

# Cohort Profile: The 1946 National Birth Cohort (MRC National Survey of Health and Development)

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## How did the study come about?

The first of the British National Birth Cohort studies aimed to address two health and social policy questions of importance in the years before the establishment of the National Health Service (NHS) in 1948. The first question, identified by the Royal Commission on Population, asked why the national fertility rate had been falling consistently since the middle of the 19th century. A proposed explanation was that the 'medical and other costs associated with the birth of a baby may today be a serious deterrent to parenthood.'<sup>1</sup> The second question asked 'what was the national distribution and use of obstetric medical and midwifery services, and how far do they prevent premature and infant death, and promote the health of mothers and infants?'<sup>1</sup>

The study set up to address these questions was promoted by the Royal College of Obstetricians and the Population Investigation Committee, and funded by the Nuffield Foundation and the National Birthday Trust Fund for a data collection from all who delivered births that took place during March 3–9, 1946 throughout England, Wales, and Scotland.

## What does it cover?

Policy concerns, as well as scientific interests, have been continued, as described in Table 1.

The first two investigations at ages 2 and 4 years of the sample selected for follow-up were concerned with socioeconomic differences in the infant's growth, development, and morbidity, and with the effect of mothers' and health visitors' care and the family's socioeconomic circumstances on those health outcomes (Table 1). During the school years (ages 5–15 years) the measurement of growth and health continued, and a new strand of work was begun on educational experience and attainment (Table 1). In early adulthood (ages 16–31 years) the collection of health data continued, a study of delinquency was undertaken, and the outcomes of education were studied in terms of income and occupation (Table 1). At the beginning of middle adulthood (ages 32–53 years in Table 1), the study's health data collections were re-oriented in order to make the prime aim the measurement of physical and mental function and the study of pathways to those outcomes, in addition to the study of morbidity and mortality; that aim has continued.

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## Who is in the sample?

Figure 1 shows that the target sample for the first data collection was all the births in England, Scotland, and Wales that occurred in one week in March 1946. Subsequent data collections have been from a sample of all single births to married women using the selection criteria described in Figure 1. A weighting can be applied in analyses in order to adjust for the sampling procedure. The sample was distributed geographically in proportion to the national population.

## How often have they been followed-up?

Data collections were frequent in infancy and the school years because of the pace of development and growth (Table 2).

In adulthood the periods between collections lengthened partly because biological and cognitive change then happens at a slower rate, and also because of cost. Between birth and age 15 years, data collection was undertaken by health care and educational professionals responsible for the child. After a period of postal data collection, and one round of data collection at home visits by professional interviewers at age 26 years, the three subsequent data collections have been at home visits by research nurses.

## What has been measured?

Descriptions of measures are given in Table 3 using the same periods as in Table 1.

## Attrition

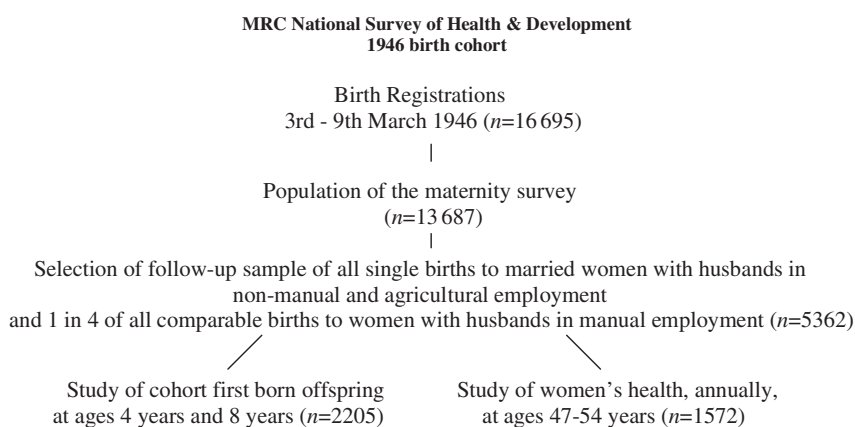
Attrition is summarized in Table 4.<sup>2</sup>

The greatest overall attrition occurred, not unexpectedly, in the early adult years, when name and address changes were particularly frequent, and five of the seven data collections from the total sample were by postal questionnaire. Sample members are traced annually and a birthday card is sent together with a card to check and return on current address and name.

Unavoidable losses through death were high in infancy, and by age 53 years amounted to 8.7% of the cohort. Similarly, by the same age, unavoidable losses through emigration (8.6%) and living abroad (2.2%) are high in a sample that was affected by the 'brain drain' earlier in life, and is beginning to be affected by emigration for retirement. Death and emigration data have been supplied from the NHS Central Register since the cohort was first flagged in 1971, and cancer registrations are now also supplied.

