APPRaisal of the health of new ENTrants Into the workplace:

The APPRENTICE Study

Report to the British Occupational and Health Research Foundation

Kin Bong Hubert Lam [1]

John Henderson [2]

Jon G Ayres [1]

[1] Institute of Occupational and Environmental Medicine, University of Birmingham, Edgbaston, Birmingham B15 2TT

[2] Centre for Child and Adolescent Health, University of Bristol, Oakfield House, Oakfield Grove, Bristol BS8 2BN

May 2013

UNIVERSITY OF BIRMINGHAM

University of BRISTOL

BOHRF

British Occupational Health Research Foundation

Funding

This study was funded by the British Occupational Health Research Foundation, including the partial costs of CCS and CCT questionnaires and the partial salary costs for KBHL. Funding for the core ALSPAC study was jointly provided by the UK Medical Research Council (MRC), the Wellcome Trust and the University of Bristol.

Acknowledgements

We would like to thank all the families who took part in the ALSPAC study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. We are also grateful to Dr Alison Teyhan of the ALSPAC team who has helped in the release of data.

Contents

Executive summary

Background

The effects of work on health have been the centre of attention for centuries. In the UK alone 452,000 new cases of work-related ill-health were reported in 2011/12. Among all the workers who are at risk, relatively little is known about those entering the workplace for the first time when lack of experience may be critically important. Potentially relevant influences such as self-selection of jobs because of actual or perceived risks and pre-existing conditions are unclear.

Aims

The main aims of this exploratory study were to investigate the factors associated with occupational choice, to determine the effect of pre-existing conditions on the incidence of conditions and accidents following starting work, and to assess the impact of work on health following starting work.

Methods

The study was based on data from the Avon Longitudinal Study of Parents and Children (ALSPAC). In the 16 (CCS) and 18 years (CCT) questionnaires, we included questions that inquire into employment status, duration and type of employment, along with routine questions on general and respiratory health and accidents. The factors associated with occupational choice obtained at age 13 years were depicted. The prevalence of pre-existing asthma was recorded and the spread of occupations was described. Multivariate analysis was applied to determine the relationship between previous illness and current occupations.

Results

The CCS and CCT questionnaires were completed by 5087 and 3347 participants, respectively, a total of 2855 completing both. Substance use, including tobacco, alcohol and cannabis use, was common among the respondents. Self-perception of general health was good overall, with a quarter having or having had diagnosed asthma. Sports injury was the most frequently reported type of accident.

The majority of the ALSPAC respondents aspired to stay on in education at the age of 16 years and to go to university. Those who actually left education and were employed only accounted for 4% at 16 years, and 26% at 18 years. However, 58% of the CCS respondents and 47% of the CCT respondents who were in full time education were engaged in paid work. At 16 years, the four most prevalent Standard Occupational Classification (SOC) 2010 major groups were sales and customer service occupations (sales and retail assistants, retail cashiers and check-out operators), elementary occupations (waiters and waitresses, kitchen

and catering assistants, cleaners, paper rounds), and caring, leisure and other service occupations (childminders, sports and leisure assistants, sports coaches). At 18 years, the spread of occupation remained largely similar, although the proportion engaged in skilled trades occupations increased.

Health was relevant to employment status in this ALSPAC population. At 16 years, the student groups (not employed / engaged in paid work) tended to have better perceived health compared to the school leavers. At 18 years, the respondents staying on in education had the best overall health, although the Short Form (SF)-36 scales and summary scores were not discriminating between students and non-students. In the CCS questionnaire, managers, directors and senior officials and process, plant and machine operatives stood out as the two major groups that had the largest proportion of reported fair or poor health at 16 years. In the CCT questionnaire, respondents employed in the skilled trades occupations were more likely to report poor health.

At 16 years, those who left education and were employed had, in general, less severe asthma compared to those in education. As for the respondents of the CCT questionnaire, asthma prevalence appeared to be higher among the employed, but the severity of asthma in these individuals did not differ significantly from those staying in education and who were not employed. There was no obvious relationship between the prevalence of asthma or the major occupational groups and the proportion of respondents reporting time lost from work. Of all respondents who had asthma, 3% had lost time due to the condition, and 11% suggested the symptoms were better at weekends. Symptom improvement was mostly seen among waiters and waitresses, kitchen and catering assistants, and sales and retail assistants.

Those working in high risk jobs (defined as jobs associated with an elevated risk of adult onset asthma) were more likely to report a diagnosis of asthma at 16 years, or to have a new diagnosis of asthma between 15 and 16 years. In contrast, those remitting cases were less likely to be engaged in high risk jobs. However, at 18 years a diagnosis of asthma was associated with a reduced likelihood of being employed in high risk occupations. Those who reported to have asthma in the CCS but not in the CCT questionnaire had a significantly increased likelihood of engagement in high risk jobs.

Conclusions

This study has demonstrated the possibility of using data from ALSPAC in exploring the context of work and health in young individuals. Further analyses and plans to investigate the occupational health of ALSPAC participants after their undergraduate studies are warranted.

Introduction

Background

Current situation in occupational health

As summarised by the Joint International Labour Organization / World Health Organization Committee on Occupational Health, occupational health should aim at "*the adaptation of work to man and of each man to his job*" [1]. Until recently, much of the focus of the occupation health has been devoted to the identification of the hazards and risks in the work environment and the study of the effects of such hazards on health and well-being of workers. Research in these areas has led to the discovery of a number of workplace hazards and the characterisation of a number of work-related illnesses, and the subsequent institution of regulations aiming to prevent or minimise risks.

Notwithstanding the efforts and resources dedicated to the improvement of the work environment and work, maintaining and promoting the health and well-being of workers continues to be one of the major challenges in modern society. Regulatory steps have been instituted to reduce the incidence of work-related illnesses throughout history, with varying success, in different countries for different conditions. In the UK, the Self-reported Work-related Illness and Injury (SWI) module included in the Labour Force Survey (LFS) 2011/12 recorded 452,000 new cases of ill health believed to be caused by or made worse by work during the previous 12 months (equivalent to 1500 per 100,000 employed) [2]. Data from The Health and Occupation Reporting network in General Practice (THOR-GP), a physician-led reporting scheme for occupational diseases, estimated an incidence rate of 1237 per 100,000 working population in 2011, resulting in 8.4 million days of certified sickness absence [3]. Musculoskeletal disorders were the most common type of work-related illnesses (47%), but mental ill health contributed to most of the working days lost (59%) [3]. Skin and respiratory conditions were comparatively less common, but still accounted for an incidence of 139 and 22 per 100,000, respectively, of which 20% and 25% of the corresponding diagnoses were issued with sickness certification [3]. It was estimated that in 2010/11, work-related ill health has incurred a total cost of £8192 million to the British society [4]. These figures clearly demonstrate the need for more vigorous strategies in the prevention of work-related illnesses.

Occupational health in young workers

In 2012, approximately 3.7 million young adults between 16 and 24 years of age were employed, representing 13% of the working population in the UK [5]. Although being a minority in the labour force, these young workers deserve special attention. Primarily because of their lack of experience, young workers tend to work in elementary occupations and jobs with lowest skill requirement [6], which may represent different patterns of exposures compared to older workers. In addition, young workers, particularly adolescents, are physically smaller than adults, and are in a stage of rapid physical and sexual growth, potentially rendering them more susceptible to lower levels of occupational exposures [7].

Compared to workers of other age groups, young workers have higher rates of work-related accidents and injuries [8-12]. A report from the European Agency for Safety and Health at Work suggests that in 2003 the incidence of work-related non-fatal accidents among those aged 18-24 years is 40% higher than the total workforce or those aged 55-64 years [12], while data from the Health and Safety Executive (HSE) in UK reveal that non-fatal major injuries are more common in 20-24 years than those 25-34 years [13,14]. For adolescents, biological and psychosocial factors, such as inadequate fitness, strength, and cognitive abilities, may be contributing determinants, but lack of experience and safety training and awareness among those entering the workplace for the first time are likely to be the crucially important risk factors. In addition it is entirely possible that accidents have been under-reported by young workers because of their lack of knowledge of the reporting process and a hesitation to report due to fear of management response [12].

Compared to the relative abundance of information on accidents and injuries among young workers, much less is known about the incidence and risk factors for occupational diseases in these individuals. A systematic review conducted in 2006 identified just 19 studies on three common occupational illnesses (hand dermatitis, respiratory conditions and toxic exposures) [15]. This might be partly due to the lack of national reporting systems for occupational diseases in many countries. In the UK, HSE data suggest that on average the risk of self-reporting [2] and diagnosing [16-19] occupational diseases among young workers is lower than their older counterparts. This, however, has to be interpreted with caution as unlike older workers, young workers have shorter employment histories and therefore illnesses that require higher cumulative exposure and/or latency periods to develop are less likely to be found in this group [12]. This is reflected by the predominance of acute onset diseases reported by young workers. According to the European Union labour force survey ad hoc module 1999, the most prevalent conditions affecting young workers are skin problems (16% of respondents), headache and eye strain (11%), infectious diseases (11%) and pulmonary disorders (9%) [12].

On the other hand, exposures starting at a young age may confer a higher risk of chronic occupational diseases with a long latency, than the same exposure occurring later in life, because of the resulting higher cumulative exposure. A British population-based case-control study has found that mesothelioma risk for exposure starting at age 20 is around twice as high as for the same exposure starting at age 30 [20]. In addition, there is evidence from cross-sectional data that anxiety and depression (not necessarily work-related) are more common among younger than older individuals [21, 22].

New workers

Among all young workers, new entrants to the workplace are perhaps the most neglected and yet the most vulnerable. A study examined compensation claims between 1986 and 1999 in British Columbia, Canada and found that in 1999 among workers aged 15 to 24, 23% of compensated injuries occurred in the first month on the job, and 50% within the first five months [23]. Lack of experience and training may play an important role for high incidence of accidents in new workers. On the other hand, as there are few prospective longitudinal studies following young individuals starting from day one at work, it is not clear whether these new workers, who are exposed to hazards for the first time, may face an

enhanced risk of workplace diseases with relatively short latency such as occupational asthma.

The temporality of the onset of common occupational diseases is less well-defined. The knowledge of this lead in time is important as removal from the cause can have a critical effect on prognosis, with delay being more likely to result in more severe condition and in some cases progressive worsening despite removal from that cause [24].

According to the British Occupational Health Research Foundation guidelines the majority of those who develop classical sensitising occupational asthma do so within two years of being first exposed to the specific agent [25]. An example of rapid onset is clearly demonstrated by a German study on rhinitis. Adolescents entering high risk occupations who are exposed to low molecular weight agents have an 80% increased risk of developing rhinitis compared to those who have never been exposed. This rapid onset is seen in those employed in high risk jobs for <10 months [26].

A prospective study of newly hired young coal miners in China showed a relatively sharp decrement in lung function (as forced expiratory volume in 1 s, FEV_1) during their first year of coal mining, followed by a plateau during the second year, and a partial recovery during their third year. A mean reduction of 22 mL/year was recorded among non-smoking miners who were 16-20 years, while during the same period an increase of 160 mL/year was observed among students of the same age range from a local mining technical school [27]. In another analysis of the same study sample (mean age 22.3±2.5 years, current smokers: 41%), incident bronchitic symptoms were significantly increased after 11 months of underground mining and stayed elevated thereafter, averaging 10.7%, compared with 1.3% during the first 11 months [28].

A Chinese [29] and a Turkish [30] study followed up young workers newly employed in cotton mills and both found significant declines in lung function in textile workers. Of particular note, acute cross-shift and cross-week changes in FEV_1 were apparent within the first week of exposure [30].

Equally important are the potential effects of pre-existing conditions on the risk of subsequent work-related illness incidence and severity, which remain largely unclear. For example, a history of low back pain is a predictor of future recurrence and delayed recovery [31, 32]. This lack of information hampers study of the natural history of work-place-related conditions. Understanding how new workplace entrants develop work-related illnesses will therefore inform the development of improvements in its primary prevention and management in the workplace and, consequently, lead to reductions in illness incidence and prevalence.

Determinants of job selection

As the first jobs could be important determinants of the subsequent health and well-being of young workers, it is important to recognise the distribution of these jobs, but also to understand the determinants of job selection itself. Personal characteristics such as academic achievement and career aspiration, which may interact with influences and

expectations from family and society obviously play key roles in the decision-making process. Current literature has focused on the expectations of employers and young people in terms of qualifications and attributes of skills ("employability skills"), but the level of understanding of workplaces and the particulars of jobs among young people still in education has only been explored by a few studies [33]. Work in the UK has found that young people receive little information and guidance about the consequences of pursuing particular occupational pathways [34], and those who are disadvantaged or living in rural areas have virtually no practical understanding of workplaces or the details of the jobs they aspire to [35, 36].

Cross-sectional epidemiological surveys may be biased by a "healthy worker effect" whereby workers tend to exhibit better health than the general population [37]. For example, volunteer miners working in underground coal mines in the USA were found to be less likely to respond to methacholine challenge with increasing dust exposure, as estimated by duration of work at the coal face [38]. This may be explained partly by the health-based selection *out of* the workforce (survivor effect), and partly by the health-based selection *into* the workforce (healthy hire effect) [39].

Pre-employment self-selection (and potentially restriction) has important implications for many occupational conditions where removal or reduction of exposure may be difficult, e.g. occupational asthma, rhinitis and dermatitis. However, few studies have investigated the factors that influence career choices in adolescents. In the German arm of the International Study of Asthma and Allergies in Childhood [40] teenagers with rhinitis chose high risk jobs less frequently than did those with asthma while a Dutch study found a small effect of pre-existing disease on job selection [41]. A larger Swedish study, which took advantage of linked national datasets, showed that adolescents with asthma tended to avoid high risk jobs (odds ratio [OR] = 0.88, 95% confidence interval [CI] 0.71-1.09) and that this effect was even more marked in those with pre-existing rhinitis (OR = 0.58, 95% CI 0.47-0.70) [42].

