual and family biography.[52] A subsequent follow-up of persons in this study who were recipients of care services at interview (N=73) was made to estimate health service usage.[53-55] Sixty percent of this group were found to be living at home with their parents, while the remainder were institutionalised, mainly in long-stay mental disability facilities.[54]

**The WHEASE Study**

From the mid-1980s the 'family survey' population (described above) have been followed up in an investigation of respiratory symptoms known as the WHEASE study. The original family survey identified individuals with this respiratory impairment[56] and this group was traced 25 years after study induction,[57;58] as were the offspring of a selected sample.[59;60] In 1995, some 30 years after the original study, successful attempts were also made to contact the remaining study members, then in middle age, who had no record of childhood asthma.[61-65] An investigation of secular trends in respiratory symptoms and atopy has been made by comparing pulmonary

measurements in children in the family survey with those in another cohort of similar age 25 years later.[66] The success of the WHEASE study investigators in tracing this sub-group boded well for a larger scale follow-up of the whole ACDS population which will be described next.

## REVITALISING THE ACDS: THE *CHILDREN OF THE 1950s* STUDY

In 1998 we began the process of revitalising the ACDS, naming this follow-up the Aberdeen *Children of the 1950s* study. This work involved tracing the study participants, mailing a questionnaire regarding current health and health-related behaviours to traced survivors, and linking research participants still in Scotland to routinely collected morbidity and maternity records. Figure 1 depicts these and related study components.

All components of the study revitalisation have been granted various ethical committee permissions, including those from the Multi-centre Research Ethics Committee for Scotland, the Local Research Ethics Committee for Grampian (the region in which Aberdeen falls), and the London School of Hygiene & Tropical Medicine Research Ethics Committee. Tracing of study members using the General Register Office (GRO) (Scotland) was approved by the Privacy Advisory Committee. Permission to link to the events from the Scottish Morbidity Record (SMR) system was given by the Privacy Advisory Committee on the proviso that the linked data provided to us by the Information and Statistics Division (ISD) of the National Health Service (Scotland) were anonymised. The database containing names and

address details of study members is kept separate from the main database of variables, and access to names and addresses is strictly controlled.

**Characteristics of the core population**

The *Children of the 1950s* study population comprises 12,150 individuals (6276 males, 5874 females; aged between 6 and 12 years in 1962) in the ACDS who were born in Aberdeen and had been linked to obstetric records during this period. For 93% of this group, information is also available on weight and height and other medical examination results between 4 and 6 years of age, and cognition scores at 7, 9 and 11 years. The distribution of study participants by birth year is presented in table 4. The ratio of male to female study participants was approximately equal, and almost 95% of participants were born in the period 1951 to 1955.

The results of a re-analysis of data from the core population are presented in table 5. Here we relate father's occupational social class at the birth of the child – as derived from obstetric records – to other early life characteristics with the purpose of validating our findings by comparison against those seen elsewhere. Consistent with what would be expected, father's social class at birth showed associations with behavioural disorder,[67] pre-term births,[68] low birthweight,[68] reduced childhood height,[69] low scores on a test of cognition at 7 years,[70-72] and low reading test results,[73] with the highest proportion of each outcome seen in children from the poorest social backgrounds. That there was no clear relationship between our index of

childhood socio-economic position and childhood body mass index, a marker of adiposity, is consistent with other findings.[69;74]

**Tracing the core population**

We extracted names and dates of birth for the study participants from the original manual used in the ACDS in 1962. This information was then sent to the General Registry Office (Scotland) who used the National Health Service Central Register to ascertain vital status and area of residence of survivors. Over 97% (N=11,727) of this core population were successfully traced (table 6). In our follow-up, there had been 288 (2.4%) emigrations (outside the United Kingdom) and 477 (3.9%) deaths in the core population by March 2002. Almost twice as many deaths had occurred in men as in women (table 7), as anticipated.

To assess if subjects in our traced group were representative of the core population – so addressing the issue of selection bias – we compared their early life characteristics with those who were not traced (table 8). While the two groups were similar in most respects, there was evidence that the 'no trace' group were more advantaged than the 'traced' group: as children, adults in the former were less likely to have low cognition scores, be of sub-optimal height, and have fathers in manual employment.

Based on the geographical location of the general practice with which the study participants were registered, as provided to us after the flagging

exercise, it is evident that the large majority (81%) are still reside in Scotland and most (73%) have remained in the Grampian region which incorporates Aberdeen. Our cohort of Aberdonians entered the labour market in the early 1970s around the time that Aberdeen became the centre of a rapidly expanding North Sea oil industry. The generation of favourable employment levels and higher than average income over the following decades provided a strong economic rationale for people to remain in the area.[75] The observation of geographical stability among Aberdonians was first made in the 1950s when Illsley,[36] one of the ACDS's original investigators, noted that in a sample of mothers, 80% were still in Aberdeen 5 years following their first delivery. More recently, it was found that in a follow up of WHEASE study participants,[61] two thirds were still living in or near Aberdeen when followed into middle-age.

Although the population on which the Aberdeen *Children of the 1950s* study is based is very stable, there has inevitably been some migration within and outside of Scotland. Having categorised migration into four groups ('Grampian', 'rest of Scotland', 'other areas of the UK', and 'embarked from the UK'), we assessed the predictive capacity of infant and childhood characteristics as ascertained during the ACDS (table 9). Children from the higher social classes were more likely as adults to have left Grampian to live elsewhere in Scotland, the rest of the UK, or abroad than those from poorer backgrounds. The association of this indicator of socio-economic position with childhood height and cognition test score reported earlier (table 5) may

explain their relation with migration, such that taller children and those with higher scores on the cognition test were also more likely to out-migrate from Grampian to the rest of Scotland and the rest of the UK in later life. These observations are consistent with our analyses comparing the characteristics of those traced to those lost to follow-up (table 8): the latter group were probably so classified because they were more likely to migrate than the traced group.

A number of studies have explored the relation of occupational social class to inter-regional migration, with the observation that both individuals with aspirations to migrate,[76;77] and those who actually do so,[36;78-82] are the most socially advantaged. With regard to emigration, in a four year follow-up of the National Survey of Health and Development[81] (1946 birth cohort study), those families classified as professional and salaried – based on the status of the father – were six times more likely to move abroad than the semi-skilled and unskilled. It should be noted, however, that routine notification of emigrations via the National Health Service Central Registry only cover about half of these events.[83]

Most studies of inter-regional migration in relation to stature have focused on adults,[36;82;84;85] with the findings that migrants are generally taller than the geographically stable population. In one of the few studies of children, a random sample of 11 year olds in the 1947 Scottish Mental Survey had their stature recorded.[86] In this sub-group, children whose parents migrated into

or out of urban areas were taller than those who did not. The association of childhood cognition with migration is less well explored than that of socio-economic position and body stature, and we are unaware of any data on children in this respect. However, in a small-scale follow-up study of women in their 6th month of pregnancy,[85] those who left the city of Aberdeen within a 5 year period had higher scores on non-verbal and verbal reasoning tests than those who remained.