**Table 1** Science (data collection and aims) and funding in relation to contemporary policy questions

Years	Cohort Ages	National Policy Problems	Aims	Funding
1946	Birth	Costs of maternity, reason for falling fertility.	To show the cost of and care in pregnancy and child birth.	The Nuffield Foundation and the National Birthday Trust Fund
1947–50	1–4 years	Social class differences in maternal and child mortality and morbidity.	To see whether initial SES differences in weight at birth were reflected in growth, and to show the effectiveness of maternal, as well as community maternal and child welfare care.	The Nuffield Foundation Great Ormond Street Hospital The Ford Foundation The Eugenics Society 14 Regional Hospital Boards
1951–59	5–15 years	Increasing the national level of educational attainment. The ‘waste of talent’ problem, i.e. the apparently low recruitment of high IQ children from poor SES circumstances into higher education.	To study family and environmental effects on growth and educational attainment, and the working of the education system.	Medical Research Council The Nuffield Foundation The Ford Foundation The (US) Population Council
1960–76	16–31 years	Outcomes of education in terms of occupational choice and skills, effects of atmospheric pollution. Problem behaviour.	To study the occupational and earnings outcomes of education and cognitive development, and pathways to ability and attainment, respiratory disease, and problem behaviour.	Medical Research Council (main funder) Home Office Department of Employment
1977– to the present	32– years	Ageing processes, self care of health, receptivity to health promotion.	To study pathways to physical and cognitive ageing using data collected throughout life, and change in women’s health during the menopause transition.	Medical Research Council (main funder) Alcohol Education Research Council National Institutes of Aging The European Commission The Leverhulme Trust Economic and Social Research Council Institute for Social Studies in Medical Care Food Standards Agency

**Figure 1** The samples studied

Avoidable and potentially avoidable losses by age 53 years were through permanent refusal (12.4% of the original sample), temporary refusal for this data collection only (5.2%), and failure to trace (6.1%). New permanent refusals (28) were the lowest ever at this most recent data collection.

Of the sample available for contact at age 53 years, that is, all those who were alive and resident in England, Wales, or Scotland, and not already a permanent refusal ( $N = 3673$ ), 3035 (82.6%) provided information. Among the sample successfully contacted (i.e. providing data) at 53 years, 73% had been

**Table 2** Years, ages, and methods of data collections from the original sample selected at birth, and years, ages at data collection, and methods of data collections in studies of women's health and the first born offspring

Year	Age at collections from birth cohort sample (method of data collection)	Age at collections from women's health sub-sample (method of data collection)	Age at collections from first born offspring sub-sample (method of data collection)
1946	Birth (HV,M,O)		
1948	2 (HV)		
1950	4 (HV)		
1952	6 (SD)		
1953	7 (HV/SN)		
1954	8 (HV/SN,T)		
1955	9 (HV/SN,T)		
1956	10 (T)		
1957	11 (HV/SN, SD,T)		
1959	13 (T)		
1961	15 (HV/SN,T)		
1965	19 (HV)		19 (I)
1966	20 (P)		20 (I)
1967			21 (I)
1968	22 (P)		22 (I)
1969	23 (P)		23 (I)
1970			24 (I)
1971	25 (P)		25 (I)
1972	26 (I)		
1977	31 (P)		
1982	36 (RN)		
1989	43 (RN)		
1993		47 (P)	
1994		48 (P)	
1995		49 (P)	
1996		50 (P)	
1997		51 (P)	
1998		52 (P)	
1999	53 (RN)	53 (P)	
2000		54 (P)	
2003		57 (P)	

M = midwife, O = obstetrician, HV = health visitor, SN = school nurse, SD = school doctor, T = teacher, P = postal questionnaire, I = interviewer, RN = research nurse.

successfully contacted at 17 or more of the 20 data collections from the whole cohort since age 2 years. Only 7% of them had taken part in 10 or fewer previous data collections.

Comparisons with Census data of the sample successfully contacted at 53 years and weighted to adjust for the initial sampling procedure, show that that sample represented in most respects the national population of a similar age.<sup>2</sup> At the most recent data collection 49% of respondents were men and 51% women. The sample also represents the population born in the early post-war period, at the time of the first post-war baby-boom, and will be the first of the generations who lived most of their lives in a welfare state. It represents now the population that will soon become the beginnings of the steeper increase in the national population of those aged  $\geq 65$ .

## Key findings and publications

Findings have been summarized in eight books.<sup>1,3-9</sup> References to all publications are on the study's website ([www.nshd.mrc.ac.uk](http://www.nshd.mrc.ac.uk)) and only selected references are given here.