Two recent publications aimed to explore the healthy hire effect among young adults with asthma [43, 44]. The European Community Respiratory Health Survey analysed data from 19,874 adults (mean age at survey: 33.6±6.9 years) and investigated the association between onset of asthma before completion of full time education and exposure at first occupation (estimated by job exposure matrices). The results suggested a lower risk of high occupational exposure to dusts, gases or fumes among individuals with asthma presenting before completion of full-time education (OR = 0.79; 95% CI 0.68-0.92) [43]. A similar conclusion was drawn from the French Epidemiological Study on the Genetics and Environment of Asthma (n = 298), in which individuals with asthma onset before first employment and parental asthma history had a significantly lower risk of exposure at the first occupation compared to those without (OR = 0.48, 95% CI 0.25-0.89) [44]. It is worth noting that only in the latter study participants were recruited in their childhood, an important measure to avoid various biases, particularly selection and recall biases.

The recent call by Le Moual and colleagues [39] for prospective studies of new entrants to the workforce to be conducted, optimally with prospective exposure assessment, is timely. Such studies would provide better indicators of risk factors for development of occupational ill health while providing measures of outcome. In the UK the Avon Longitudinal Study of Parents and Children (ALSPAC) [45-47], a large cohort of young persons well-characterised

in terms of their health, lifestyle, and socioeconomic background from birth, is ideal to provide such an approach.

Aims

The APPRENTICE study (*APPR*aisal of the health of new *ENT*rants *I*nto the workpla*CE*) is designed in an attempt to inform the study of the natural history of work-place-related conditions, taking advantage of the renowned ALSPAC birth cohort [45-47] whose participants (born between 1991 and 1992) are now in their early adulthood.

The study aimed to investigate the factors associated with occupational choice, including influence of past behavioural patterns and psychosocial factors, pre-existing conditions, attainment at school, socioeconomic status, and risk factors for developing certain conditions. In addition, the impact on health (in terms of incident asthma and accidents) by occupation following starting work is assessed. Finally, the effect of pre-existing conditions (particularly respiratory-related and histories of injuries) on the incidence of conditions and accidents following starting work is determined.

Specifically our original aims were:

1.What factors are associated with the decision to continue in further education or to enter the workplace within the ALSPAC subjects?

2. What is the spread of occupations and what are the factors associated with occupational choice?

3. What is the incidence of respiratory conditions (new asthma and new wheezing), skin symptoms/dermatitis, and newly recorded or recurrent mental ill-health by occupational group following starting work?

4. What is the incidence of accidents at work by occupational group?

5. What is the effect of pre-existing conditions (respiratory and mental, and history of injuries) on the incidence of conditions and accidents following starting work?

Methods

Description of ALSPAC cohort

The Avon Longitudinal Study of Parents and Children (ALSPAC, originally named *Avon Longitudinal Study of Pregnancy and Childhood*) is a long term, prospective birth cohort study initiated by Professor Jean Golding at the University of Bristol, designed to examine environmental and genetic influences on the health and development of young children [45].

Full particulars of the setting and recruitment have been detailed in two cohort profiles published elsewhere [46, 47]. In brief, all pregnant women residing in the three Bristol-based health administration districts (Southmead, Frenchay, and Bristol and Weston) of the former administrative county of Avon whose expected date of delivery was between 1 April 1991 and 31 December 1992 were eligible. This area (population 0.94 million in 1991) includes the City of Bristol and surrounding urban and rural areas, including towns, villages and farming communities; but excludes the area of Avon around the City of Bath. Pregnant women migrating into the catchment area were eligible up to the point of delivery; those migrating out of the catchment area prior to delivery were excluded unless they had completed the questionnaire scheduled for the third trimester of pregnancy.

Recruitment to ALSPAC was opportunistic through media information and routine antenatal and maternity health services. At the time of the recruitment campaign, there was no available sampling frame to support systematic invitation of eligible ALSPAC target sample. As a result, the eligible study sample (n = 20,248) was defined retrospectively based on ALSPAC recruitment records and maternity, birth and child health records. During the 21-month recruitment process, 16,734 pregnancies (82.6%) were known and contacted, of which 14,541 were enrolled, forming the core sample of the ALSPAC cohort.

Subsequently, at age 7 years of the ALSPAC participants, 5707 eligible pregnancies who were not known (n = 3514) or not enrolled at baseline (n = 2193), excluding those who had previously refused recruitment, were invited to “Focus@7” assessment visit. An additional 452 pregnancies (456 children) were recruited during this systematic recruitment Phase II. Further effort was made by opportunistic contacting those who were eligible but had not been enrolled. A further 254 pregnancies (257 children) were enrolled between ages 8-18 years (Phase III recruitment). The final enrolled sample consists of 15,247 pregnancies, giving an overall recruitment rate of 75.3%.

Of the 14,541 pregnancies in the core sample, 69 outcomes were unknown, 195 were twins, 3 were triplets and 1 was quadruplets, giving a total of 14,676 foetuses, resulting in 14,062 live-born children of whom 13988 were alive at 1 year of age. Recruitment at Phase II (age 7 years) and III (age 8-18 years) added 456 and 257 children into the cohort, respectively. Overall, the ALSPAC sample consists of 14,775 live births, with 14,701 alive at age 1 (72.1% of 20390 eligible children/foetuses).

Protocols of the ALSPAC study were approved by the Ethics Committees of United Bristol Healthcare Trust and Frenchay and Southmead Healthcare Trusts. Informed consent or assent had been obtained from adult participants.

Methods in the APPRENTICE study

Participants

Over the course of time, attrition (due to refusal to continue participation or loss of contact) and diminishing response has been observed at each follow up time point. By the time the "Your Changing Life" questionnaire (at 18.5 years) was sent, the total number of participants remaining in ALSPAC was 9991 (response rates for individual questionnaires are given in the following paragraphs). As baseline information (completed by mothers during pregnancy) and certain questionnaires were omitted for the pregnancies recruited in Phases II and III, these 713 children are excluded in the current analysis. In addition, for reasons of confidentiality, data on 13 triplet and quadruplet children are not released by ALSPAC. Subsequently, the present investigation is restricted to singletons and twins in the core recruitment (n = 13,978).

Measurements

The ALSPAC study is notable for the breadth and depth of information it has obtained and the frequency of measurements it has undertaken. Data available included biological samples, clinical records and postal questionnaires completed by the mothers, partners and children collected at multiple time points (68 data collection time points between birth and 18 years of age). This allows the assessment of changes in various aspects (in particular, health and wellbeing) across the key development phases of the children (grouped retrospectively as infancy [≥4 weeks and ≤2 years], early childhood [>2 years and <7 years], childhood [7 years], late childhood [>7 years and <13 years], adolescence [≥13 years and <16 years], and transition to adulthood [≥16 years and ≤18 years]).

The majority of this report is based on data from a questionnaire at age 16.5 years "**Life of a 16+ Teenager**" completed by the study participants and one questionnaire at age 18.5 years: "**Your Changing Life**" completed by the young person. In addition, this report also makes use of information collected at baseline (completed by the mother during gestation) and from the "**Travelling, Leisure and School**" questionnaire, completed by the study participants at 13 years 10 months (166 months). Apart from questionnaire data, clinical measurements from "**Teen Focus 3**" at 15.5 years (186 months) were included.

A brief description of the measurement points (questionnaires and clinic visit) is given below. In the subsequent text, the questionnaires are referred to by their respective codenames.

Travelling, Leisure and School (CCP questionnaire)

The “Travelling, Leisure and School” questionnaire was sent out to study participants when they were 166 months old. There are 10 sections in this questionnaire. Relevant to this report is Section J, in which the participants were asked about their plans and thoughts for the future, including their intention to stay on or to leave full time education at age 16, and what they would do if they leave education. In addition, a number of questions aiming to capture their views on job and career development were included.

The questionnaire were sent out to 10,752 cohort members, of whom 6908 (64.2%) completed and returned. Data from 6593 respondents are included in this report.

Teen Focus 3 (TF3)

Teen Focus 3 was a clinic visit aiming to collect clinical measurements at 15.5 years. The visit was four hours long and included spirometry among other measurements. Only self-reports of physician-diagnosis of asthma and lung function data were relevant to this investigation.

Invitation letter was sent to 10,692 participants and the clinic was attended by 5515 (51.6%) cohort members. Data from 5247 respondents are included in this report.

Life of a 16+ Teenager (CCS questionnaire)

The “Life of a 16+ Teenager” is a questionnaire completed when the study participants were 198 months old. It is a comprehensive with 15 sections. For the purpose of this investigation, the following information was obtained: Section A, how the respondents spend their time; Section B, the 11 item Chalder Fatigue Scale [48]; Section C, life events; Section F, alcohol use; Section G, smoking and drug use; Section I, asthma and allergies; Section M, transport use and accidents and Section N, employment and occupation.

Questionnaires were sent out to 9994 participants, of which 5131 (51.3%) were completed and returned. Information from 4901 respondents is presented in this report.

Your Changing Life (CCT questionnaire)

The “Your Changing Life” questionnaire was sent to the study participants at approximately 18.5 years, consisting of 7 sections. Of interest to this study are Section A, how the respondents spend their time; Section B, education and university and employment including voluntary work; Section C, health-related quality of life (using the SF-36v2 Health Survey [49] and a series of questions about wheezing and asthma; Section D, weight loss and eating disorders; Section E, smoking, alcohol and other drug use; Section F, travelling to/from school/work and different types of accidents.

The questionnaire was sent to 9991 participants. Subsequently, 3377 (33.8%) were completed and returned. A total of 3228 respondents are included in this investigation.

Main variables and their derivation

Ethnicity

Ethnic background of the cohort members was derived from the response to the question "How would you describe the race or ethnic group of yourself, your partner and your parents?" by their mothers at 32 weeks gestation. Participants were categorised as white if both their mother and partner (biological father) were white. All other combinations of ethnic group were categorised as non-white. Missing data were grouped as "not specified".

Socioeconomic status

Information on socioeconomic status was obtained from the study participants' mothers at 32 weeks gestation. Social class was classified according to the Registrar General's Social Class based on Occupation [50] into four categories: (I) professional; (II) managerial and technical; (IIIN/IIIM) skilled non-manual or manual; and (IV/V) semi-skilled or unskilled manual. The IIIN and IIIM were combined, as were IV and V, because of the smaller numbers in these categories, consistent with a previous study using ALSPAC data [51]. The highest social class of either parent was used to define parental social class.

Substance use

Information on the history, frequency and quantity of tobacco, alcohol and cannabis use was collected in both CCS and CCT questionnaires.

Tobacco use was evaluated by the question "Have you ever smoked a cigarette (including roll-ups)?" which differentiated between never smokers and ever smokers. Ever smokers were further classified into experimenters (those who had smoked less than 100 cigarettes in their lifetime) and established smokers (those who had smoked 100 cigarettes or more) [52].

Binge drinking was defined as ever consuming ≥5 drinks in a day for males (16 and 18 years) and ≥3 drinks for females at 16 years and ≥5 drinks for females at 18 years. The thresholds were chosen to reflect blood alcohol concentration 2 hours after peak level of ≥80 mg/dL as a measure of alcohol intoxication, consistent with the National Institute of Alcohol Abuse and Alcoholism criteria [53].

Questions on the habits on the use of cannabis were framed differently in CCS and CCT questionnaires. For the purpose of this report, regular users of cannabis at 16 years were defined as those using cannabis ≥5 times in total; and at 18 years, those who used cannabis at least once monthly in the previous 12 months.

Career and future aspirations

In the CCP questionnaire, the study participants were asked about their plans and thoughts for the future, including their intention to stay on or to leave full time education at the age of 16, and what they would do if they leave education. In addition, a number of questions aiming to capture their views on job and career development were included. The mothers (or carers) were also asked to comment on the aspirations and expectations for the children's future in the TC questionnaire.

Education

The study participants were asked in the CCS questionnaire whether they were currently in full time education and whether they were to continue to higher education. If they had left education, the reason for leaving was queried. Similar questions were asked in the CCT questionnaire, with additional questions on whether the participants had obtained or were studying for vocational qualifications, as well as the reasons for the change in their plans since the previous survey.

Employment history

In CCS file, the study participants were asked to report their current employment status and the particulars of the current and previous full time or part time paid jobs they had held, including the main tasks they were responsible were, and the duration for these employments. A similar set of questions was repeated in CCT file, with a separate set questioning the current and previous voluntary work the participants had done.

Job titles, recorded as free text, were coded according to the Standard Occupational Classification (SOC) 2010 [54] using the CASCOT (Computer Assisted Structured Coding of Text) software (Warwick Institute for Employment Research) by the author (KBHL). The CASCOT software automatically compares the job title to the words in the classification, and provides a list of recommended SOC2010 codes, sorted by a score (1-100) based on the probability that the code recommended is correct. The quality of coding depends on the availability of qualifying terms in the job title that enable CASCOT to distinguish it from other categories. For example, if an ambiguous job title such as "engineer" is entered, CASCOT will attempt to recommend "engineer, mechanical" among others. As a result, the topmost recommendation may not necessarily be the correct code. To ensure the accuracy of coding, all coded output from CASCOT was manually checked by the author (KBHL) by taking into account of the information of the tasks provided by the respondents.