**Linkage to Scottish Morbidity Records**

*Pregnancy and birth outcome to female study members*

The foetal-origins and life course paradigms have a strong inter-generational component. Barker,[87] for example, places emphasis upon the importance of improving the health and nutrition of young women before they start child-bearing. The Aberdeen study can make an important contribution in this area. Aged between 43 and 49 years at the time of study revitalisation, the large majority of female subjects would have been expected to have completed their childbearing by 1999.

Using two sources (the Scottish Morbidity Records [SMR02] scheme – based on Scottish maternity discharge records, and the Aberdeen Maternity and Neonatal Databank [AMND] – based on Aberdeen antenatal and delivery records), we have linked the female members of the cohort (born between 1950 and 1956) to their offspring born in Scotland between 1967 (the inception of the SMR02) and 1999. Linkage was restricted to

singleton deliveries of viable infants, defined as a birthweight of at least 500 grams and a gestational age of at least 24 completed weeks. Linkage to the SMR02 records was attempted for the 5634 (96%) women in the study who had been successfully traced using the National Health Service Central Register. Full perinatal information at their birth was available for 4997 (88.7%) of this group. Of these, 3485 (69.7%) were linked to valid records of their own pregnancies and deliveries, yielding 7080 singleton viable offspring.

In table 10 the distribution of parental characteristics of female study participants according to offspring linkage status is presented. The non-linked group tended to be from more socially advantaged groups and be born to mothers with more years of completed education than the linked group.[88] This is likely to be largely explained by the higher likelihood of migration out of Scotland, and therefore a failure to link to delivery records in persons from more affluent social backgrounds, as described previously.

*Morbidity of study participants*

Since 1968, routinely collected morbidity data have been collated by the Information and Statistics Division (ISD).[83;89-91] In the present study, cohort members have been linked to a range of outcomes including diagnoses of cardiovascular disease (SMR01 – general acute inpatient and day case discharges), schizophrenia (SMR04 – psychiatric and mental handicap hospitals and units: admissions, residents and discharges) and breast cancer

(SMR06 – Scottish cancer registrations), all of which may be influenced by early life circumstances.[92] These linkages will complement and extend the data on morbidity we have collected on the study population through the questionnaire follow-up survey (described below) and will also be of value in validating these responses.

**Postal questionnaire**

In addition to the follow-up information collected on mortality experience and hospital admissions, we have distributed a sex-specific questionnaire to traced surviving cohort members which covers a range of issues including living conditions, occupation, education, income, height and weight, health, health-related behaviours, and parental vital status. Questionnaires were sent out on our behalf by the ISD using address information from the Community Health Index for study participants believed to be resident in Scotland. For those resident in England and Wales, health authorities undertook the mailing exercise. The study team did not receive any address data from these sources. As of October 2002, the response proportion stood at 63%. The differential response according to sex – males (57%) were less likely to respond than females (68%) – has been demonstrated in other surveys.[93] We also enquired about consent to further contact and, for women, where appropriate, permission to access their obstetrics records. Encouragingly, almost all responders (95%) were willing to take part in future surveys and provided their current address, and a high proportion of

women (80%) gave consent for information to be extracted from their medical records.

## STRENGTHS AND WEAKNESSES

### Representativeness of the core population

One notable strength of the 1946,[19] the 1958,[21] the 1970,[23] and the Millennium[22] birth cohort studies is that they are based on representative samples of the UK child population. By contrast, the present study, while comprehensive in its coverage of almost all primary school children found in Aberdeen between 1962 and 1964, is nonetheless based on residents of a specific geographical group.

It is possible to get an indication of the representativeness of the present study population by comparison with other surveys. Some comparison of the prevalence of very low (less than 50) cognition scores in 8-10 year old ACDS subjects has been made with those reported in other studies.[44] Agreement was high – the prevalence in the ACDS was 0.37% while elsewhere it ranged between 0.35% and 0.37%. We further examined the representativeness of this cohort by comparing the distribution of occupational social class with those in other surveys we knew to have been conduced during a similar era: the 1946[18] and 1958[21] birth cohorts, and the 1951 census for Scotland.[94] The Aberdeen study is, by definition, a cohort of children who survived to ages 6-13 years, thus we made comparison with children in the birth cohort studies who were alive at age 11. We also

restricted the census results to 865,037 men aged 20-44 years which corresponds approximately to the age range of fathers of members of the *Children of the 1950s* core population. A comparison of occupational social class data between the Aberdeen *Children of the 1950s* study and these surveys is presented in table 11. Although agreement was generally good, a greater representation of men from the unskilled classes in the *Children of the 1950s* and a commensurate under-representation from the 'intermediate' social classes was seen. This may be ascribed to the high prevalence of low skill industries in Aberdeen – particularly fishing – during this period.

**Multi-level characteristics of the cohort**

The Aberdeen *Children of the 1950s* study is unusual because of its multi-level nature, defined at the level of the study participant, family, school, and neighbourhood. This distinguishes it from the 1946, the 1958 and the 1970 birth cohorts. Within the cohort there are a substantial number of siblings – a total of 11,704 study participants are drawn from 9,195 families. Further, the 12,150 persons in the core population attended 47 primary schools in 1962, and within each of these the children's classes can be identified. Individuals within the cohort can also be aggregated into neighbourhoods according to place of residence in childhood and these may be described using data from the city archives, including reports on housing conditions, rateable values, rents and house-prices, and small-area census data.

**Information across the life course**

Although the multi-level nature of socio-economic data from the Aberdeen *Children of the 1950s* study is a distinguishing characteristic, one of its limitations is the absence of direct contact with the majority of study participants between the survey in 1962, when the children were aged 6-13 years, and 1999 when they were aged 43-50 years. This contrasts markedly with the afore mentioned British birth cohorts studies which have serially collected data. In the 1946 birth cohort, for instance, study participants – on occasion, females only – have been contacted a total of twenty-two times between 2 (1948) and 49 (1995) years of age, an average of almost one contact every 2 years.[18] To address this lack of data in the Aberdeen study we have included some enquiries in the questionnaire mailing which covers the period between childhood and midlife. These pertain to lifestyle (e.g., smoking habits) and socio-economic position (e.g., educational attainment, age at leaving full time education).

## CURRENT AND FUTURE RESEARCH AREAS

We have currently prioritised three research areas: intergenerational influences on health, childhood cognition and adult health, and early growth and adult health.

**Intergenerational influences on health**

As described, using routinely collected Scottish maternity data we have been able to link female study participants to course of pregnancy and birth

outcome. Analyses of these data[95;96] have shown that maternal intrauterine growth has an enduring intergenerational effect on offspring growth that is not fully explained by her later adult maternal biological or social characteristics. We have also demonstrated that the socioeconomic inequalities seen in offspring size at birth were largely generated by continuity of social environments across generations, in particular early childhood social circumstances strongly influenced maternal lifetime growth.[97]

To date, while there are studies that have separately examined early life influences on later reproductive health and others that have examined the impact of reproductive health on later adult health outcomes, particularly breast and ovarian cancers and cardiovascular disease,[98] as yet, no large study of women's health in the United Kingdom has sufficient data on intergenerational and lifecourse measures of health – including full reproductive histories – and the potential to collect data on later adult health outcomes. The Aberdeen study affords us the opportunity to consider these issues.