### Findings and publications during the years before adulthood

Findings on health, survival, growth, development, and morbidity, and their association with family circumstances and health services care, showed the beneficial impact of health visiting (community nursing) and community infant care services,<sup>3</sup> and the considerable geographic and SES differences in health, survival, and the cost of child birth.<sup>1</sup>

**Table 3** Summary of data collected

Years	Cohort ages	Number of data collections	Data collected
1946	Birth	1	Experience of ante-natal and post-natal care, costs of care, weight and survival of the baby, SES circumstances of the family.
1947–50	1–4 years	2	Survival, morbidity, measures of height and weight (2 and 4 years), use of health services and preschool facilities, infant feeding experience, diet at 4 years, maternal care, SES and family circumstances.
1951–61	5–15 years	8	Survival, morbidity, height and weight, and other health measures by school doctors (ages 6, 7, 11, and 15 years), teachers' reports of adolescent temperament and behaviour (ages 13 and 15 years), teachers' reports of parental interest in education (10 and 15 years), measures of cognitive function (verbal and non-verbal at ages 8, 11, and 15 years), SES and family circumstances.
1962–77	16–31 years	8	Survival, morbidity, personality (short Maudsley Inventory at 16 and 26 years) histories of occupation, fertility, earnings and social attitudes (26 years). SES, occupation, fertility, and family circumstances.
1978–99	32–53 years	3 from the whole cohort, and an additional 9 from women cohort members.	Survival and cancer registration. Smoking, exercise, and diet (data at each collection from the whole cohort; dietary data from diaries). Respiratory function (PEFR at 36 years, FEV1, FVC, PEFR and MRC chronic bronchitis questions at 36, 43, and 53 years). Cardiovascular function (systolic and diastolic blood pressure, resting pulse and Rose and Blackburn questions at 36, 43, and 53 years). Anthropometric measures (height weight, circumference of upper arm, abdomen, and chest at 36, 43, and 53 years, sitting height and hip circumference at 43 and 53 years). Musculoskeletal measures (balance, chair rises, grip strength, examination of hands and knees for OA at 53 years). Cognitive measures (short-term verbal memory, laterality, speed and concentration and manual dexterity at 43 and 53 years, co-ordination at 43 years, verbal ability and fluency at 53 years). Mental health (short Present State Examination at 36 years, Psychiatric Symptom Frequency Inventory at 43 years, General Health Questionnaire 28 item at 53 years) SES (occupation, income, fertility, family circumstances, housing) Women's health (menopausal status, symptoms and their treatment, monthly HRT history, incontinence, mammograms, life stress, wellbeing, annually 47–54 and 57 years) Social function (contacts with others, social support and participation)

**Table 4** Contacts made with the cohort ( $n = 5362$ ) at data collections from the whole population<sup>2</sup>

Year	Age in years (no. of contacts)	Population not attempted				Population available				Successfully contacted
		Deaths	Permanent refusal	Living abroad	Emigrated	Lost	Temporary refusal	New permanent refusal	%	
Means (for each age period)										
1946–50	0–4 (2)	230	1	28	162	252	–	–	4695	95
1951–61	5–15 (8)	253	1	36	269	508	–	–	4307	89
1962–81	16–35 (6)	321	158	56	404	998	–	–	3538	78
Totals (for each contact year)										
1982	36 (1)	323	520	73	571	553		–	3322	86
1989	43 (1)	365	540	618	**	276	195	106	3262	87
1999	53 (1)	469	640	119	461	330	280	28	3035	83

\* Denominator value excludes deaths, persons living abroad or untraced, and permanent refusals.

\*\* Not known for this period.

Findings on educational attainment showed the power of parental interest and concern for their cohort child's education independently of school and SES related factors.<sup>4</sup> It was also clear that adverse SES circumstances reduced the longer-term

educational opportunity and attainment, even of children with high measured cognitive ability.<sup>5</sup>

Behaviour problems in adolescence were more frequent in those who had experienced long or repeated hospital admission

by age 5 years,<sup>10</sup> and disruption of family life through parental separation was also a risk for that outcome,<sup>6</sup> as well as for poor educational attainment.<sup>11</sup>

### Findings and publications during the adult years

Our health studies in the adult years, from age 36 years onwards, have concentrated on outcome measures of cardiovascular, musculoskeletal, respiratory and mental health, cognitive function, and women's reproductive health. Our aim is to describe the processes of ageing, and pathways to those processes and to disease risk, as well as to good health and well-being.