The SOC2010 is the most recent update of the occupation classification scheme in the United Kingdom since its first introduction in 1990 and revision in 2000 [54]. Jobs are classified into groups according to skill level (duration of training and qualifications required) and skill specialisation (field of knowledge required). The SOC2010 classification system has a hierarchical group structure, designed to bring together a range of jobs with similar skill levels and specialisations. There are nine major groups, 25 sub-major groups, 90 minor groups and 369 unit groups.

Under SOC2010, jobs are assigned 4-digit codes. Each digit corresponds to the groups aforementioned, respectively. The major and sub-major groups, and associated skill levels are presented in Table 1. As mandated by ALSPAC rules, codes having less than 5 cases must be aggregated to larger groups to prevent the identification of individuals. Therefore, we only presented SOC2010 codes held by 10 or more participants.

General health status

Self-assessed health status was reported by the respondents in both CCS and CCT questionnaires. In the latter, a health-related quality of life instrument, the Short Form (SF)-36 version 2 (SF-36v2) was included. The SF-36 is a commonly used generic health survey, which measures domains of functional health and well-being summarised in eight scales: physical functioning, physical role functioning, bodily pain, general health perceptions, vitality, social role functioning, emotional role functioning, and mental health [49]. Two summary measures, physical component summary score (PCS) and mental component summary score (MCS) were then aggregated from the eight scales. All scales and summary measures were normalised based on the 1998 United States population to a mean of 50 and a standard deviation of 10. A summary of the definitions of the scales is presented in Table 2. Details for deriving the scores can be found elsewhere [49].

Asthma symptoms

In CCS and CCT files, the respondents were asked specifically to report the presence of symptoms suggestive of asthma and atopy (wheezing, breathlessness, asthma, eczema, and hay fever) in the previous 12 months using questions similar to those used by the International Study of Asthma and Allergies in Childhood [55]. The participants were also asked to describe in further details about the frequency and severity of the episodes.

As self-reports of physician-diagnosed asthma were obtained at TF3, CCS and CCT, in the longitudinal analysis the persistence of asthma cases across two consecutive questionnaires (i.e. TF3 and CCS, and CCS and CCT) was taken into consideration. Individuals were grouped into persistent cases, emerging, remitting and non-cases. Persistent cases were those asthma reports that appeared in consecutive questionnaires. Emerging is defined as new cases reported in the later questionnaire but not the earlier (e.g. in CCS but not in TF3). Remitting cases were only reported in the earlier questionnaire but not in the later (e.g. in TF3 but not in CS). Non-cases refer to respondents who had not reported asthma at both time points.

Lung function

Lung function was measured at the TF3 clinic visit by means of spirometry using a Vitalograph 2120 pneumotachometer (Maids Moreton, UK), with calibration performed at the start of each day, as per the American Thoracic Society / European Respiratory Society

Table 1 SOC2010 Major groups, sub-major groups and skill levels

Code	Major group	Code	Sub-major group	Skill level
1	Managers, directors and senior officials	11	Corporate managers and directors	4
		12	Other managers and proprietors	3
2	Professional occupations	21	Science, research, engineering and technology professionals	4
		22	Health professionals	4
		23	Teaching and educational professionals	4
		24	Business, media and public service professionals	4
3	Associate professional and technical occupations	31	Science, engineering and technology associate professionals	3
		32	Health and social care associate professionals	3
		33	Protective service occupations	3
		34	Culture, media and sports occupations	3
		35	Business and public service associate professionals	3
4	Administrative and secretarial occupations	41	Administrative occupations	2
		42	Secretarial and related occupations	2
5	Skilled trades occupations	51	Skilled agricultural and related trades	3
		52	Skilled metal, electrical and electronic trades	3
		53	Skilled construction and building trades	3
		54	Textiles, printing and other skilled trades	3
6	Caring, leisure and other service occupations	61	Caring personal service occupations	2
		62	Leisure, travel and related personal service occupations	2
7	Sales and customer service occupations	71	Sales occupations	2
		72	Customer service occupations	2
8	Process, plant and machine operatives	81	Process, plant and machine operatives	2
		82	Transport and mobile machine drivers and operatives	2
9	Elementary occupations	91	Elementary trades and related occupations	1
		92	Elementary administration and service occupations	1

recommendations [56]. At least three forced expiratory manoeuvres were attempted in a sitting position with a nose clip before and 10 minutes after administration of bronchodilator (400 µg salbutamol) using a metered dose inhaler and a spacer (Volumatic). Flow-volume curves were reviewed by a respiratory physician (JH) to ensure adherence to standards. The

best measurements of forced expiratory volume in 1 s (FEV_1) and forced vital capacity (FVC) from three reproducible flow-volume curves were used for analyses. As the correlation between pre- and post-bronchodilator measurements was strong (r_{FVC} = 0.96; r_{FEV1} = 0.95), only the post-bronchodilator results are reported.

Sex-, age-, and height-adjusted z-scores for FEV_1, FVC and FEV_1/FVC were calculated by two methods. In the first method, a multi-ethnic reference equation for 3-95 years as recommended by the Global Lungs Initiative [57] was used. In the second method, the adjustments were made internally, as per described by Chinn and Rona [58], which has been adapted in a previous study on ALSPAC participants [59]. Regardless of the method, the z-scores were then used to derive the lower limit of normal (LLN), which is defined as the 5^{th} percentile of the distribution of z-scores (i.e. z = -1.645), and is used as a cut-point for lung function impairment [60].

Table 2 Summary of information about SF-36 scales

Scale	Definition	
	Lowest possible score	Highest possible score
Physical Component Summary		
Physical functioning	Very limited in performing all physical activities, including bathing or dressing	Performs all types of physical activities including the most vigorous without limitations due to health
Role physical	Problems with work or other daily activities as a result of physical health	No problems with work or other daily activities
Bodily pain	Very severe and extremely limiting pain	No pain or limitations due to pain
General health	Evaluates personal health as poor and believes it is likely to get worse	Evaluates personal health as excellent
Mental Component Summary		
Vitality	Feels tired and worn out all of the time	Feels full of pep and energy all of the time
Social functioning	Extreme and frequent interference with normal social activities due to physical and emotional problems	Performs normal social activities without interference due to physical or emotional problems
Role emotional	Problems with work or other daily activities as a result of emotional problems	No problems with work or other daily activities
Mental health	Feelings of nervousness and depression all of the time	Feels peaceful, happy, and calm all of the time

Accidents

The study participants were asked to report any accidents (fall, fracture, burn, ingestion, sports injury, other) that required medical attention in the last six months. In the CCT questionnaire, whether the participants had accidents at work in the last year was documented.

Statistical analysis

Cross tabulation with sex was performed and the results were presented as n (%) unless otherwise stated. P values were obtained by χ^2 test to elicit any differences across levels in categorical variables.

For the analysis of the possible relationship between pre-existing asthma and subsequent job selection, the presence of asthma was indicated by a positive response to the question at 16: “Have you or your parent ever been told by a doctor that you have asthma?”, or at 18: “Have you ever had asthma?” The respondents were also grouped into persistent cases, emerging, remitting, and non-cases as described previously under the heading *Asthma symptoms*.

Current job reported by the respondents at 16 years and 18 years were considered separately. Eighteen jobs that were identified to be associated with adult onset asthma in a study using data from the 1958 birth cohort [61] were grouped as high risk, while all other jobs were considered to be low risk. The high risk occupations, coded to the International Standard Classification of Occupations (ISCO-88) [62], were then mapped to SOC2010, with some ISCO codes mapped to more than one SOC code, as shown in Table 3.

A logistic regression model was then built to assess the association of self-reported physician-diagnosed asthma by age 16 with current high asthma risk occupation, with adjustment for a prior confounders including sex (male, female), ethnicity (white, non-white, not-specified), parental social class (I, II, IIIN/IIIM, IV/V), self-rated health status (excellent/very good/good, fair/poor), regular tobacco use (no, yes), and regular cannabis use (no, yes).

All analyses were undertaken using Stata version 11.2 (College Station, Texas, USA). P values were two-tailed and values < 0.05 were considered statistically significant.

Table 3 Occupations identified to be associated with high risk of adult onset asthma

ISCO-88 unit group		SOC2010 unit group	
5122	Cooks	5434	Chefs
		5435	Cooks
5123	Waiters, waitresses and bartenders	9273	Waiters and waitresses
		9274	Bar staff
5133	Home-based personal care workers	6145	Care workers and home carers
		6146	Senior care workers
		6147	Care escorts
5141	Hairdressers, barbers, beauticians	6221	Hairdressers and barbers
		6222	Beauticians and related occupations
5169	Protective services workers	3311	NCOs and other ranks
		3312	Police officers (sergeant and below)
		3313	Fire service officers (watch manager and below)
		3314	Prison service officers (below principal officer)
		3315	Police community support officers
		3319	Protective service associate professionals n.e.c.
6130	Market-oriented crop and animal producers	5111	Farmers
		5119	Agricultural and fishing trades n.e.c.
		9111	Farm workers
		9119	Fishing and other elementary agriculture occupations n.e.c.
7232	Aircraft engine mechanics and fitters	5235	Aircraft maintenance and related trades
7341	Compositors, typesetters	5421	Pre-press technicians
8263	Sewing machine operators	8137	Sewing machinists
9130	Cleaner unspecified	9231	Window cleaners
		9232	Street cleaners
		9233	Cleaners and domestics
		9235	Refuse and salvage occupations
		9236	Vehicle valeters and cleaners
		9239	Elementary cleaning occupations n.e.c.
9131	Domestic helpers and cleaners	9233	Cleaners and domestics
9132	Helpers and cleaners in offices, hotels	9233	Cleaners and domestics
9133	Hand-launderers and pressers	9234	Launderers, dry cleaners and pressers

Table 3 continued

ISCO-88 unit group		SOC2010 unit group	
9151	Messengers, package and luggage porters and deliverers	9211	Postal workers, mail sorters, messengers and couriers
		9271	Hospital porters
9152	Doorkeepers, watchpersons	9241	Security guards and related occupations
		9249	Elementary security occupations n.e.c.
9313	Building construction labourers	9120	Elementary construction occupations
9320	Manufacturing labourers	9139	Elementary process plant occupations n.e.c.
9322	Hand packers and other manufacturing labourers	9134	Packers, bottlers, canners and fillers

Results

Data were analysed both cross-sectionally (i.e. concerning only a single time point) and longitudinally (i.e. using data from multiple time points). CCS and CCT, the two main questionnaires of interest, were completed by 5087 and 3347 participants, respectively. For analyses involving multiple time points, we were interested in those who completed both CCS and CCT. A total of 2855 had completed both CCS and CCT questionnaires, while 2176 had available data across four time points (CCP, TF3, CCS and CCT).

Cross-sectional analysis

Demographic characteristics

Table 4 provides details of demographic information of the participants grouped by points of measurements. The full dataset consists of data from 13978 respondents, with 7220 males (51.7%) and 6758 females (48.4%). Of note, the response rate and the proportion of male participants fell in successive data collection points, particularly in CCT.

Compared to the full dataset, the subsets of data consisted of a higher proportion of white participants, and those who were first born. Those who responded in these follow-up questionnaires were also more likely to have parents of higher social classes, compared to the baseline data.

The demographic characteristics of the respondents in CCS and CCT files were largely similar, except sex. Despite the differences, within each data collection point the males and females were very similar in terms of gestational age, ethnic background, and parity, although parents of the male participants tended to have higher social class than their female counterparts.

Substance use

Table 5 presents the prevalence of substance use reported in CCS and CCT. About half (46.6%) of all 16 years respondents had ever smoked (including those only tried once or twice). The prevalence was significantly higher in females (53.8%) than in males (36.2%) ($p < 0.001$). If only those who had smoked 100 cigarettes or more were considered, the prevalence fell to 11.7% (male: 9.2%; female: 13.4%; $p < 0.001$). At 18 years, while the overall smoking prevalence was similar (47.3%), there was a rise in male smokers (to 42.5%) and a slight drop in female smokers (50.0%). There was also a substantial increase in established smokers (male: 16.3%; female: 19.7%).

The majority of the respondents reported to have tried alcoholic drinks, with 63.4% of the participants at 16 years and 52.4% of those at 18 years consuming more than the recommended limit in a day. The prevalence among females was statistically higher in the CCS file but there was no material sex difference at 18 years.