**Childhood cognition and adult health**

Over the last decade there has been growing interest in the predictive capacity of cognition for future health in middle[99]- and particularly older-aged populations.[100] In these studies, investigators have reported inverse associations, such that low cognition scores are related to an elevated risk of all-cause mortality. An alternative explanation for this effect is that of

reverse causality whereby ill-health – clinical, sub-clinical, or both – leads to reduced cognition[101] and this generates the associations seen. Long term follow-up studies of children, who are less likely than adults to carry a morbid load, is one strategy to address this issue. In a recent report of an extended follow-up[102] of a sub-group of children from the 1932 Scottish Mental Survey,[103;104] the same pattern of association to that seen in studies of older persons was apparent. A further plausible explanation for this association is confounding by socio-economic position. As described, socio-economic position – in terms of occupational social class and family size – in addition to cognition are particularly well characterised in the present study. In preliminary analyses using cognition measured at 7 years of age,[105] we have also found an inverse, incremental cognition–mortality association which, notably, was only partially attenuated by controlling for these social factors in early life. Further, in an analysis of our questionnaire data, cognition was also associated with a range of potential intermediary or confounding factors such as smoking, binge drinking and short stature as reported in later life – the most favourable levels were evident in the higher cognition groups – suggesting that these relationships may, in part, explain the effect of childhood cognition on adult mortality experience.[105] As the *Children of the 1950s* study matures and we accumulate deaths among questionnaire respondents, it will become possible to examine in more detail the role of these risk factors on the cognition–mortality pathway.

Given the evidence suggesting a correlation between early life cognition and later health, it is important to ascertain if this characteristic is modifiable. In this regard, we have examined early life determinants of childhood cognition using data from the ACDS.[105] In our analyses, paternal social class, birthweight-for-gestational age and childhood growth (as indexed by height) were all predictive of childhood cognition levels. That growth in utero and during childhood are correlated with later cognition score in the Aberdeen study has been supported elsewhere[106-108] and implies a role for childhood nutrition.

**Early growth and adult health**

Given that cognition may be an indicator of socio-economic position in childhood, we have explored its role in the birthweight–mortality association. Studies of this relation are relatively uncommon and often have limitations in their design. The Aberdeen *Children of the 1950s study* overcomes many of the limitations of other studies in that birthweight and gestational age were abstracted directly from high quality obstetric records, detailed information is available on socio-economic circumstances (including cognition), and follow-up is almost complete. Moreover, being based on a population born between 1950 and 1956, it provides an opportunity to assess if the inverse birthweight–cardiovascular disease (CVD) association observed in earlier cohorts[7] is also seen in people born in the more affluent latter half of the 20$^{th}$ century. In our analyses we found that for every 1000g decrease in birthweight the rate of CVD mortality

increased by a factor of 1.87 (95% CI 1.01, 3.49; P[trend]=0.05) after adjustment for sex and gestational age.[109] Further statistical control for number of siblings, paternal occupational social class at birth of the child, and cognition score at seven years of age resulted in marginal attenuation (1.82; 95% CI 0.98, 3.38; P[trend]=0.06).[109] Similar relationships were seen when the endpoint of interest was coronary heart disease (CHD) mortality. These findings confirm that birthweight adjusted for length of gestation and socio-economic circumstances is inversely related to subsequent CVD and CHD in a modern, post-war cohort.

## CONCLUSION

In the present paper we have described the ACDS and its revitalisation as the Aberdeen *Children of the 1950s* study. This has involved the acquisition of data for both study members and their offspring from a number of sources: mortality surveillance, hospital and institutional admission records, and a questionnaire follow-up. We believe that this study represents an important platform for research into life course and intergenerational influences on health.

ACKNOWLEDGMENTS

We are very grateful to Raymond Illsley for providing us with the data from the Aberdeen Child Development Survey and for his advice about the study. Graeme Ford played a crucial role in identifying individual cohort members and in helping us initiate the process of revitalisation. John Nisbet provided valuable information about the characteristics of local schools in the 1950s and early 60s, and the nature of routine cognitive testing regimes they employed. John Lemon undertook the linkage to the Aberdeen Maternity and Neonatal Databank. Bianca de Stavola, David Godden, Di Kuh and Viveca Östberg collaborated with us on establishing the cohort, and Margaret Beveridge undertook many essential tasks in the process. We would also like to thank staff at the ISD (Edinburgh) and the GRO (Scotland) who were also involved in the revitalisation. We are grateful to Suzie Butterworth and Barbara Jefferis for their analyses of the occupational social class data from the 1946 and 1958 birth cohorts, respectively. We acknowledge the study participants who responded to our questionnaire almost forty years after the original survey was conducted. The Aberdeen *Children of the 1950s* Study is funded as a component project (G0828205) of a Medical Research Council Co-operative Group *Life course and trans-generational influences on disease risk* (G9819083). We welcome enquiries from potential collaborators interested in the data we have described.

References


1. Reid DD, Hamilton PJS, McCartney P, Rose G, Jarrett RJ, Keen H *et al*. Cardiorespiratory disease and diabetes among middle-aged male civil servants. *Lancet* 1974;**i**:469-73.
2. Morris JN, Heady JA, Raffle PAB, Roberts CG, Parks JW. Coronary heart-disease and physical activity of work. *Lancet* 1953;**ii**:1053-7.
3. Doll R,.Bradford Hill A. The mortality of doctors in relation to their smoking habits. A preliminary report. *BMJ* 1954;**i**:1451-5.
4. Dawber TR, Meadors GF, Moore FE. Epidemiological approaches to heart disease: the Framingham study. *Am J Public Health* 1951;**41**:279-86.
5. Labarthe DR. Epidemiology and prevention of cardiovascular diseases. Gaithersburg, Maryland: Aspen Publishers, Inc., 1998.
6. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. *Circulation* 2001;**104**:2746-53.
7. Barker DJP. Mothers, babies and health in later life. Churchill Livingstone: Edinburgh, 1998.
8. Godfrey K,.Barker D. Fetal programming and adult health. *Public Health Nutr.* 2001;**4**:611-24.

9. Barker DJ, Winter PD, Osmond C, Margetts B, Simmonds SJ. Weight in infancy and death from ischaemic heart disease. *Lancet* 1989;**2**:577-80.
10. Barker DJ, Osmond C, Simmonds SJ, Wield GA. The relation of small head circumference and thinness at birth to death from cardiovascular disease in adult life. *BMJ* 1993;**306**:422-6.
11. Leon DA, Lithell HO, Vagero D, Koupilova I, Mohsen R, Berglund L *et al*. Reduced fetal growth rate and increased risk of death from ischaemic heart disease: cohort study of 15 000 Swedish men and women born 1915- 29. *BMJ* 1998;**317**:241-5.
12. Forsen T, Eriksson JG, Tuomilehto J, Teramo K, Osmond C, Barker DJ. Mother's weight in pregnancy and coronary heart disease in a cohort of Finnish men: follow up study. *BMJ* 1997;**315**:837-40.
13. Gunnarsdottir I, Birgisdottir BE, Thorsdottir I, Gudnason V, Benediktsson R. Size at birth and coronary artery disease in a population with high birth weight. *Am.J Clin.Nutr.* 2002;**76**:1290-4.
14. Osler M, Nybo Andersen A-M, Due P, Trab Damsgaard M, Holstein B. Parental social position, birth weight, childhood cognitive function and mortality in adult life. A longitudinal study of Danish men born in 1953 (in press). *Journal of Epidemiology and Community Health* 2003.
15. Ben Shlomo Y,.Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int.J Epidemiol* 2002;**31**:285-93.