We are concerned with the relationships between development and ageing, and age-related diseases. For example, we show the effects of the growth trajectory in childhood and body weight change in adulthood on a range of adult outcomes and their change with age, including blood pressure,<sup>12</sup> adult obesity,<sup>13</sup> cognitive function,<sup>14</sup> mid-life muscle strength<sup>15</sup> and physical capability,<sup>16</sup> pre-menopausal breast cancer,<sup>17</sup> and mammographic density.<sup>18</sup> In other studies of ageing processes we report effects on the timing of the menopause of early growth and breast-feeding,<sup>19</sup> cognition,<sup>20</sup> and the early social environment,<sup>21</sup> in addition to the adult life risks.<sup>22</sup> We show the importance of the early social environment, independent of the adult life environment, for many aspects of adult health, such as adult obesity,<sup>23</sup> blood pressure,<sup>24</sup> cognitive function,<sup>25</sup> and survival,<sup>26</sup> as well as for socioeconomic outcomes. We show that cognitive function, in childhood and adulthood, is a determinant of physical health,<sup>27</sup> and survival,<sup>28</sup> and that despite the influences of adult exercise, smoking, and alcohol, adult occupation can protect against age associated cognitive decline.<sup>29</sup> Our genetic studies are just beginning, and show, for example in respiratory health, a genetic effect to be of importance independently of early growth, atmospheric pollution, and current lifestyle.<sup>30</sup> In our studies of health related behaviour over the life course we show lifetime variation in nutrient intakes,<sup>31</sup> as well as differences in nutrient intake in childhood in this cohort and more recently born cohorts.<sup>32</sup> Comparative collaborative studies are taking place using data from other cohorts, [for example refs (33–34)] and funding begins this year for comparison with the National Birth Cohort born in 1958 of growth trajectory and other effects on adult respiratory and cardiovascular outcomes. New work is beginning on childhood diet in relation to breast cancer and mammographic density. Other aspects of development studied include investigation of trajectories of early bladder control<sup>35</sup> and their association with mid-life urinary symptoms, and a study of diet in childhood in relation to mental health outcomes. A range of other life course determinants are being investigated in relation to cognitive function and its age related change in adulthood, including educational attainment and cognitive function at 8 years, which may be sensitive markers for genetic and early environmental exposures (e.g. stress, atmospheric pollution, nutrition) that also have long-term influence on health. New studies of social and behavioural pathways are concerned with musculoskeletal outcomes in terms of physical performance and disability.<sup>36</sup> New studies of health care include investigation of the risk factors for and consequences of hysterectomy and the characteristics of women taking HRT or alternative therapies,<sup>37</sup> and a study of

whether social function is improved in those who received prescribed medication for depression between ages 36 and 53 years, as compared with those who did not.

We continue to develop methods, including the use of traditional epidemiological techniques such as regression to more complex structural equation models, for the analysis of life course data and testing of life course models.<sup>38</sup> In particular, we are concerned with the modelling of risk factor trajectories in relation to a later life outcome, distinguishing cumulative models from critical period models and modelling pathways from early risk to later life health. We are also developing approaches to handling missing data.<sup>39</sup>

### Strengths

The study's strengths are as follows:

- Its national and representative sample.
- Its repeated measures, particularly of growth in early life, childhood, and adolescence, of cognitive function in childhood, adolescence, and adulthood, and of physical and mental function three times in adulthood.
- Its source of DNA.
- Its information on diet that includes infant feeding, 24 h recall at age 4 years, and 5–7 day diet diaries at three adult ages; these have been coded into both foods and nutrients. Blood nutrient analytes were also collected at 53 years.
- Its extensive information, throughout life, on occupation, home circumstances, marital and fertility histories, education, and training, and information in adulthood on social support, integration, and networks.
- Its high quality data, which has been ensured through careful training of data collectors, checking with hospital records, and specialist coding, for example of disease events, mammograms, and dietary data.
- Its measures of function and functional change, and of clinically valid measures, in which the treated can be differentiated from the untreated.

### The study in retrospect

As Table 1 shows the study is inevitably concerned with the science of its time, and measures that we wish had been taken in childhood and adolescence, for example of blood pressure, respiratory function, mental health, and temperament, were not then usually undertaken on those who were not evidently ill. The adverse health effects of smoking were not clearly demonstrated at the time the study began, and in consequence data on parental smoking was collected in retrospect. We also regret that the initial sampling before the first follow-up, greatly reduced the sample size and excluded births to the unmarried and multiple births, but that was dictated by the available information technology, by lack of access to the Adoption Register at a time when many births to the unmarried were adopted, perceptions of the statistical value of small numbers of multiple births, and by funding.

### The data source

The data are the responsibility of the MRC National Survey of Health and Development ([www.nshd.mrc.ac.uk](http://www.nshd.mrc.ac.uk)), and are

available in so far as consent and ethical approval permit, and as it is within the scope of the team's resources to make them available. We hope that, in due course, the Medical Research Council's initiative on data sharing will result in increased resources to make data more widely available.

## Acknowledgements

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