Table 4 Demographic characteristics of ALSPAC participants

Questionnaire/Visit	Whole cohort	Single time point				Multiple time points		
		CCP	TF3	CCS	CCT	CCP, CCS and CCT	CCS and CCT	CCP, TF3, CCS and CCT
Questionnaire/invitation								
Sent; n	-	10752	10692	9994	9991	-	-	-
Completed; n	-	6908	5515	5131	3377	-	-	-
Response rate; %	-	64.2	51.6	51.3	33.8	-	-	-
Included in this report; n	13978	6593	5247	4901	3228	2584	2749	2090
Sex; n (%)								
Male	7220 (51.7)	3016 (45.8)	2476 (47.2)	2013 (41.1)	1161 (36.0)	929 (36.0)	977 (35.3)	781 (37.4)
Female	6758 (48.4)	3577 (54.3)	2771 (52.8)	2888 (58.9)	2067 (64.0)	1655 (64.1)	1772 (64.5)	1309 (62.6)
Ethnic background; n (%)								
White	11474 (82.1)	6031 (91.5)	4774 (91.0)	4523 (92.3)	3000 (92.9)	2430 (94.0)	2572 (93.6)	1976 (94.6)
Non-white	601 (4.3)	250 (3.8)	212 (4.0)	181 (3.7)	121 (3.8)	84 (3.3)	94 (3.4)	66 (3.2)
Not specified	1903 (13.6)	312 (4.7)	261 (5.0)	197 (4.0)	107 (3.3)	70 (2.7)	83 (3.0)	48 (2.3)
Gestational age (weeks); mean (SD)	39.4 (1.9)	39.4 (1.8)	39.4 (1.9)	39.4 (1.9)	39.4 (1.8)	39.4 (1.8)	39.4 (1.8)	39.4 (1.9)
Parity; n (%)								
0	5772 (44.6)	3017 (47.2)	2482 (49.0)	2327 (48.8)	1537 (48.8)	1251 (49.4)	1333 (49.5)	1034 (50.4)
1	4539 (35.1)	2277 (35.6)	1753 (34.6)	1672 (35.0)	1102 (35.0)	891 (35.2)	942 (35.0)	708 (34.5)
≥2	2618 (20.3)	1096 (17.2)	832 (16.4)	773 (16.2)	514 (16.3)	393 (15.5)	420 (15.6)	309 (15.1)
Parental social class; n (%)								
I	1529 (13.3)	1031 (16.9)	825 (17.0)	875 (19.2)	611 (20.1)	515 (21.0)	543 (20.9)	411 (20.6)
II	4807 (41.9)	2759 (45.3)	2226 (45.9)	2085 (45.7)	1385 (45.6)	1131 (46.1)	1190 (45.8)	946 (47.4)
IIIN/IIIM	4470 (38.9)	2069 (34.0)	1600 (33.0)	1446 (31.7)	943 (31.1)	738 (30.1)	788 (30.3)	585 (29.3)
IV/V	677 (5.9)	232 (3.8)	197 (4.1)	161 (3.5)	97 (3.2)	69 (2.8)	80 (3.1)	54 (2.7)

CCP=year 13 questionnaire; TF3=clinic visit at year 15; CCS=year 16 questionnaire; CCT=year 18 questionnaire

Similar to smoking and drinking, the prevalence of ever and regular cannabis use was higher in female respondents at year 16. By the age of 18, 38.9% the participants admitted to have tried cannabis and 18.5% smoked at least monthly in the last 12 months.

Overall, 6.6% at 16 years and 6.3% at 18 years reported to smoke tobacco and cannabis and consume alcohol regularly. In the CCS questionnaire, multiple substance use was more common in females (7.0%) than in males (5.9%), but the situation was reversed in the CCT questionnaire (male: 7.5%; female: 5.6%).

Table 5 Prevalence of substance use at 16 and 18 years

Substance	Whole cohort	Male	Female	p (M v.F)
Completed at 16 years				
Tobacco; n (%)	4867	1995	2872	
Ever smoked	2268 (46.6)	722 (36.2)	1546 (53.8)	<0.001
Ever smoked ≥100 cigarettes	568 (11.7)	184 (9.2)	384 (13.4)	<0.001
Alcohol; n (%)	4885	2003	2882	
Ever consumed	4575 (93.7)	1826 (91.2)	2749 (95.4)	<0.001
Ever binge drinking	3095 (63.4)	998 (49.8)	2097 (72.8)	<0.001
Cannabis; n (%)	4853	1983	2870	
Ever smoked	1374 (28.3)	530 (26.7)	844 (29.4)	0.042
Ever smoked ≥5 times	726 (15.0)	326 (16.4)	400 (13.9)	0.016
Multiple substance use; n (%)	4892	2005	2887	
None	1671 (34.4)	934 (46.6)	747 (25.9)	
Any 1 substance	2354 (48.1)	752 (37.5)	1602 (55.5)	
Any 2 substances	536 (11.0)	201 (10.0)	335 (11.6)	
All 3 substances	321 (6.6)	118 (5.9)	203 (7.0)	<0.001
Completed at 18 years				
Tobacco; n	3216	1154	2062	
Ever smoked; n (%)	1520 (47.3)	490 (42.5)	1030 (50.0)	<0.001
Ever smoked ≥100 cigarettes; n (%)	595 (18.5)	188 (16.3)	407 (19.7)	0.016
Alcohol; n	3222	1156	1085	
Ever consumed; n (%)	3086 (95.8)	1099 (95.1)	1987 (96.2)	0.134
Ever binge drinking; n (%)	1688 (52.4)	603 (52.2)	1085 (52.5)	0.847
Cannabis; n	3217	1155	2062	
Ever smoked; n (%)	1250 (38.9)	447 (38.7)	803 (38.9)	0.893
Smoked at least monthly in past 12 months; n (%)	595 (18.5)	238 (20.6)	357 (17.3)	0.021
Multiple substance use; n (%)	3222	1156	2066	
None	1244 (38.6)	456 (39.5)	788 (38.1)	
Any 1 substance	1280 (39.7)	458 (39.6)	822 (39.8)	
Any 2 substances	496 (15.4)	155 (13.4)	341 (16.5)	
All 3 substances	202 (6.3)	87 (7.5)	115 (5.6)	0.023

General health

In both CCS and CCT questionnaires, the respondents' own assessments suggest in general they were in good health, although males were more likely to rate themselves as having "excellent" health and less likely to be "fair" (Table 6). Compared to the year 16 response, the perception of health status seemed to be poorer, as demonstrated by a decline in the proportion of "excellent" in both males and females.

In the year 18 questionnaire, SF-36v2 quality of life instrument was included. Scores of individual scales revealed that the respondents had little restrictions in physical activities (physical functioning), work or other daily activities (role physical) due to health. However, their less-than-excellent general health, limitations due to pain (bodily pain), the feeling of tiredness (vitality), nervousness and depression (mental health) could be a cause of concern. Overall, females had lower physical and mental component summary scores (indicating poorer health) than males, with the difference most marked in the mental score. Nevertheless, within each sex, the difference between the score and 50 (which is the norm) did not reach minimal important difference (typically 2.5 points), except mental component summary score in female.

Table 6 General health of the respondents at 16 and 18 years

	Whole cohort	Male	Female	p (M v.F)
Completed at 16 years; n	4871	1997	2874	
Self-rated health status; n (%)				
Excellent	1304 (26.8)	727 (36.4)	577 (20.1)	
Very good	1943 (39.9)	758 (38.0)	1185 (41.2)	
Good	1105 (22.7)	367 (18.4)	738 (25.7)	
Fair	427 (8.8)	117 (5.9)	310 (10.8)	
Poor	92 (1.9)	28 (1.4)	64 (2.2)	<0.001
Completed at 18 years; n	3215	1153	2062	
Self-rated health status; n (%)				
Excellent	639 (19.9)	340 (29.5)	299 (14.5)	
Very good	1338 (41.6)	490 (42.5)	848 (41.1)	
Good	839 (26.1)	229 (19.9)	610 (29.6)	
Fair	313 (9.7)	78 (6.8)	235 (11.4)	
Poor	86 (2.7)	16 (1.4)	70 (3.4)	<0.001
SF-36 sub scale score; mean (SD)				
Physical functioning	54.4 (7.4)	55.2 (5.5)	53.4 (7.4)	<0.001
Role physical	53.2 (6.1)	54.0 (4.9)	52.8 (6.7)	<0.001
Bodily pain	38.2 (4.1)	38.6 (3.7)	38.0 (4.2)	<0.001
General health	48.0 (7.8)	50.1 (6.8)	46.9 (8.1)	<0.001
Vitality	48.5 (9.1)	51.1 (8.4)	47.1 (9.1)	<0.001
Social functioning	50.8 (9.1)	52.6 (7.9)	49.8 (9.6)	<0.001
Role emotional	50.3 (9.6)	52.1 (8.0)	49.4 (10.2)	<0.001
Mental health	46.9 (9.9)	49.2 (9.0)	45.6 (10.1)	<0.001
SF-36 component summary score; mean (SD)				
Physical Component Summary	49.3 (5.6)	49.8 (4.5)	49.0 (6.0)	<0.001
Mental Component Summary	48.4 (10.7)	50.9 (9.3)	46.9 (11.2)	<0.001

Multiple substance use was associated with poorer health status. Those who reported to use tobacco, alcohol and cannabis regularly at 16 years were 4.8 times as likely to report fair or poor health compared to the never users (OR = 4.79, 95% CI 3.57-6.44). The corresponding OR at 18 years is 2.92 (95% CI 2.02-4.23). Both physical and mental component summary scores, in particular the latter, fell with increasing number of substances used.

Respiratory health

Around a quarter of the respondents had a previous diagnosis of asthma (23.8% in CCP, 26.1% in CCS and 23.0% in CCT). Male respondents had a higher prevalence than their female counterparts in all three occasions, although the difference in CCT was not statistically significant.

Nevertheless, among those with diagnosed asthma, female respondents appeared to have more severe asthma as evidenced by a higher proportion of females reporting more episodes of wheeze, the use of medication, and more frequent sleep disturbances at all three time points (Table 7).

Table 7 Respiratory health of the respondents at 15, 16 and 18 years

	Whole cohort	Male	Female	p (M v.F)
Completed at 15 years; n	4537	2144	2393	
Physician-diagnosed asthma; n (%)	1081 (23.8)	553 (25.8)	528 (22.1)	0.003
Of those with asthma, in the last 12 months; n (%):				
≥2 episodes of wheeze	313 (29.0)	142 (25.7)	171 (32.4)	0.015
Used medication ≥1 time	458 (42.4)	232 (42.0)	226 (42.8)	0.777
Completed at 16 years; n	4835	1974	2861	
Physician-diagnosed asthma; n (%)	1262 (26.1)	545 (27.6)	717 (25.1)	0.047
Of those with asthma, in the last 12 months; n (%):				
≥2 episodes of wheeze	258 (20.4)	93 (17.1)	165 (23.0)	0.009
Used medication ≥1 time	485 (38.4)	198 (36.3)	287 (40.0)	0.181
Sleep disturbed due to wheezing ≥1 night/week	42 (3.3)	7 (1.3)	35 (4.9)	<0.001
Completed at 18 years; n	3215	1154	2061	
Physician-diagnosed asthma; n (%)	740 (23.0)	275 (23.8)	465 (22.6)	0.413
Of those with asthma, in the last 12 months; n (%):				
1-3 episodes of wheeze	179 (24.2)	53 (19.3)	126 (27.1)	
4-12 episodes of wheeze	87 (11.8)	29 (10.6)	58 (12.5)	
>12 episodes of wheeze	42 (5.7)	8 (2.9)	34 (7.3)	0.001
Sleep disturbed due to wheezing ≥1 night/week	21 (2.8)	3 (1.1)	18 (3.9)	0.028

Lung function

At 15.5 years, study participants were invited to a clinic visit, during which spirometry was undertaken. The lung function indices, FEV_1 and FVC, and the ratio of the two indices FEV_1/FVC were lower than the predicted values estimated from a recently published reference equation generated from healthy individuals having the same sex, age, height and ethnic background [57] (Table 8).

When LLN (i.e. z = -1.645) was used to define lung function impairment, a substantial proportion of respondents fell in this group, with 18.4% of the males and 22.0% of the females with impaired FEV_1, while 26.3% and 27.6%, respectively had impaired FVC. A higher prevalence of lung function impairment was observed among females, although the difference was significant only in FEV_1. While both FEV_1 and FVC were substantially smaller than the predicted values, the ratio of the two, FEV_1/FVC, which is an indicator of airflow obstruction, was remarkably normal, since by definition LLN is the lowest 5th percentile of the distribution of z-scores.

However, if the lung function indices were adjusted internally, they conformed to a normal distribution with no obvious deviation, such that the prevalence of impairment remained to be approximately 5%, although the proportion of FEV_1/FVC < LLN was slightly more than what would be expected, with a non-significant predominance by females.

Table 8 Lung function of the respondents at 15 years

	Whole cohort	Male	Female	p (M v.F)
N	4002	1862	2140	
FEV_1 (L); mean (SD)	3.34 (0.74)	3.72 (0.75)	3.00 (0.54)	<0.001
FVC (L); mean (SD)	3.71 (0.85)	4.19 (0.84)	3.30 (0.85)	<0.001
FEV_1/FVC; mean (SD)	0.90 (0.07)	0.89 (0.08)	0.91 (0.07)	<0.001
z score calculated by the Global Lung Function 2012 equations [57]				
FEV_1 z score; mean (SD)	-0.40 (2.94)	-0.38 (2.68)	-0.41 (3.15)	0.792
FVC z score; mean (SD)	-0.67 (2.75)	-0.69 (2.76)	-0.65 (2.75)	0.671
FEV_1/FVC z score; mean (SD)	0.46 (1.22)	0.52 (1.24)	0.40 (1.19)	0.003
FEV_1 < LLN; n (%)	801 (20.3)	338 (18.4)	463 (22.0)	0.005
FVC < LLN; n (%)	1078 (27.0)	489 (26.3)	589 (27.6)	0.356
FEV_1/FVC < LLN; n (%)	191 (4.9)	83 (4.5)	108 (5.1)	0.368
z score calculated according to Chinn and Rona [58]				
FEV_1 z score; mean (SD)	0.02 (0.98)	0.01 (0.99)	0.03 (0.97)	0.591
FVC z score; mean (SD)	0.02 (0.98)	0.01 (0.99)	0.03 (0.97)	0.488
FEV_1/FVC z score; mean (SD)	0.01 (0.97)	0.004 (0.97)	0.007 (0.99)	0.921
FEV_1 < LLN; n (%)	226 (5.7)	103 (5.6)	123 (5.8)	0.753
FVC < LLN; n (%)	229 (5.7)	117 (6.3)	112 (5.2)	0.154
FEV_1/FVC < LLN; n (%)	273 (6.9)	114 (6.2)	159 (7.5)	0.097

Accidents

Table 9 shows the incidence of accidents or injuries in the 6 months prior to the CCS and CCT questionnaires. At 16 years, 20.7% of the respondents had accidents or injuries that required medical attention, with the figure significantly higher in males (25.1%) than females (17.7%). Sports-related injury (12.0%) was the most common type of accident, predominantly reported by males. It is unclear about the nature and the site of these sports injuries as no further information was obtained from the questionnaire. However, those reporting sports injuries were 10 times as likely to report also fall or fracture (OR = 10.1, 95% CI 8.1-12.6), and 3 times to report head injury (OR = 2.9, 95% CI 2.3-3.7) compared to those who did not.