16. Kuh D, Ben Shlomo Y. A lifecourse approach to chronic disease epidemiology. Oxford: Oxford Medical Publications, 1997.
17. Kuh D, Hardy R. A life course approach to women's health. Oxford: Oxford University Press, 2002.
18. Wadsworth ME. Follow-up of the first national birth cohort: findings from the Medical Research Council National Survey of Health and Development. *Paediatr.Perinat.Epidemiol.* 1987;**1**:95-117.
19. Wadsworth ME,.Kuh DJ. Childhood influences on adult health: a review of recent work from the British 1946 national birth cohort study, the MRC National Survey of Health and Development. *Paediatr.Perinat.Epidemiol.* 1997;**11**:2-20.
20. Wadsworth MEJ. The Imprint of Time : Childhood, History, and Adult Life. Oxford: Clarendon Press, 1991.
21. Power C. A review of child health in the 1958 birth cohort: National Child Development Study. *Paediatr Perinat.Epidemiol.* 1992;**6**:81-110.
22. Smith K,.Joshi H. The Millennium Cohort Study. *Popul.Trends* 2002;30-4.
23. Chamberlain R, Chamberlain G, Howlett B, Claireaux A. British Births: Vol. 1. The First Week of Life. London: Wm Heinemann, 1975.
24. MacKenzie H. The City of Aberdeen. The Third Statistical Account of Scotland. Edinburgh: Oliver and Boyd, 1953.

25. Baird D. Epidemiology of congenital malformations of the central nervous system in (a) Aberdeen and (b) Scotland. *J.Biosoc.Sci.* 1974;**6**:113-37.

26. Baird D. The epidemiology of low birth weight : Changes in incidence in Aberdeen, 1948-72. *J.Biosoc.Sci.* 1974;**6**:323-41.

27. Illsley R. Social class selection and class differences in relation to sillbirths and infant deaths. *Br.Med.J.* 1955;**2**:1520-4.

28. Harris AH, Lloyd MG, Newlands DA. The Impact of Oil on the Aberdeen Economy. Aldershot: Avebury, 1988.

29. McLaren GL, Bain MRS. Deprivation and Health in Scotland : Insights from NHS data. Edinburgh: ISD Scotland Publications, 1998.

30. Carr-Hill R, Pritchard C. Women's social standing : the empirical problem of female social class. Basingstoke: Macmillan Press, 1992.

31. Elbourne D, Pritchard C, Dauncey M. Perinatal outcomes and related factors: social class differences within and between geographical areas. *J.Epidemiol.Community.Health* 1986;**40**:301-8.

32. Bodner CH, Ross S, Little J, Douglas JG, Legge JS, Friend JAR *et al*. Risk factors for adult onset wheeze. *Am.J.Respir.Crit.Care Med.* 1998;**157**:35-42.

33. MacMahon B,.Sawa JM. Physical damage to the fetus in Causes of Mental Disorders : A Review of the Epidemiological Knowledge, 1959. *Milbank.Mem.Fund.Q.* 1961;14-83.

34. Thompson B, Samphier M, Hall MH. The Aberdeen Obstetric Data Bank. *Acta Genet.Med Gemellol.(Roma.)* 1979;**28**:375-6.

35. Samphier M, Thompson B. Longitudinal studies in Aberdeen, Scotland. B. The Aberdeen Maternity and neonatal data bank. In Mednick S, Baert A, Bachmann B, eds. *Prospective longitudinal research. An empirical basis for the primary prevention of psychosocial disorders*, pp 61-5. Oxford: Oxford University Press, 1981.

36. Illsley R, Finlayson A, Thompson B. The motivation and characteristics of internal migrants. A socio-medical study of young migrants in Scotland. Part I. *Milbank Mem Fund Q* 1963;**XLI**:115-44.

37. Rutter M. A children's behaviour questionnaire for completion by teachers: preliminary findings. *J Child Psychol.Psychiatry* 1967;**8**:1-11.

38. Rutter M, Tizard J. Education, health and behaviour. London: Longman, 1970.

39. Puura K, Almqvist F, Tamminen T, Piha J, Rasanen E, Kumpulainen K *et al*. Psychiatric disturbances among prepubertal children in southern Finland. *Soc Psychiatry Psychiatr.Epidemiol* 1998;**33**:310-8.

40. Kumpulainen K, Rasanen E, Henttonen I. The persistence of psychiatric disturbance among children. *Soc Psychiatry Psychiatr.Epidemiol* 1997;**32**:113-22.

41. Kresanov K, Tuominen J, Piha J, Almqvist F. Validity of child psychiatric screening methods. *Eur Child Adolesc.Psychiatry* 1998;**7**:85-95.

42. Kresanov K, Tuominen J, Piha J, Almqvist F. Validity of child psychiatric screening methods. *Eur Child Adolesc.Psychiatry* 1998;**7**:85-95.

43. Illsley R, Wilson F. Longitudinal studies in Aberdeen, Scotland. C. The Aberdeen child development survey. In Mednick S, Baert A, Bachmann B, eds. *Prospective longitudinal research. An empirical basis for the primary prevention of psychosocial disorders*, pp 66-8. Oxford: Oxford Univerity Press, 1981.

44. Birch HG, Richardson SA, Baird D, Horobin G, Illsley R. Mental subnormality in the community: a clinical and epidemiologic study. Baltimore: Williams and Wilkins Co., 1970.

45. Oldman D, Bytheway B, Horobin G. Family structure and educational achievement. *J.Biosoc.Sci.Suppl* 1971;81-91.

46. Illsley R. Family growth and its effect on the relationship between obstetric factors and child functioning. In Platt R, Parks A, eds. *Social and genetic influences on life and death*, pp 29-42. Edinburgh: Oliver and Boyd, 1967.

47. Illsley R. A city's schools: from equality of input to inequality of outcome. *Oxford review of Education* 2002;**28**:427-45.

48. Nisbett J, Welsh J, Watt J. Reading standards in Aberdeen 1962-72. *Educational Research* 1974;**16**:172-5.

49. Neisser U, Boodoo G, Bouchard Jnr T, et al. Intelligence: knowns and unknowns. *American Psychologist* 1996;**51**:77-101.

50. Östberg V. Children in classrooms: peer status, status distribution and mental well-being. *Soc.Sci.Med.* 2003;**56**:17-29.

51. Batty G, Leon D, Rahi J. Relation of birth weight, gestational age, paternal socio-economic position, and early childhood height to prevalent reduced distant visual acuity in children born in Aberdeen in the 1950s. *J Epidemiol Community Health* 2001;**A24 (abstract 91)**.