Compared with the CCS file, fewer reports of accidents or injuries were documented in the CCT questionnaire, reported by 11.0% of the respondents. The decline was most marked in sports injury, with incidence of 3.3%, although the male predominance was still observed. On the other hand, head injury leading to unconsciousness since 17 years was 9.3%. Among those who worked in the previous year, 6.6% had accidents in the workplace.

Regular users of multiple substances were more likely to report accident/injury. At 18 years, the risk of accident/injury was significantly elevated even among those who only used one type of substance regularly compared to non-users.

Table 9 Reports of accidents and injuries at 16 and 18 years

	Whole cohort	Male	Female	p (M v.F)
Completed at 16 years; n	4844	1988	2856	
Any accident/injury in past 6 months; n (%)	1003 (20.7)	499 (25.1)	504 (17.7)	<0.001
Type of accident/injury; n (%)				
Fall	251 (5.2)	107 (5.4)	144 (5.0)	0.599
Bone fracture	216 (4.5)	115 (5.8)	101 (3.5)	<0.001
Burn or scald	88 (1.8)	33 (1.7)	55 (1.9)	0.496
Sports injury	583 (12.0)	345 (17.4)	238 (8.3)	<0.001
Other	228 (4.7)	87 (4.4)	141 (4.9)	0.365
Head injury resulting in loss of consciousness since 14 years; n (%)	398 (8.3)	221 (11.2)	177 (6.2)	<0.001
Completed at 18 years; n	3209	1151	2058	
Any accident/injury in past 6 months; n (%)	354 (11.0)	137 (11.9)	217 (10.5)	0.239
Type of accident/injury; n (%)				
Fall	84 (2.6)	19 (1.7)	65 (3.2)	0.010
Bone fracture	58 (1.8)	22 (1.9)	36 (1.8)	0.741
Burn or scald	14 (0.4)	2 (0.2)	12 (0.6)	0.092
Sports injury	106 (3.3)	62 (5.4)	44 (2.1)	<0.001
Other	149 (4.6)	56 (4.9)	93 (4.5)	0.655
Head injury resulting in loss of consciousness since 17 years; n (%)	295 (9.3)	113 (9.9)	182 (8.9)	0.346
Worked in previous year; n	2914	1005	1909	
Accidents at work in past year; n (%)	192 (6.6)	71 (7.1)	121 (6.3)	0.453

Future aspirations

Full time education at 16 years

At the age of 13, 88.2% of the study participants desired and perceived that they would stay on in full time education at 16 (Table 10). Females were more likely than males to desire or to perceive to remain in education. At 16 years, 91.8% of the respondents reported to be in full time education.

Table 10 Educational aspirations at 13 years and educational status at 16 years

	Whole cohort	Male	Female	p (M v.F)
Completed at 13 years				
Desired plan at 16 years; n (%)	6409	2921	3488	
Stay on in full time education	5652 (88.2)	2482 (85.0)	3170 (90.9)	
Leave full time education	757 (11.8)	439 (15.0)	318 (9.1)	<0.001
Perceived reality at 16 years; n (%)	6368	2899	3469	
Stay on in full time education	5616 (88.2)	2456 (84.7)	3160 (91.1)	
Leave full time education	752 (11.8)	443 (15.3)	309 (8.9)	<0.001
Completed at 16 years				
Respondents in full time education; n (%)	4852	1987	2865	
Yes	4456 (91.8)	1792 (90.2)	2664 (93.0)	
No	396 (8.2)	195 (9.8)	201 (7.0)	<0.001

Plan when leaving education at 16 years

In the CCP questionnaire, the participants were also asked about their desired plan should they leave education. Of those who responded to this question, about one-third stated their intention to work full time, with another 27% said they would be learning a trade and 18% considered modern apprenticeship. Just over one-fifth had other plans or had not yet made up their mind (Table 11). Not surprisingly, apprenticeship appeared to be more attractive to males than females.

University aspirations

Most participants at age 13 were confident that they would be going to university or college, with only 6.8% indicated it would be very unlikely or quite unlikely for them to study in higher education and another 5.9% being unsure (Table 12). By the time CCT questionnaire was administered (at 18.5 years), 57.6% of the respondents had applied to university, and among them three-quarters had secured a place at university.

Table 11 Respondents' desired plan and perception at 13 years if they leave education at 16 years

	Whole cohort	Male	Female	p (M v.F)
Desired plan at 16 years; n (%)	713	423	290	
Start work full time	237 (33.2)	127 (30.0)	110 (37.9)	
Start learning a trade	190 (26.7)	108 (25.5)	82 (28.3)	
Modern apprenticeship	131 (18.4)	93 (22.0)	38 (13.1)	
Be unemployed/sign on	6 (0.8)	4 (1.0)	2 (0.7)	
Other	149 (20.9)	91 (21.5)	58 (20.0)	0.022
Perceived reality at 16 years; n (%)	704	425	279	
Start work full time	244 (34.7)	133 (31.3)	111 (39.8)	
Start learning a trade	188 (26.7)	108 (25.4)	80 (28.7)	
Modern apprenticeship	131 (18.6)	97 (22.8)	34 (12.2)	
Be unemployed/sign on	17 (2.4)	10 (2.4)	7 (2.5)	
Other	124 (17.6)	77 (18.1)	47 (16.9)	0.006

Table 12 University aspirations of the respondents at 13 years and the reality at 18 years

	Whole cohort	Male	Female	p (M v.F)
Completed at 13 years				
Likelihood to go to university; n (%)	5629	2466	3163	
Very/quite likely	4915 (87.3)	2089 (84.7)	2826 (89.4)	
Very/quite unlikely	381 (6.8)	194 (7.9)	187 (5.9)	
Don't know	333 (5.9)	183 (7.4)	150 (4.7)	<0.001
Completed at 18 years				
Applied to university; n (%)	3198	1147	2051	
Yes	1843 (57.6)	651 (56.8)	1192 (58.1)	
No	1355 (42.4)	496 (43.2)	859 (41.9)	0.455
Respondents who applied to university				
Awarded a place at university; n (%)	1817	647	1170	
Yes	1378 (75.8)	482 (74.5)	896 (76.6)	
No	439 (24.2)	165 (25.5)	274 (23.4)	0.320

Attitude towards employment

In the CCP questionnaire, the participants were asked about their opinions on the importance of various aspects in the deciding the career they would pursue in the future. It might not be surprising that compared with females, a greater proportion of male respondents appeared to agree that to have a job (and a career as well) would be important to them. The results also suggest a sex difference in the job selection decision making

process. Males seemed to put more weight into factors that mattered to them, for instance higher income, getting promotion and being able to work for themselves, and less on altruistic considerations (a job that can help others) (Appendix Table A1).

By the age of 13, the overwhelming majority of the respondents agreed it was important to have a career, and 64% and 71% of the respondents had thought about their career and would not just wait and see where they would end up, respectively. Of note, 36% of the teenagers believed it was more important to do something that might help with their job later than to do something they might enjoy (Appendix Table A2).

Employment status

Data on employment are presented in Table 13. At age 16, only a minority of the teenagers (4.3%; male: 5.4%; female: 3.5%) had left full time education and engaged in full time or part time paid work (equivalent to 52.8% of the respondents not in school), with another 2.7% unemployed at the time of CCS and were seeking work (32.8% of those who left education). Among those who were still in full time education, 58.1% of them had worked for paid job in their spare time. The proportion was higher in females (63.6%) than in males (49.9%).

Table 13 Employment status at 16 and 18 years

	Whole cohort	Male	Female
Employment status at 16 years; n	4852	1987	2865
In full time education; n (%)			
Not employed	1867 (38.5)	898 (45.2)	969 (33.8)
Engaged in paid work	2589 (53.4)	894 (45.0)	1695 (59.2)
Not in full time education; n (%)			
Full time work	116 (2.4)	70 (3.5)	46 (1.6)
Part time work	93 (1.9)	38 (1.9)	55 (1.9)
Voluntary work	8 (0.2)	0 (0)	8 (0.3)
Seeking work	130 (2.7)	60 (3.0)	70 (2.4)
Disability/sickness	5 (0.1)	2 (0.1)	3 (0.1)
Not specified	44 (0.9)	25 (1.3)	19 (0.7)
Employment status at 18 years; n	3225	1159	2066
In education; n (%)			
Not employed	1140 (35.4)	475 (41.0)	665 (32.2)
Engaged in paid work	1029 (31.9)	302 (26.1)	727 (35.2)
Not in education; n (%)			
Full time work	513 (15.9)	192 (16.6)	321 (15.5)
Part time work	327 (10.1)	96 (8.3)	231 (11.2)
Work experience	9 (0.3)	2 (0.2)	7 (0.3)
Seeking work	152 (4.7)	72 (6.2)	80 (3.9)
Disability/sickness	11 (0.3)	2 (0.2)	9 (0.4)
Carer for family	13 (0.4)	2 (0.2)	11 (0.5)
Not specified	31 (1.0)	16 (1.4)	15 (0.7)

Compared to the previous time point, at age 18 a larger proportion of the respondents (26.0%; male: 24.9%; female: 26.7%) were working full time or part time. A very small fraction of respondents (0.3%) were participating in the work experience programme. These two groups together accounted for 80.4% of the teenagers who were not in education. Those unemployed and seeking work represented 4.7% of all respondents, or 14.4% of all who were not in education.

Spread of occupations

The study participants were requested to report their current job title if they were engaged in paid employment, including part time work. The results, categorised by SOC2010 major groups are presented in Table 14.

Of the 2798 teenagers who were in paid employment (either full time or part time) at the time of the CCS questionnaire, 2589 (92.5%) provided information of their current job title. Among them, the four most prevalent major groups were sales and customer service occupations (40.4%), elementary occupations (35.8%), caring, leisure and other service occupations (12.2%) and skilled trade occupations (4.8%). Sex difference was more obvious in the major groups associate professionals and technical occupations (male: 11.5%; female: 1.1%), caring, leisure and other service occupations (male: 8.2%; female: 14.4%), and sales and customer service occupations (male: 33.5%; female: 44.2%) than the others.

Individually there were 120 different SOC2010 codes, among which 26 codes were reported by 10 participants or more (Table 15). The most common job title in the CCS questionnaire was sales and retail assistants (SOC2010 code 7111), reported by 844 teenagers (32.6%). Other popular jobs included waiters and waitresses (SOC2010 code 9273) (n = 416; 16.1%), kitchen and catering assistants (9272) (n = 215; 8.3%), retail cashiers and check-out operators (7712) (n = 165; 6.4%), and cleaners and domestics (9233) (n =109; 4.2%).

When restricted to those who had left education (n = 199), there was 57 individual SOC2010 codes, of which only four were reported by 10 or more respondents. The prominent jobs were sales and retail assistants (SOC2010 code 7111) (n = 41; 20.6%), hairdressers and barbers (6221) (n = 22; 11.1%), carpenters and joiners (5315) (n = 10; 5.0%), and kitchen and catering assistants (9272) (n = 10; 5.0%).

In the CCT questionnaire, 1816 (96.7%) of the 1878 respondents who were employed reported their current job titles (Table 14). The three most common SOC2010 major groups were similar the same as those observed in the CCS file: sales and customer service occupations (41.9%), elementary occupations (25.8%) and caring, leisure and other service occupations (15.0%). However, administrative and secretarial occupations (6.2%) overtook skilled trade occupations (4.9%) to become rank fourth.

Similar trend of sex difference continued to be observed in associate professionals and technical occupations (male: 7.2%; female: 2.9%), caring, leisure and other service occupations (male: 8.8%; female: 17.7%), and sales and customer service occupations (male: 34.4%; female: 45.2%), with additional groups more likely to be males: managers, directors and senior officials (male: 1.3%; female: 0.3%), professional occupations (male:

1.8%; female: 0.6%), skilled trades occupations (male: 13.2%; female: 0.9%), and process, plant and machine operatives (male: 2.3%; female: 0.1%).

Only 28 of the 136 SOC2010 codes were shared by 10 or more teenagers (Table 16). Not surprisingly, the four most popular jobs were the same as those reported at 16 years, although the order was slightly altered. Topping the list was sales and retail assistants (n = 531; 29.2%), followed by waiter and waitresses (n = 149; 8.2%), retail cashiers and check-out operators (n = 148; 8.2%) and kitchen and catering assistant (n = 118; 6.5%). Bar staff (SOC2010 code 9274), which was the fifth most popular job (n = 92; 5.1%), was in the 19th place in the previous questionnaire. The same five jobs remained to be the most common jobs among those who had left education.

Table 14 Current job reported at the time of CCS and CCT questionnaires by sex and by education status

	Whole cohort	Sex		Education status	
		Male	Female	In education	Not in education
Current job at 16 years; n (%)					
Managers, directors and senior officials	5 (0.2)	5 (0.6)	0 (0)	5 (0.2)	0 (0)
Professional occupations	19 (0.7)	7 (0.8)	12 (0.7)	18 (0.8)	1 (0.5)
Associate professionals and technical occupations	77 (3.0)	50 (5.5)	27 (1.6)	72 (3.0)	5 (2.5)
Administrative and secretarial occupations	70 (2.7)	19 (2.1)	51 (3.1)	58 (2.4)	12 (6.0)
Skilled trades occupations	123 (4.8)	105 (11.5)	18 (1.1)	62 (2.6)	61 (30.7)
Caring, leisure and other service occupations	315 (12.2)	75 (8.2)	240 (14.4)	286 (12.0)	29 (14.6)
Sales and customer service occupations	1046 (40.4)	307 (33.5)	739 (44.2)	992 (41.5)	54 (27.1)
Process, plant and machine operatives	7 (0.3)	5 (0.6)	2 (0.1)	4 (0.2)	3 (1.5)
Elementary occupations	927 (35.8)	343 (37.5)	584 (34.9)	893 (37.4)	34 (17.1)
Current job at 18 years; n (%)					
Managers, directors and senior officials	11 (0.6)	7 (1.3)	4 (0.3)	3 (0.3)	8 (1.0)
Professional occupations	17 (0.9)	10 (1.8)	7 (0.6)	5 (0.5)	12 (1.5)
Associate professionals and technical occupations	76 (4.2)	40 (7.2)	36 (2.9)	33 (3.3)	43 (5.2)
Administrative and secretarial occupations	113 (6.2)	26 (4.7)	87 (6.9)	32 (3.2)	81 (9.9)
Skilled trades occupations	84 (4.6)	73 (13.2)	11 (0.9)	21 (2.1)	63 (7.7)
Caring, leisure and other service occupations	272 (15.0)	49 (8.8)	223 (17.7)	114 (11.5)	158 (19.2)
Sales and customer service occupations	761 (41.9)	191 (34.4)	570 (45.2)	492 (49.5)	269 (32.8)
Process, plant and machine operatives	14 (0.8)	13 (2.3)	1 (0.1)	7 (0.7)	7 (0.9)
Elementary occupations	468 (25.8)	146 (26.3)	322 (25.5)	288 (28.9)	180 (21.9)

Table 15 Most common jobs (by SOC2010 codes) at 16 years (≥10 respondents)

			Whole cohort		Not in education	
Major group	Code	Unit group	n (%)	Rank	n (%)	Rank
Sales and customer service occupations	7111	Sales and retail assistants	844 (32.6)	1	41 (20.6)	1
Elementary occupations	9273	Waiters and waitresses	416 (16.1)	2		
Elementary occupations	9272	Kitchen and catering assistants	215 (8.3)	3	10 (5.0)	3
Sales and customer service occupations	7112	Retail cashiers and check-out operators	165 (6.4)	4		
Elementary occupations	9233	Cleaners and domestics	109 (4.2)	5		
Caring, leisure and other service occupations	6122	Childminders and related occupations	96 (3.7)	6		
Elementary occupations	9211	Postal workers, mail sorters, messengers and couriers	94 (3.6)	7		
Caring, leisure and other service occupations	6211	Sports and leisure assistants	79 (3.1)	8		
Caring, leisure and other service occupations	6221	Hairdressers and barbers	50 (1.9)	9	22 (11.1)	2
Associate professionals and technical occupations	3442	Sports coaches, instructors and officials	47 (1.8)	10		
Caring, leisure and other service occupations	6139	Animal care services occupations n.e.c.	34 (1.3)	11		
Administrative and secretarial occupations	4159	Other administrative occupations n.e.c.	29 (1.1)	12		
Elementary occupations	9275	Leisure and theme park attendants	22 (0.9)	13		
Caring, leisure and other service occupations	6123	Playworkers	18 (0.7)	14		
Administrative and secretarial occupations	4216	Receptionists	18 (0.7)	15		
Caring, leisure and other service occupations	6125	Teaching assistants	14 (0.5)	16		
Skilled trades occupations	5315	Carpenters and joiners	13 (0.5)	17	10 (5.0)	3
Skilled trades occupations	5434	Chefs	13 (0.5)	17		
Professional occupations	2319	Teaching and other educational professionals n.e.c.	12 (0.5)	19		
Sales and customer service occupations	7114	Pharmacy and other dispensing assistants	12 (0.5)	19		
Elementary occupations	9274	Bar staff	12 (0.5)	19		
Skilled trades occupations	5314	Plumbers and heating and ventilating engineers	11 (0.4)	22		
Elementary occupations	9251	Shelf fillers	11 (0.4)	22		
Skilled trades occupations	5223	Metal working production and maintenance fitters	10 (0.4)	24		
Skilled trades occupations	5241	Electricians and electrical fitters	10 (0.4)	24		
Elementary occupations	9260	Elementary storage occupations	10 (0.4)	24		

Table 16 Most common jobs (by SOC2010 codes) at 18 years (≥10 respondents)

			Whole cohort		Not in education	
Major group	Code	Unit group	n (%)	Rank	n (%)	Rank
Sales and customer service occupations	7111	Sales and retail assistants	531 (29.2)	1	165 (20.1)	1
Elementary occupations	9273	Waiters and waitresses	149 (8.2)	2	50 (6.3)	3
Sales and customer service occupations	7112	Retail cashiers and check-out operators	148 (8.2)	3	52 (6.3)	2
Elementary occupations	9272	Kitchen and catering assistants	118 (6.5)	4	37 (4.5)	4
Elementary occupations	9274	Bar staff	92 (5.1)	5	37 (4.5)	4
Caring, leisure and other service occupations	6211	Sports and leisure assistants	51 (2.8)	6	14 (1.7)	12
Caring, leisure and other service occupations	6145	Care workers and home carers	49 (2.7)	7	34 (4.1)	6
Administrative and secretarial occupations	4159	Other administrative occupations n.e.c.	39 (2.2)	8	32 (3.9)	7
Elementary occupations	9233	Cleaners and domestics	33 (1.8)	9	16 (2.0)	10
Caring, leisure and other service occupations	6121	Nursery nurses and assistants	31 (1.7)	10	27 (3.3)	8
Administrative and secretarial occupations	4216	Receptionists	28 (1.5)	11	13 (1.6)	14
Caring, leisure and other service occupations	6221	Hairdressers and barbers	27 (1.5)	12	19 (2.3)	9
Associate professionals and technical occupations	3442	Sports coaches, instructors and officials	23 (1.3)	13		
Sales and customer service occupations	7130	Sales supervisors	23 (1.3)	13	15 (1.8)	11
Sales and customer service occupations	7211	Call and contact centre occupations	19 (1.1)	15	14 (1.7)	12
Caring, leisure and other service occupations	6123	Playworkers	17 (0.9)	16		
Skilled trades occupations	5241	Electricians and electrical fitters	15 (0.8)	17	12 (1.5)	15
Caring, leisure and other service occupations	6139	Animal care services occupations n.e.c.	15 (0.8)	17		
Elementary occupations	9260	Elementary storage occupations	15 (0.8)	17	12 (1.5)	15
Caring, leisure and other service occupations	6125	Teaching assistants	14 (0.8)	20		
Caring, leisure and other service occupations	6222	Beauticians and related occupations	14 (0.8)	20		
Skilled trades occupations	5434	Chefs	13 (0.7)	22	10 (1.2)	17
Sales and customer service occupations	7114	Pharmacy and other dispensing assistants	12 (0.7)	23		
Elementary occupations	9275	Leisure and theme park attendants	12 (0.7)	23		
Elementary occupations	9251	Shelf fillers	11 (0.6)	25		
Administrative and secretarial occupations	4123	Book-keepers, payroll managers and wage clerks	10 (0.6)	26		
Caring, leisure and other service occupations	6122	Childminders and related occupations	10 (0.6)	26		
Caring, leisure and other service occupations	6141	Nursing auxiliaries and assistants	10 (0.6)	26		

Longitudinal analysis

Educational aspirations

When the responses in CCP and CCS questionnaires were compared (Table 17), 94.4% of those who desired to and 94.6% of those who perceived to stay on in full time education ended up remaining in education at 16 years. Interestingly, while a small number of respondents at 13 years thought they would leave education, the majority of these individuals (just over 70%) actually stayed on. A substantially higher proportion of males than females who intended to leave education did so.

Table 17 Educational aspirations at 13 years and educational status at 16 years

Completed at 13 years	In full time education at 16 years		
	Yes	No	p
Whole cohort			
Desired plan at 16 years; n (row %)	3907	323	
Stay on in full time education	3621 (94.4)	217 (5.7)	
Leave full time education	286 (73.0)	106 (27.0)	<0.001
Perceived reality at 16 years; n (row %)	3894	315	
Stay on in full time education	3617 (94.6)	207 (5.4)	
Leave full time education	277 (72.0)	108 (28.1)	<0.001
Male			
Desired plan at 16 years; n (row %)	1560	166	
Stay on in full time education	1426 (93.6)	97 (6.4)	
Leave full time education	134 (66.0)	69 (34.0)	<0.001
Perceived reality at 16 years; n (row %)	1556		
Stay on in full time education	1424 (94.2)	88 (5.8)	
Leave full time education	132 (65.0)	71 (35.0)	<0.001
Female			
Desired plan at 16 years; n (row %)	2347	157	
Stay on in full time education	2195 (94.8)	120 (5.2)	
Leave full time education	152 (80.4)	37 (19.6)	<0.001
Perceived reality at 16 years; n (row %)	2338	156	
Stay on in full time education	2193 (94.9)	119 (5.2)	
Leave full time education	145 (79.7)	37 (20.3)	<0.001

When linking the perception at CCP and the application status at CCT from the same participants, 93.7% who applied to university matched their judgement at 13 years but only 8.6% of those who did not apply had thought it was unlikely they would go to university (Table 18). This is in sharp contrast to another question in the CCT, which queried the participants whether they were doing what they had planned before they took GCSE. Of those who applied, 65.9% were doing as planned. The respective figure was 49.6% for those who did not apply to university. The most common reason cited (67%) for target not met was that they just changed their mind.

Table 18 Application to university by university aspirations

Completed at 13 years	Applied to university at 18 years		
	Yes	No	p
Whole cohort			
Likelihood to go to university; n (%)	1625	953	
Very/quite likely	1523 (93.7)	784 (82.3)	
Very/quite unlikely	38 (2.3)	82 (8.6)	
Don't know	64 (3.9)	87 (9.1)	<0.001
Male			
Likelihood to go to university; n (%)	562	341	
Very/quite likely	516 (91.8)	273 (80.1)	
Very/quite unlikely	13 (2.3)	27 (7.9)	
Don't know	33 (5.9)	41 (12.0)	<0.001
Female			
Likelihood to go to university; n (%)	1063	612	
Very/quite likely	1007 (94.7)	511 (83.5)	
Very/quite unlikely	25 (2.4)	55 (9.0)	
Don't know	31 (2.9)	46 (7.5)	<0.001

Employment status in CCS and CCT

Table 19 compares the employment pathway of respondents at the two time points. It is clear that between 16 years and 18 years, most of the respondents would remain in the same employment categories. However, closer scrutiny reveals that those who were employed in their spare time whilst in education at 16 years were more likely to quit education at 18 years than those who had no work experience (28.3% v. 18.8%). This difference was more apparent among males (28.5% v. 16.0%) than among females (28.3% v. 21.0%). In addition, a substantial proportion of those who left education and were unemployed at 16 years went back to education (52.8%).

Table 19 Comparison of employment status at 16 and 18 years

Employment status at 16 years	Employment status at 18 years			
	In education		Not in education	
	Not employed	Paid work	Paid work	Unemployed
Whole cohort; n (row %)	989	885	686	127
In education, not employed	525 (50.2)	260 (24.9)	197 (18.8)	64 (6.1)
In education, with paid work	441 (29.4)	590 (39.3)	425 (28.3)	44 (2.9)
Paid/voluntary work	7 (8.0)	23 (26.1)	52 (59.1)	6 (6.8)
Unemployed	16 (30.2)	12 (22.6)	12 (22.6)	13 (24.5)
Male; n (row %)	404	261	230	52
In education, not employed	261 (58.7)	86 (19.3)	71 (16.0)	27 (6.1)
In education, with paid work	134 (30.5)	160 (36.5)	125 (28.5)	20 (4.6)
Paid/voluntary work	2 (4.8)	9 (21.4)	28 (66.7)	3 (7.1)
Unemployed	7 (33.3)	6 (28.6)	6 (28.6)	2 (9.5)
Female; n (row %)	585	624	456	75
In education, not employed	264 (42.9)	174 (29.0)	126 (21.0)	37 (6.2)
In education, with paid work	307 (28.9)	430 (40.5)	300 (28.3)	24 (2.3)
Paid/voluntary work	5 (10.9)	14 (30.4)	24 (52.2)	3 (6.5)
Unemployed	9 (28.1)	6 (18.8)	6 (18.8)	11 (34.4)

Factors relating to employment

Socioeconomic status

To find out whether employment status at 16 and 18 years was related to socioeconomic status and health, a series of cross-tabulations were performed. Table 20 clearly shows that teenagers with higher socioeconomic status, as proxied by parental social class at 32 weeks of pregnancy, were more likely to stay in education and not be engaged in any employment. In contrast, those with the lowest socioeconomic status were mostly likely to leave education to work or remain unemployed.

Substance use

Those who were employed (regardless of whether they were in education) appeared to have a higher prevalence of substance use (Table 21). While those still in education but engaged in paid work in spare time had a moderately higher tobacco and alcohol use compared to those who did not work, the prevalence of tobacco and cannabis smoking was substantially higher among school leavers, especially those unemployed. This observation was consistent in teenagers at 16 years and 18 years. The pattern was even more obvious when focusing on the number of substances regularly used by the respondents. Those engaged in paid work working were more likely to be users of 1-2 substances, while those who had left education tended to use tobacco, alcohol and cannabis at the same time.