52. Richardson SA, Koller H. Twenty-two years - causes and consequences of mental retardation. Cambridge, Mass: Harvard University Press, 1996.

53. May D,.Hogg J. Is there a 'hidden' population of adults with intellectual disabilities? Evidence from a follow-up study. *Journal of Applied Research in Intellectual Disabilities* 1999;**12**:177-89.

54. May D,.Hogg J. Continuity and change in the use of residential services by adults with intellectual disability: the Aberdeen cohort at mid-life. *J.Intellect.Disabil.Res.* 2000;**44 (Pt 1)**:68-80.

55. May D, Hogg J. Experiencing adulthood: age related needs and quality of life of people with learning disabilities and their carers. Dundee: University of Dundee, Departments of Psychiatry and Social Work, 1997.

56. Dawson B, Horobin G, Illsley R, Mitchell R. A survey of childhood asthma in Aberdeen. *Lancet* 1969;**i**:827-30.

57. Ross S, Godden D, McMurray D. Social effects of wheeze in childhood: a 25 year follow up. *British Medical Journal* 1992;**305**:545-8.

58. Godden DJ, Ross S, Abdalla M, McMurray D, Douglas A, Oldman D *et al*. Outcome of wheeze in childhood. Symptoms and pulmonary function 25 years later. *Am.J Respir.Crit Care Med.* 1994;**149**:106-12.

59. Christie GL, Helms PJ, Godden DJ, Ross SJ, Friend JA, Legge JS *et al*. Asthma, wheezy bronchitis, and atopy across two generations. *Am.J Respir.Crit Care Med.* 1999;**159**:125-9.

60. Christie GL, Helms PJ, Ross SJ, Godden DJ, Friend JA, Legge JS *et al*. Outcome of children of parents with atopic asthma and transient childhood wheezy bronchitis. *Thorax* 1997;**52**:953-7.

61. Bodner C, Ross S, Douglas G. The prevalence of adult onset wheeze: longitudinal study. *British Medical Journal* 1997;**314**:792-3.

62. Bodner CH, Ross S, Little J, Douglas JG, Legge JS, Friend JA *et al*. Risk factors for adult onset wheeze: a case control study. *Am.J Respir.Crit Care Med.* 1998;**157**:35-42.

63. Bodner C, Godden D, Brown K, Little J, Ross S, Seaton A. Antioxidant intake and adult-onset wheeze: a case-control study. Aberdeen WHEASE Study Group. *Eur.Respir.J* 1999;**13**:22-30.

64. Bodner C, Godden D, Ross S, Little J, Douglas JG, Legge J *et al*. Bronchial hyperresponsiveness and adult onset wheeze: the influence of atopy. *Eur.Respir.J* 1999;**14**:335-8.

65. Bodner C, Anderson WJ, Reid TS, Godden DJ. Childhood exposure to infection and risk of adult onset wheeze and atopy. *Thorax* 2000;**55**:383-7.

66. Ninan TK,.Russell G. Respiratory symptoms and atopy in Aberdeen schoolchildren: evidence from two surveys 25 years apart. *BMJ* 1992;**304**:873-5.

67. Neligan G, Prudham D, Steiner H. The formative years. London: Oxford University Press, 1974.

68. Macfarlane A, Mugford M. Birth Counts. Statistics of pregnancy and childbirth. Volume 1. London: HMSO, 2000.

69. Batty GD,.Leon D. Socio-economic position and coronary heart disease risk factors in children and young people. Evidence from UK epidemiological studies. *Eur J Public Health* 2002;**12**:263-72.

70. Grove WM, Andreasen NC, McDonald-Scott P, Keller MB, Shapiro RW. Reliability studies of psychiatric diagnosis. Theory and practice. *Arch Gen.Psychiatry* 1981;**38**:408-13.

71. Kramer RA, Allen L, Gergen PJ. Health and social characteristics and children's cognitive functioning: results from a national cohort. *Am.J Public Health* 1995;**85**:312-8.

72. Neligan G,.Prudham D. Family factors affecting child development. *Arch Dis Child* 1976;**51**:853-8.

73. Hutchinson D, Prosser H, Wedge P. Prediction of eductional failure. *Educational Studies* 1979;**5**:73-82.

74. Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a sytematic review. *Int J Obes* 1999;**23 (Suppl. 8)**:S1-S107.

75. MacKenzie H. The City of Aberdeen. Edinburgh: Oliver and Boyd, 1953.

76. Anonymous. Depopulation and rural life in Scotland. London: HMSO, 1949.

77. Central Statistics Office. Report on Vital Statistics. Dublin: The Stationery Office, 1959.

78. Leon DA,.Strachan DP. Socioeconomic characteristics of interregional migrants in England and Wales, 1939-1971. *Environment and Planning A* 1993;**25**:1441-51.

79. Strachan DP, Leon DA, Dodgeon B. Mortality from cardiovascular disease among interregional migrants in England and Wales. *BMJ* 1995;**310**:423-7.

80. Owen D, Green A. Migration Patterns and Trends. In Stillwell J, Rees P, Boden P, eds. *Migration Processes and Patterns: Volume 2 - Population Redistribution in the United Kingdom*, pp 28-55. London: Belhaven Press, 1992.

81. Douglas J, Blonfield J. Children Under Five. London: Allen and Unwin, 1958.

82. Johnson RC, Honbo KA, Nagoshi CT. Characteristics of emigrants from Hawaii. *J Biosoc.Sci* 1989;**21**:453-9.

83. Hattersley L, Creeser R. Longitudinal study 1971-1991. London: HMSO, 1995.

84. Shapiro H. Migration and Environment. London: OUP, 1939.

85. Illsley R, Finlayson A, Thompson B. The motivation and characteristics of young migrants. Part II. Other characteristics of migrants. *Milbank Mem Fund Q* 1963;**XLI**:217-48.

86. Scottish Council for Research in Education. Social implications of the 1947 Scottish Mental Survey. London: University Press, 1953.

87. Barker DJ. Early growth and cardiovascular disease. *Arch.Dis.Child* 1999;**80**:305-7.

88. Morton SMB, De Stavola BL, Leon DA. The "missing links" - bias in identifying reproducers in an intergenerational study (abstract). *Int J Circumpolar Health* 2002;**61 (suppl. 1)**:70.

89. Heasman MA. Scottish Consultant Review of In-patient Statistics (SCRIPS). *Scott.Med.J.* 1970;**15**:386-90.

90. Heasman MA,.Clarke JA. Medical record linkage in Scotland. *Health Bull.(Edinb.)* 1979;**37**:97-103.

91. Anonymous. Information and Statistics Division: National data sets (http://www.show.scot.nhs.uk/isd/isd_services/aboutisd/aboutisd_nds_activity_patient.htm - accessed December 2002). 2002.

92. Leon DA. Commentary: Getting to grips with fetal programming-aspects of a rapidly evolving agenda. *Int J Epidemiol.* 2001;**30**:96-8.

93. Dengler R, Roberts H, Rushton L. Lifestyle surveys - the complete answer? *Journal of Epidemiology and Community Health* 1997;**51**:46-51.