Table 20 Employment status by parent social class

	In education		Not in education	
Parental social class	Not employed	Paid work	Paid work	Unemployed
		Employment status at 16 years		
Whole cohort; n (row %)	1728	2435	207	118
I	411 (47.9)	430 (50.1)	9 (1.1)	8 (0.9)
II	769 (37.4)	1172 (56.9)	72 (3.5)	46 (2.2)
IIIN/IIIM	490 (34.7)	759 (53.7)	110 (7.8)	54 (3.8)
IV/V	58 (36.7)	74 (46.8)	16 (10.1)	10 (6.3)
Male; n (row %)	827	849	105	58
I	213 (54.9)	164 (42.3)	6 (1.6)	5 (1.3)
II	369 (42.9)	432 (50.2)	37 (4.3)	23 (2.7)
IIIN/IIIM	227 (42.0)	233 (43.1)	56 (10.4)	25 (4.6)
IV/V	18 (36.7)	20 (40.8)	6 (12.2)	5 (10.2)
Female; n (row %)	901	1586	102	60
I	198 (42.1)	266 (56.6)	3 (0.6)	3 (0.6)
II	400 (33.4)	740 (61.8)	35 (2.9)	23 (1.9)
IIIN/IIIM	263 (30.2)	526 (60.3)	54 (6.2)	29 (3.3)
IV/V	40 (36.7)	54 (49.5)	10 (9.2)	5 (4.6)
		Employment status at 18 years		
Whole cohort; n (row %)	1070	962	811	162
I	315 (52.1)	162 (26.8)	105 (17.4)	23 (3.8)
II	487 (35.4)	456 (33.2)	366 (26.6)	65 (4.7)
IIIN/IIIM	245 (26.3)	320 (34.4)	302 (32.4)	64 (6.9)
IV/V	23 (24.2)	24 (25.3)	38 (40.0)	10 (10.5)
Male; n (row %)	444	282	283	75
I	139 (56.7)	51 (20.8)	44 (18.0)	11 (4.5)
II	203 (39.9)	142 (27.9)	131 (25.7)	33 (6.5)
IIIN/IIIM	92 (30.4)	85 (28.1)	97 (32.0)	29 (9.6)
IV/V	10 (37.0)	4 (14.8)	11 (40.7)	2 (7.4)
Female; n (row %)	626	680	528	87
I	176 (48.9)	111 (30.8)	61 (16.9)	12 (3.3)
II	284 (32.8)	314 (36.3)	235 (27.2)	32 (3.7)
IIIN/IIIM	153 (24.4)	235 (37.4)	205 (32.6)	35 (5.6)
IV/V	13 (19.1)	20 (29.4)	27 (39.7)	8 (11.8)

General health

Health was also relevant to employment status in this ALSPAC population (Table 22). At 16 years, the distribution of health status was similar within the student groups (not employed / engaged in paid work), with a higher prevalence of excellent self-reported health among those in education and yet not employed. On the other hand, those school leavers were more likely to report good or fair health. In particular, those unemployed had the highest

Table 21 Employment status by substance use

Substance use	In education		Not in education	
	Not employed	Paid work	Paid work	Unemployed
Completed at 16 years	Employment status at 16 years			
Tobacco; n (%)	1854	2581	216	135
Ever smoked ≥100 cigarettes	152 (8.2)	298 (11.6)	63 (29.2)	42 (31.1)
Alcohol; n (%)	1863	2587	215	135
Ever binge drinking	1037 (55.7)	1773 (68.5)	141 (65.6)	87 (64.4)
Cannabis; n (%)	1849	2574	214	135
Ever smoked ≥5 times	230 (12.4)	379 (14.7)	52 (24.3)	45 (33.3)
Regular use of substances; n (%)	1867	2588	217	135
None	795 (42.6)	758 (29.3)	63 (29.0)	41 (30.4)
Any 1-2 substances	979 (52.4)	1672 (64.6)	123 (56.7)	65 (48.2)
All 3 substances	93 (5.0)	158 (6.1)	31 (14.3)	29 (21.5)
Completed at 18 years	Employment status at 18 years			
Tobacco; n (%)	1136	1025	847	176
Ever smoked ≥100 cigarettes	132 (11.6)	171 (16.7)	231 (27.3)	53 (30.1)
Alcohol; n (%)	1138	1027	849	176
Ever binge drinking	559 (49.1)	563 (54.8)	463 (54.5)	90 (51.1)
Cannabis; n (%)	1136	1025	848	176
Smoked at least monthly in past 12 months	167 (14.7)	170 (16.6)	204 (24.1)	49 (27.8)
Regular use of substances; n (%)	1138	1027	849	176
None	513 (45.1)	370 (36.0)	278 (32.7)	67 (38.1)
Any 1-2 substances	573 (50.4)	614 (59.8)	490 (57.7)	85 (48.3)
All 3 substances	52 (4.6)	43 (4.2)	81 (9.5)	24 (13.6)

prevalence of poor health. At 18 years, the respondents staying on in education had the best overall health, although the SF36 scales and summary scores were not discriminating between students and non-students. The unemployed had the lowest mental health scales and mental component summary score, which were distinctively different than the other three groups.

Self-reported health status across the jobs (in terms of SOC2010 major groups) held by the respondents at the time of the questionnaires was compared in Table 23. As the number in each major occupation group was small, the categories excellent, very good and good were combined. Overall, 88.5% of those who provided information on their job at 16 years and 87.0% at 18 years reported to have good health. Managers, directors and senior officials and process, plant and machine operatives stood out as the two major groups that had the largest proportion of reported fair or poor health at 16 years. In the CCT questionnaire, respondents employed in the skilled trades occupations were more likely to report poor health. However, no real difference was observed across the nine major groups.

Table 22 Employment status by general health of the respondents

	In education		Not in education	
	Not employed	Paid work	Paid work	Unemployed
	Employment status at 16 years			
Health status at 16 years; n (%)	1859	2582	215	132
Excellent	525 (28.2)	679 (26.3)	49 (22.8)	28 (21.2)
Very good	732 (39.4)	1073 (41.6)	74 (34.4)	34 (25.8)
Good	406 (21.8)	579 (22.4)	58 (27.0)	43 (32.6)
Fair	150 (8.1)	221 (8.6)	29 (13.5)	18 (13.6)
Poor	46 (2.5)	30 (1.2)	5 (2.3)	9 (6.8)
	Employment status at 18 years			
Health status at 18 years; n (%)	1132	1028	847	176
Excellent	240 (21.2)	178 (17.3)	187 (22.1)	27 (15.3)
Very good	496 (43.8)	453 (44.1)	311 (36.7)	66 (37.5)
Good	282 (24.9)	265 (25.8)	235 (27.7)	51 (29.0)
Fair	85 (7.5)	110 (10.7)	93 (11.0)	20 (11.4)
Poor	29 (2.6)	22 (2.1)	21 (2.5)	12 (6.8)
SF-36 scores; mean (SD)				
Physical functioning	54.5 (6.4)	54.3 (6.2)	53.9 (6.9)	51.8 (9.7)
Role physical	53.5 (5.9)	53.1 (6.0)	53.4 (5.8)	51.7 (8.7)
Bodily pain	38.5 (3.7)	38.2 (4.1)	38.0 (4.3)	37.7 (4.5)
General health	48.6 (7.6)	47.7 (8.0)	48.2 (7.7)	46.0 (8.5)
Vitality	49.2 (8.8)	48.1 (9.1)	48.5 (9.1)	46.8 (10.8)
Social functioning	51.3 (8.9)	50.8 (8.9)	50.9 (8.8)	47.3 (11.9)
Role emotional	50.2 (9.6)	50.2 (9.6)	51.4 (8.6)	47.2 (12.3)
Mental health	47.0 (9.3)	46.8 (9.6)	47.9 (10.0)	42.8 (12.5)
Physical Component Summary	49.8 (5.3)	49.2 (5.4)	48.8 (5.4)	48.7 (8.1)
Mental Component Summary	48.5 (10.4)	48.1 (10.7)	49.3 (10.3)	44.4 (13.6)

Respiratory health

In terms of respiratory health, asthma prevalence was similar across all groups although was a few percentage points higher among the 16-year-old unemployed (Table 24). However, those who left education and were employed had, in general, less severe asthma compared to those in education, as indicated by a lower proportion of frequent wheeze and medication use. When comparing the onset of asthma across employment status, those who left education had a marginally higher incidence of emerging and prevalent asthma, compared to those remaining in education.

As for the respondents of the CCT questionnaire, asthma prevalence appeared to be higher among the employed, which was a combination of a higher proportion of existing and of new cases. However, the severity of asthma in these individuals did not differ significantly from those staying in education and who were not employed.

Table 23 General health of the respondents by current job

Current job	Health status		
	Excellent/very good/good	Fair	Poor
Completed at 16 years; n (row %)	2313 (88.5)	260 (10.0)	41 (1.6)
Managers, directors and senior officials	4 (80.0)	1 (20.0)	0 (0)
Professional occupations	19 (95.0)	1 (5.0)	0 (0)
Associate professionals and technical occupations	74 (92.5)	5 (6.3)	1 (1.3)
Administrative and secretarial occupations	58 (84.1)	8 (11.6)	3 (4.4)
Skilled trades occupations	114 (89.8)	10 (7.9)	3 (2.4)
Caring, leisure and other service occupations	286 (88.8)	33 (10.3)	3 (0.9)
Sales and customer service occupations	909 (86.4)	127 (12.1)	16 (1.5)
Process, plant and machine operatives	4 (57.1)	1 (14.3)	2 (28.6)
Elementary occupations	845 (90.7)	74 (7.9)	13 (1.4)
Completed at 18 years; n (row %)	1671 (87.0)	207 (10.8)	42 (2.2)
Managers, directors and senior officials	10 (90.9)	1 (9.1)	0 (0)
Professional occupations	16 (88.9)	2 (11.1)	0 (0)
Associate professionals and technical occupations	82 (92.1)	5 (5.6)	2 (2.3)
Administrative and secretarial occupations	102 (86.4)	15 (12.7)	1 (0.9)
Skilled trades occupations	73 (83.9)	11 (12.6)	3 (3.5)
Caring, leisure and other service occupations	255 (87.9)	29 (10.0)	6 (2.1)
Sales and customer service occupations	664 (85.2)	96 (12.3)	19 (2.4)
Process, plant and machine operatives	14 (93.3)	1 (6.7)	0 (0)
Elementary occupations	455 (88.7)	47 (9.2)	11 (2.1)

Onset of asthma (proxied by time of report) across the major occupation groups is shown in Table 25. At age 16, associate professionals and technical occupations, and sales and customer service occupations appeared to have a smaller proportion of persistent cases, but a higher incidence of asthma between 15 and 16 years. Of note, the incidence was comparatively higher among those engaged in elementary occupations. On the other hand, professional occupations seemed to have the highest proportion of persistent cases, although the actual number was small.

At age 18, professional occupations had the highest proportion of persistent cases, followed by administrative and secretarial occupations. Incidence of asthma was low, both in terms of rate and absolute numbers. Interestingly remission was on the rise compared to 16 years, with the highest rates reported by those in managers, directors and senior officials, caring, leisure and other service occupations, and associate professionals and technical occupations.

The respondents of the CCT questionnaire were asked whether asthma had led to time lost from work and to estimate the number of days lost (Table 26). There was no obvious relationship between prevalence of asthma or the major occupation group and the proportion of respondents reporting time lost from work. Of all respondents who had asthma, 3.3% had lost time due to the condition, losing a median of 2 days (IQR 1.5) from work. Table 26 also shows the unit groups (4 digit SOC2010 codes) where there were at least 10 respondents.

Table 24 Employment status by respiratory health of the respondents

	In education		Not in education	
	Not employed	Paid work	Paid work	Unemployed
	Employment status at 16 years			
Completed at 16 years; n	1844	2570	210	132
Ever diagnosed asthma; n (%)	470 (25.5)	672 (26.2)	57 (27.1)	40 (30.3)
Of those with asthma, in the last 12 months; n (%):				
≥2 episodes of wheeze	94 (20.0)	145 (21.6)	7 (12.3)	7 (17.5)
Used medication ≥1 time	166 (35.3)	279 (41.5)	18 (31.6)	11 (27.5)
Sleep disturbed due to wheezing ≥1 night/week	15 (3.2)	23 (3.4)	1 (1.8)	2 (5.0)
Completed at 15 and 16 years; n (%)	1150	1679	131	72
Persistent cases	239 (20.8)	339 (20.2)	31 (23.7)	17 (23.6)
Emerging	60 (5.2)	110 (6.6)	9 (6.9)	6 (8.3)
Remitting	32 (2.8)	48 (2.9)	5 (3.8)	0 (0)
Non-cases	819 (71.2)	1182 (70.4)	86 (65.7)	49 (68.1)
	Employment status at 18 years			
Completed at 18 years; n	1134	1028	846	175
Ever diagnosed asthma; n (%)	240 (21.2)	253 (24.6)	198 (23.4)	39 (22.3)
Of those with asthma, in the last 12 months; n (%):				
1-3 episodes of wheeze	60 (25.0)	66 (26.1)	43 (21.7)	8 (20.5)
4-12 episodes of wheeze	12 (13.3)	31 (12.3)	21 (10.6)	3 (7.7)
>12 episodes of wheeze	11 (4.6)	17 (6.7)	9 (4.6)	5 (12.8)
Sleep disturbed due to wheezing ≥1 night/week	4 (1.7)	6 (2.4)	6 (3.0)	5 (12.8)
Completed at 16 and 18 years; n (%)	988	886	688	129
Persistent cases	182 (18.4)	185 (20.9)	137 (19.9)	27 (20.9)
Emerging	22 (2.2)	31 (3.5)	18 (2.6)	2 (1.6)
Remitting	43 (4.4)	40 (4.5)	46 (6.7)	6 (4.7)
Non-cases	741 (75.0)	630 (71.1)	487 (70.8)	94 (72.9)

As seen clearly in the table, the proportion of individuals with asthma reporting lost time from work was not dependent on asthma prevalence.