94. Anonymous. Census 1951. Scotland. Volume IV. Occupations and Industries. 1956.

95. Morton S, Leon D, De Stavola BL. Transgenerational influences of inequalities in size at birth (abstract). *J Epidemiol Community Health* 2000;**54**:774.

96. Morton S, Leon D, De Stavola BL, Campbell DM, Hall MH, Clark H. Does maternal birth weight mediate the intergenerational continuities in hypertension in pregnancy (abstract)? *Pediatric Research* 2001;**50 (Suppl 1)**:91 (9/2).

97. Morton SMB. Life course determinants of offspring size at birth: an intergenerational study of Aberdeen women. PhD thesis. London School of Hygience and Tropical Medicine (University of London), 2002.

98. Rich-Edwards J. A life course approach to women's reproductive health. In Kuh D, Hardy R, eds. *A life course approach to women's health*, pp 23-43. Oxford: Oxford University Press, 2002.

99. Pavlik VN, de Moraes SA, Szklo M, Knopman DS, Mosley TH, Jr., Hyman DJ. Relation between cognitive function and mortality in middle-aged adults: the atherosclerosis risk in communities study. *Am J Epidemiol.* 2003;**157**:327-34.

100. Deeg DJ, Hofman A, van Zonneveld RJ. The association between change in cognitive function and longevity in Dutch elderly. *Am.J Epidemiol* 1990;**132**:973-82.

101. Siegler IC. The terminal drop hypothesis: fact or artifact? *Exp.Aging Res.* 1975;**1**:169-85.

102. Whalley LJ,.Deary IJ. Longitudinal cohort study of childhood IQ and survival up to age 76. *BMJ* 2001;**322**:819.

103. Deary I, Whiteman M, Starr J, Whalley L, Fox H. The impact of childhood intelligence on later life: following up the Scottish Mental Surveys of 1932 and 1947. *J Pers Soc Psychol (in press)* 2002.

104. Scottish Council for Research in Education. The intelligence of Scottish school children: a national survey of an age group. London: University of London Press, 1933.

105. Batty GD, Clark H, Morton SMB, MacIntyre S, Leon DA. Intelligence in childhood and mortality, migration, questionnaire response rate, and self-reported morbidity and risk factor levels in adulthood - preliminary findings from the Aberdeen 'Children of the 1950s' study (abstract). *J Epidemiol.Community Health* 2002;**56 (suppl II)**:A1.

106. Shenkin SD, Starr JM, Pattie A, Rush MA, Whalley LJ, Deary IJ. Birth weight and cognitive function at age 11 years: the Scottish Mental Survey 1932. *Arch Dis Child* 2001;**85**:189-96.

107. Richards M, Hardy R, Kuh D, Wadsworth ME. Birth weight and cognitive function in the British 1946 birth cohort: longitudinal population based study. *BMJ* 2001;**322**:199-203.

108. Richards M, Hardy R, Kuh D, Wadsworth ME. Birthweight, postnatal growth and cognitive function in a national UK birth cohort. *Int.J Epidemiol* 2002;**31**:342-8.

109. Batty GD, Morton S, MacIntyre S, Leon DA. Size at birth and cardiovascular disease mortality: evidence from the Aberdeen *Children of the 1950s* study (presented at the Second World Congress on the Foetal Origins of Adult Disease. Brighton, UK, 2003). *Pediatr Res (Suppl.)* 2003;**53**:21A (no. P218).

110. Office of Population Censuses and Surveys. Classification of Occupations (1950). London: HMSO, 1951.

111. Gunnell DJ, Frankel SJ, Nanchahal K, Peters TJ, Davey Smith G. Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort. *Am J Clin Nutr* 1998;**67**:1111-8.

Table 1. Reading attainment tests used in the Aberdeen Child Development Survey in December 1962

| **Name of test** | **Elements tested** | **School class administered test** |
|---|---|---|
| Metropolitan Achievement Test (Primary II Battery [Form B][a])<br><br>NFER[b] Sentence Reading Test 1[c] | Word Knowledge<br>Word Discrimination<br>Reading: sentences | Primary III (age 7[d]) |
| Metropolitan Achievement Test (Elementary Battery [Form B][a])<br><br>NFER Sentence Reading Test[c] 1 | Word Knowledge<br>Word Discrimination<br>Reading | Primary IV and V (age 8-9) |
| Metropolitan Achievement Test (Intermediate Battery [Form B][a])<br>NFER Reading Test N.S.6[c] | Word Knowledge<br>Reading | Primary VI and VII (age 10-11)[e] |

[a]American test
[b]National Foundation for Education Research
[c]English test
[d]Age is a close approximation: a small proportion of children will have been young or old for their class year
[e]In contrast to the younger school classes, a test of word discrimination was not administered to primary VI and VII

Table 2. The Aberdeen Child Development Survey: sources and information available

| Source | Population for which data available | Variables | Comment |
|---|---|---|---|
| Survey of primary school children aged 6-13 years conducted in December 1962 | All school children in Aberdeen primary schools classes III to VII (born 1950-56), except for special schools for children with a 'sub-normality', 'handicap' or deafness | Name, address, date of birth of child, occupation of father and number of older and younger siblings and whether twin or triplet all reported by child at time of test | Excludes children absent and those deemed untestable because of disability |
| | | Battery of reading tests appropriate for each age group administered specifically for the purposes of the survey (table 1) | |
| School records at December 1962 | All children who attended surveyed schools | 7+, 9+ and 11+ cognition test results as routinely administered by schools. School class and attendance figures for each child. | |
| Aberdeen Maternity Hospital (AMH) obstetric records | All children who took part in the December 1962 school survey for whom obstetric records could be traced | Parity, parent's age delivery, mother's height, pregnancy complications, delivery type, length of labour, cause caesarean section, place of upbringing of mother, time of first antenatal visit, length gestation, birthweight, puerperium, multiplicity, place of previous delivery | AMH records also include information about those born at home and in nursing homes |
| | | Occupation of mother and mother's father, mother's premarital occupation, education, marital status, interval between marriage and last menstral period, mother's age at marriage | Complete data for first pregnancies only |
| School medical records at July 1963 | For most children information available at point of entry in primary school, and for a sub-set at subsequent points. Records created for all children even if they were not part of the original survey | Age at examination, height, weight, visual (with and without correction) and hearing acuity. For most children information on height and weight available at around age 5 | Medical records kept by schools. |
| | | Laterality (handedness) | |
| | | Previous primary schools and dates of entry to them | |
| | | Info (not computerised) or various medical conditions | |
| Teachers' questionnaires conducted March 1964 | All children in classes primary IV to secondary 2B (i.e., classes in which the original reading survey children would be attending). Includes other children who were not part of December 1962 reading survey | Scale of minor behavioural problems. Scale of more serious behavioural problems | Instrument used was early version of the Rutter B scale |
| Brief questionnaire to children March 1964 | | Child's indication of three peers others they liked most in the class March 1964 | Data allows construction of friendship networks |
| | | | |

Table 3. Cognitive tests routinely used in Aberdeen schools in the 1950s and 1960s

| **Test** | **Age of child at administration** | **Purpose** |
|---|---|---|
| Moray House Picture Intelligence Test No. 1 or No. 2 | Within 6 months of the 7th birthday | Screen for learning disability |
| Schonell and Adams Essential Intelligence Test Form A or B | Within 6 months of the 9th birthday | Screen for poor readers |
| Moray House verbal reasoning tests I and II | Within 6 months of the 11th birthday | Allocation of secondary school places |

Table 4. Distribution of core population by sex and year of birth

| Year of birth | Males | | Females | |
|---|---|---|---|---|
| | N | % | N | % |
| 1950 | 332 | 5.3 | 284 | 4.8 |
| 1951 | 1207 | 19.2 | 1137 | 19.4 |
| 1952 | 1204 | 19.2 | 1121 | 19.1 |
| 1953 | 1241 | 19.8 | 1162 | 19.8 |
| 1954 | 1343 | 21.4 | 1236 | 21.0 |
| 1955 | 949 | 15.1 | 923 | 15.7 |
| 1956 | - | - | 11 | 0.2 |
| **Total** | **6276** | **100** | **5874** | **100** |

Table 5. Peri-natal and early childhood characteristics according to father's occupational social class at birth of study participant[a] in the core population (N=12,150)

| Characteristic[b] | Prof. & Inter. (I and II) | Skilled (III NM) | Skilled (III M) | Semi-skilled (IV) | Unskilled (V) | Unemployed | P-value for heterogeneity |
|---|---|---|---|---|---|---|---|
| Low birthweight (<2500g) | 3.3 (38) | 3.9 (52) | 5.8 (310) | 6.8 (115) | 6.8 (134) | 7.4 (50) | <0.001 |
| Born pre-term (<37 completed wk) | 4.7 (52) | 6.8 (85) | 6.5 (313) | 8.6 (130) | 8.1 (136) | 9.0 (44) | <0.001 |
| High number of siblings (≥4) in 1962 (6-13 yr.) | 20.0 (232) | 22.2 (295) | 32.4 (1714) | 44.6 (746) | 49.7 (969) | 37.4 (240) | <0.001 |
| Low childhood height (1 SD below mean)[c] | 6.2 (67) | 8.7 (112) | 14.7 (753) | 19.4 (317) | 24.1 (457) | 21.0 (128) | <0.001 |
| High childhood BMI (1 SD above mean)[c] | 14.6 (159) | 9.8 (126) | 11.5 (589) | 13.1 (213) | 13.0 (246) | 16.7 (102) | <0.001 |
| Low childhood cognition (≤89)[d] (approx. 7 years) | 2.4 (25) | 5.3 (69) | 12.6 (647) | 17.2 (281) | 22.6 (429) | 18.3 (109) | <0.001 |
| Low UK reading quotient score (≤89)[e] in 1962 (6-13 yr.) | 8.3 (96) | 14.1 (188) | 25.0 (1318) | 31.4 (524) | 39.3 (765) | 31.8 (204) | <0.001 |
| Father in manual occupation in 1962[a] (6-13 yr.) | 6.4 (74) | 16.9 (224) | 83.6 (4414) | 86.6 (1443) | 82.1 (1589) | 61.2 (382) | <0.001 |
| Psychological disorder[f] in 1964 (8-15 yr.) | 3.5 (39) | 4.2 (55) | 8.1 (420) | 11.0 (181) | 11.9 (228) | 12.5 (79) | <0.001 |
| **Total** | **9.6 (1163)** | **11.0 (1335)** | **43.8 (5319)** | **13.9 (1689)** | **16.2 (1963)** | **5.6 (680)** | |

[a]Based on the Registrar General's classification for 1950[110]
[b]Data are % (N) of individuals with specified characteristic within each social class group. Numbers for each characteristic vary due to some missing data.
[c]Z-scores express a child's height or body mass index (BMI) as the number of standard deviations from the mean for their age (within 3 month age bands) and were computed internally.[111] These data were collected when study participants were between 4 and 12.4 years of age.
[d]Assessed using the Moray House Picture Intelligence Test (No. 1 or 2)
[e]Assessed using the NFER[a] Sentence Reading Test 1 (for children aged 7-9 yr.) and the NFER Reading Test N.S.6 (for children aged 10-11 yr.). Scores were internally standardised for age.
[f]Assessed using the Rutter scale B (score of ≥9 denotes psychological disorder)

Table 6. Trace status in the Aberdeen *Children of the 1950s* study (March 2002)

| **Trace status** | **N** | **%** |
|---|---|---|
| Registered with a general practitioner in: | | |
| • Grampian region (inc. Aberdeen) | 8712 | 71.7 |
| • Rest of Scotland | 1026 | 8.4 |
| • England, Wales and Northern Ireland | 1254 | 10.3 |
| Armed forces (& others not registered with a GP) | 70 | 0.6 |
| No trace or cancelled registration | 323 | 2.7 |
| Emigration from the UK | 288 | 2.4 |
| Dead | 477 | 3.9 |
| **Total** | **12,150** | **100** |

Table 7. Percent (N) of total deaths by age at death in the Aberdeen *Children of the 1950s* study (N=12150) (March 2002)

| Age at death (yr.) | Males | Females | All |
|---|---|---|---|
| < 15 | 5.5 (17) | 1.8 (3) | 4.2 (20) |
| 15-24 | 18.4 (57) | 9.0 (15) | 15.1 (72) |
| 25-34 | 22.6 (70) | 17.4 (29) | 20.8 (99) |
| 35-44 | 29.7 (92) | 40.1 (67) | 33.3 (159) |
| ≥ 45 | 23.9 (74) | 31.7 (53) | 26.6 (127) |
| **Total** | **100 (310)** | **100 (167)** | **100 (477)** |

Table 8. Peri-natal and early childhood characteristics according to trace status

| | Traced[a] | | P value for difference |
|---|---|---|---|
| | No | Yes | |
| Low birthweight (<2500g) | 5.1 (9) | 5.8 (690) | 0.01 |
| Born pre-term (<37 completed wk) | 6.8 (11) | 7.0 (749) | 0.92 |
| Father in manual occupation at birth of study participant[e] | 63.3 (114) | 74.0 (8857) | 0.001 |
| High number of siblings (≥4) in 1962 (6-13 yr.) | 34.9 (60) | 34.8 (4136) | 0.98 |
| Low childhood height (1 SD below mean)[b] | 14.5 (23) | 15.8 (1811) | 0.86 |
| High childhood BMI (1 SD above mean)[b] | 16.4 (26) | 12.3 (1410) | 0.30 |
| Low childhood cognition (≤89)[d] (approx. 7 years) | 11.3 (18) | 13.5 (1542) | 0.41 |
| Low UK reading quotient score (≤89)[e] in 1962 (6-13 yr.)[d] | 26.4 (46) | 25.7 (3049) | 0.28 |
| Father in manual occupation in 1962[a] (6-13 yr.) | 61.8 (105) | 67.9 (8022) | 0.13 |
| Psychological disorder[f] in 1964 (8-15 yr.) | 4.3 (7) | 8.6 (995) | 0.105 |
| **Total** | **100.0 (180)** | **100.0 (11970)** | |

[a]Data are % (N)
[b]Z-scores express a child's height or body mass index (BMI) as the number of standard deviations from the mean for their age (within 3 month age bands) and were computed internally[111] These data were collected when study participants were between 4 and 12.4 years of age.
[c]Assessed using the Moray House Picture Intelligence Test (No. 1 or 2)
[d]Assessed using the NFER[a] Sentence Reading Test 1 (for children aged 7-9 yr.) or the NFER Reading Test N.S.6 (for children aged 10-11 yr.). Scores were internally standardised for age.
[e]Based on the Registrar General's classification for 1950[110]
[f]Assessed using the Rutter scale B (score of ≥9 denotes psychological disorder)

Table 9. Infant and childhood characteristics in relation to adult migration status in the Aberdeen *Children of the 1950s* study

| Characteristic | | Place of residence | | | | |
|---|---|---|---|---|---|---|
| | | Grampian[a] | Rest of Scotland | Other UK | Embarked | Total[e] |
| Birthweight (g) | <1500 | 77.8 (28) | 13.9 (5) | 8.3 (3) | 0 (0) | 100 (36) |
| | 1500 to <2000 | 77.4 (103) | 8.3 (11) | 12.0 (16) | 2.3 (3) | 100 (133) |
| | 2000 to <2500 | 80.4 (393) | 8.2 (40) | 9.8 (48) | 1.6 (8) | 100 (489) |
| | 2500 to <3000 | 78.0 (1489) | 9.3 (177) | 10.2 (194) | 2.5 (48) | 100 (1908) |
| | 3000 to <3500 | 78.3 (3069) | 8.3 (325) | 10.8 (425) | 2.6 (101) | 100 (3920) |
| | 3500 to <4000 | 75.7 (3101) | 9.9 (405) | 11.7 (481) | 2.7 (111) | 100 (4098) |
| | ≥4000 | 76.1 (509) | 9.0 (60) | 12.4 (83) | 2.5 (17) | 100 (669) |
| Father's occupational social class at birth of child[b] | I | 50.4 (132) | 22.5 (59) | 22.5 (59) | 4.6 (12) | 100 (262) |
| | II | 61.7 (497) | 16.8 (135) | 17.4 (140) | 4.1 (33) | 100 (805) |
| | III | 77.0 (4775) | 9.3 (577) | 10.8 (670) | 2.9 (180) | 100 (6202) |
| | IV | 83.1 (1312) | 5.0 (79) | 10.3 (163) | 1.6 (25) | 100 (1579) |
| | V | 84.9 (1545) | 6.1 (111) | 7.4 (135) | 1.6 (29) | 100 (1820) |
| | Unemployed | 73.8 (444) | 10.3 (62) | 14.5 (87) | 1.5 (9) | 100 (602) |
| Height (z-scores[c]) | < 1 SD | 83.3 (1423) | 5.9 (101) | 9.3 (158) | 1.6 (27) | 100 (1709) |
| | -1 to +1 SD | 78.2 (5787) | 8.6 (633) | 10.5 (775) | 2.8 (206) | 100 (7401) |
| | >1 SD | 71.1 (1216) | 13.1 (224) | 14.0 (240) | 1.8 (30) | 100 (1710) |
| Cognition score at 7 years of age[d] | <=89 | 87.1 (1253) | 5.1 (73) | 6.7 (96) | 1.2 (17) | 100 (1439) |
| | 90 to 99 | 85.7 (1688) | 4.6 (90) | 7.8 (154) | 1.9 (38) | 100 (1970) |
| | 100 to 109 | 80.0 (2022) | 7.4 (187) | 10.0 (252) | 2.7 (68) | 100 (2529) |
| | 110 to119 | 76.6 (1795) | 9.1 (214) | 11.3 (266) | 3.0 (70) | 100 (2345) |
| | >=120 | 65.7 (1649) | 15.5 (388) | 15.7 (394) | 3.1 (78) | 100 (2509) |

[a]Data are % (N)
[b]Based on the Registrar General's classification for 1950[110]
[c]Z-scores express a child's height as the number of standard deviations from the mean for their age (within 3 month age bands) and were computed internally.[111] These data were collected when study participants were between 4 and 12.4 years of age.
[d]Assessed using the Moray House Picture Test (No. 1 or 2)
[e]Totals differ owing to some missing data

Table 10. Parental characteristics of female study members according to whether they were linked to offspring deliveries (N=4997)

| **Characteristic**[a] | | **Linked** | | **p-value** |
|---|---|---|---|---|
| | | **Yes** | **No** | **for difference** |
| Paternal social class at birth of child[b] | I | 1.6 (56) | 3.0 (46) | <0.001 |
| | II | 6.5 (226) | 10.1 (152) | |
| | IIINM | 36.2 (1263) | 37.6 (569) | |
| | IIIM | 20.2 (705) | 18.3 (276) | |
| | IV | 14.4 (500) | 11.4 (173) | |
| | V | 16.4 (573) | 13.0 (197) | |
| | Other[e] | 4.7 (162) | 6.6 (99) | |
| Maternal higher education[c] | | 0.9 (10) | 3.1 (14) | 0.002 |
| Pregnancy Complications | Maternal Hypertension | 17.9 (624) | 17.3 (262) | 0.40 |
| | Maternal APH[d] | 1.9 (67) | 1.8 (27) | 0.74 |
| Maternal height (cm) | | 157.9 (6.1) | 158.2 (6.5) | 0.06 |
| **Total** | | **100.0 (3485)** | **100.0 (1512)** | |

[a]Data are % (N) except maternal height which is mean (SD)
[b]Based on the Registrar General's classification for 1950[110]
[c]Data were only available for first born mothers (N=1552)
[d]Ante-partum haemorrhage
[e]unemployed, dead or disabled

Table 11. Father's occupational social class at birth of child[a]

| | ***Children of the 1950s*** | **1951 Census for Scotland[c]** | **1958 Birth Cohort** | **1946 Birth Cohort[d]** |
|---|---|---|---|---|
| Professional (I) | 2.5 (290)[b] | 3.2 (27,565) | 4.6 (709) | 2.7 (289) |
| Intermediate (II) | 7.6 (873) | 11.3 (98,089) | 13.1 (2013) | 11.8 (1250) |
| Skilled (III) | 58.0 (6654) | 54.9 (474,541) | 60.3 (9265) | 55.7 (5876) |
| Semi-skilled (IV) | 14.7 (1689) | 17.6 (152,291) | 12.2 (1865) | 20.1 (2122) |
| Unskilled (V) | 17.1 (1963) | 13.0 (112,551) | 9.7 (1493) | 9.6 (1012) |
| **Total[e]** | **100 (11,469)** | **100 (865,037)** | **100 (15,347)** | **100 (10,549)** |

[a]Based on the Registrar General's classification for 1950[110]
[b]Data are % (N)
[c]Data are for males aged 20-44 yr. which approximates to age range of fathers of study participants in the *Children of the 1950s* study
[d]Numbers are based on children born between 3rd and 9th March 1946 who survived to 11 years of age. Subsequent study follow-ups were based on a random, class-stratified subgroup[18]
[e]Excludes persons with missing data and the unemployed