When asked whether the asthma symptoms improved when not at work, 10.8% suggested they were better at weekends, and 10.6% thought they were better when they were away from work for a longer period of time. Among the most reported were associate professionals and technical occupations, elementary occupations, and skilled trades occupations (Table 27).

To explore the jobs associated with potential occupational asthma, 4-digit job codes with at least 10 respondents were cross-tabulated. The results suggested that the proportion of asthma symptom improvement was greatest among waiters and waitresses (SOC2010 code 9273), kitchen and catering assistants (9272), and sales and retail assistants (7111).

Table 25 Emerging asthma by current job at 16 and 18 years

Current job	Asthma			
	Persistent cases	Emerging	Remitting	Non-cases
Completed at 15 and 16 years; n (row %)	343	113	51	1184
Managers, directors and senior officials	0 (0)	0 (0)	0 (0)	2 (100.0)
Professional occupations	3 (27.3)	0 (0)	0 (0)	8 (72.7)
Associate professionals and technical occupations	9 (18.4)	4 (8.2)	0 (0)	36 (73.5)
Administrative and secretarial occupations	10 (21.7)	4 (4.4)	2 (4.4)	32 (69.6)
Skilled trades occupations	19 (22.1)	3 (3.5)	3 (3.5)	61 (70.9)
Caring, leisure and other service occupations	49 (23.3)	12 (5.7)	6 (2.9)	143 (68.1)
Sales and customer service occupations	124 (18.3)	46 (6.8)	20 (3.0)	488 (72.0)
Process, plant and machine operatives	0 (0)	0 (0)	0 (0)	2 (100.0)
Elementary occupations	129 (21.3)	46 (7.6)	20 (3.3)	412 (67.9)
Completed at 16 and 18 years; n (row %)	335	50	88	1142
Managers, directors and senior officials	1 (11.1)	0 (0)	1 (11.1)	7 (77.8)
Professional occupations	4 (26.7)	0 (0)	0 (0)	11 (73.3)
Associate professionals and technical occupations	17 (23.0)	3 (4.1)	6 (8.1)	48 (64.9)
Administrative and secretarial occupations	24 (24.7)	4 (4.1)	5 (5.2)	64 (66.0)
Skilled trades occupations	12 (19.4)	2 (3.2)	4 (6.5)	44 (71.0)
Caring, leisure and other service occupations	37 (15.4)	6 (2.5)	20 (8.3)	178 (73.9)
Sales and customer service occupations	143 (21.7)	25 (3.8)	27 (4.1)	465 (70.5)
Process, plant and machine operatives	2 (16.7)	0 (0)	0 (0)	10 (83.3)
Elementary occupations	95 (21.4)	10 (2.3)	25 (5.6)	315 (70.8)

Table 26 Impact of asthma on work by current job at 18 years

Code	Major group / Unit group	Asthma; n (%)	Lost time from work; n (%)	Days lost; median (IQR)
All		467 (24.4)	15 (3.3)	2 (1.5)
1	Managers, directors and senior officials	1 (9.1)	0 (0)	-
2	Professional occupations	5 (27.8)	0 (0)	-
3	Associate professionals and technical occupations	25 (28.1)	1 (4.2)	7
4	Administrative and secretarial occupations	34 (28.8)	1 (2.9)	1
5	Skilled trades occupations	21 (24.1)	0 (0)	-
6	Caring, leisure and other service occupations	56 (19.3)	3 (5.5)	3 (6)
7	Sales and customer service occupations	201 (25.8)	8 (4.1)	2 (1)
8	Process, plant and machine operatives	2 (14.3)	0 (0)	-
9	Elementary occupations	122 (23.8)	2 (1.7)	2.5 (1)
4159	Other administrative occupations n.e.c.	11 (25.6)	1 (9.1)	1
4216	Receptionists	10 (35.7)	0 (0)	-
6211	Sports and leisure assistants	16 (30.2)	0 (0)	-
7111	Sales and retail assistants	134 (25.1)	6 (4.5)	2 (1)
7112	Retail cashiers and check-out operators	40 (28.8)	1 (2.5)	5 (2)
9272	Kitchen and catering assistants	32 (23.9)	2 (6.3)	2.5 (1)
9273	Waiters and waitresses	37 (23.6)	0 (0)	-
9274	Bar staff	16 (17.4)	0 (0)	-

Table 27 Improvement of asthma symptoms

Code	Major group / Unit group	Asthma symptoms better during last 12 months			
		n†	At weekends; n (%)	n†	When away from work for a longer period of time; n (%)
All		427	46 (10.8)	423	45 (10.6)
1	Managers, directors and senior officials	1	0 (0)	1	0 (0)
2	Professional occupations	3	0 (0)	3	0 (0)
3	Associate professionals and technical occupations	24	5 (20.8)	24	2 (8.3)
4	Administrative and secretarial occupations	30	2 (6.7)	29	1 (3.5)
5	Skilled trades occupations	21	2 (9.5)	21	3 (14.3)
6	Caring, leisure and other service occupations	54	4 (7.4)	54	6 (11.1)
7	Sales and customer service occupations	183	17 (9.3)	183	19 (10.4)
8	Process, plant and machine operatives	1	0 (0)	1	0 (0)
9	Elementary occupations	110	16 (14.6)	107	14 (13.1)
6211	Sports and leisure assistants	16	1 (6.3)	16	1 (6.3)
7111	Sales and retail assistants	125	16 (12.8)	125	18 (14.4)
7112	Retail cashiers and check-out operators	37	1 (2.7)	37	1 (2.7)
9272	Kitchen and catering assistants	28	4 (14.3)	27	2 (7.4)
9273	Waiters and waitresses	34	5 (14.7)	33	6 (18.2)
9274	Bar staff	16	1 (6.3)	15	1 (6.7)

*4-digit codes (unit group) are given if there were ≥10 respondents reporting diagnosed asthma

† n refers to the number of respondents with diagnosed asthma who had response to the question of symptom betterment

Wheezing in the previous 12 months of the CCT questionnaire was reported by 30.4% of those who were employed, of which 8.6% had lost time from work due to wheezing, with a median of 2 days (IQR = 2) lost (Table 28). Sports coaches, instructors and officials, care workers and home carers, sales and retail assistants, and nursery nurses and assistants were among the most affected.

Table 28 Impact of wheezing in the past 12 months by current job at 18 years

Code	Major group / Unit group	Wheezing in past 12 months; n (%)	Lost time from work; n (%)	Days lost; median (IQR)
All		583 (30.4)	50 (8.6)	2 (2)
1	Managers, directors and senior officials	3 (27.3)	0 (0)	-
2	Professional occupations	3 (16.7)	0 (0)	-
3	Associate professionals and technical occupations	30 (33.7)	3 (10.0)	6 (4)
4	Administrative and secretarial occupations	36 (30.5)	1 (2.8)	2
5	Skilled trades occupations	19 (21.8)	4 (21.1)	3 (3)
6	Caring, leisure and other service occupations	91 (31.5)	7 (7.7)	3 (2)
7	Sales and customer service occupations	246 (31.6)	27 (11.0)	2 (4)
8	Process, plant and machine operatives	3 (21.4)	1 (33.3)	2
9	Elementary occupations	152 (29.8)	7 (4.6)	2 (1)
3442	Sports coaches, instructors and officials	12 (48.0)	2 (16.7)	6.5 (1)
4159	Other administrative occupations n.e.c.	10 (23.3)	0 (0)	-
4216	Receptionists	10 (35.7)	0 (0)	-
6121	Nursery nurses and assistants	17 (54.8)	2 (11.8)	2.5 (1)
6145	Care workers and home carers	15 (27.8)	2 (13.3)	5.5 (5)
6211	Sports and leisure assistants	11 (40.7)	1 (5.3)	3
6221	Hairdressers and barbers	19 (36.5)	1 (9.1)	4
7111	Sales and retail assistants	162 (30.2)	20 (12.4)	2 (2.5)
7112	Retail cashiers and check-out operators	50 (32.7)	2 (4.0)	4 (0)
9233	Cleaners and domestics	12 (34.3)	0 (0)	-
9272	Kitchen and catering assistants	31 (23.9)	3 (9.7)	2 (0)
9273	Waiters and waitresses	52 (31.7)	1 (1.9)	1
9274	Bar staff	25 (27.2)	2 (8.0)	2.5 (1)

*4-digit codes (unit group) are given if there were ≥10 respondents reporting wheezing

Accidents

Those who were engaged in paid work were more likely to report accident or injury than those spending all of their time in education (Table 29). The difference was most marked in 16 years. Respondents of the CCT questionnaire reported fewer incidences of accidents both by absolute and relative terms compared to the previous questionnaire. Among the 18 year-old teenagers, 9.9% of those who were working had had an accident at work in the previous year. This was substantially higher than those who worked only in their spare time (6.5%). Those who were not working at the time of questionnaire also reported accidents at

Table 29 Employment status by incidence of accidents

	In education		Not in education	
	Not employed	Paid work	Paid work	Unemployed
	Employment status at 16 years			
Completed at 16 years; n	1850	2572	211	134
Accident/injury in past 6 months; n (%)	353 (19.1)	554 (21.5)	55 (26.1)	23 (17.2)
Type of accident/injury; n (%)				
Fall	86 (4.7)	142 (5.5)	13 (6.2)	6 (4.5)
Bone fracture	74 (4.0)	119 (4.6)	15 (7.1)	4 (3.0)
Burn or scald	26 (1.4)	49 (1.9)	6 (2.8)	4 (3.0)
Sports injury	212 (11.5)	326 (12.7)	27 (12.8)	8 (6.0)
Other	83 (4.5)	121 (4.7)	13 (6.2)	9 (6.7)
	Employment status at 18 years			
Completed at 18 years; n	1134	1020	847	176
Accident/injury in past 6 months; n (%)	104 (9.2)	123 (12.1)	93 (11.0)	27 (15.3)
Type of accident/injury; n (%)				
Fall	15 (1.3)	35 (3.4)	26 (3.1)	7 (4.0)
Bone fracture	17 (1.5)	23 (2.3)	11 (1.3)	5 (2.8)
Burn or scald	5 (0.4)	5 (0.5)	4 (0.5)	0 (0)
Sports injury	36 (3.2)	42 (4.1)	20 (2.4)	6 (3.4)
Other	42 (3.7)	46 (4.5)	47 (5.6)	12 (6.8)
Accidents at work in past year; n (%)	40 (4.3)	66 (6.5)	82 (9.9)	4 (3.4)

work previously, although the proportion was even lower, at 4.3% for those in education and 3.4% for those unemployed.

Process, plant and machine operatives, workers in skilled trades occupations, and professional occupations had highest incidence of accidents at work (Table 30). While the small numbers in these groups have prohibited the analysis of all individual unit groups, vehicle technicians, mechanics and electricians (5231), chefs (5434) and elementary construction occupations (9120) had particularly high rates of accidents at work.

Table 30 Accidents at work in previous 12 months by current job at 18 years

Code	Major group / Unit group	n	Accidents at work; n (%)
All		1893	149 (7.9)
1	Managers, directors and senior officials	11	2 (18.2)
2	Professional occupations	17	0 (0)
3	Associate professionals and technical occupations	89	6 (6.7)
4	Administrative and secretarial occupations	117	5 (4.3)
5	Skilled trades occupations	85	17 (20.0)
6	Caring, leisure and other service occupations	286	21 (7.3)
7	Sales and customer service occupations	768	46 (6.0)
8	Process, plant and machine operatives	15	4 (26.7)
9	Elementary occupations	505	48 (9.5)
3442	Sports coaches, instructors and officials	25	1 (4.0)
4123	Bank and post office clerks	10	1 (10.0)
4159	Other administrative occupations n.e.c.	42	2 (4.8)
4216	Receptionists	28	0 (0)
5231	Vehicle technicians, mechanics and electricians	10	4 (40.0)
5241	Electricians and electrical fitters	15	1 (6.7)
5434	Chefs	12	3 (25.0)
6121	Nursery nurses and assistants	31	0 (0)
6122	Childminders and related occupations	10	0 (0)
6123	Playworkers	20	1 (5.0)
6125	Teaching assistants	15	1 (6.7)
6139	Animal care services occupations n.e.c.	16	2 (12.5)
6145	Care workers and home carers	54	6 (11.1)
6211	Sports and leisure assistants	53	3 (5.7)
6221	Hairdressers and barbers	27	2 (7.4)
6222	Beauticians and related occupations	14	2 (14.3)
7111	Sales and retail assistants	532	36 (6.8)
7112	Retail cashiers and check-out operators	149	8 (5.4)
7114	Pharmacy and other dispensing assistants	15	0 (0)
7130	Sales supervisors	23	0 (0)
7211	Call and contact centre occupations	18	0 (0)
9120	Elementary construction occupations	10	2 (20.0)
9233	Cleaners and domestics	36	2 (5.6)
9251	Shelf fillers	10	0 (0)
9272	Kitchen and catering assistants	130	17 (13.1)
9273	Waiters and waitresses	161	14 (8.7)
9274	Bar staff	91	6 (6.6)
9275	Leisure and theme park attendants	14	0 (0)

High risk jobs and pre-existing asthma

Jobs that were identified to be associated with elevated risk of adult onset asthma (Table 3) were grouped as high risk occupations. The potential relationship between the presence of pre-existing asthma and employment in these high risk occupations was assessed. The results are shown in Table 31. Those working in high risk jobs were more likely to report a diagnosis of asthma at 16 years, or to have a new diagnosis of asthma between 15 and 16 years, although the relationships were not statistically significant. In contrast, those remitting cases were less likely to be engaged in high risk jobs.

The situation at 18 years was completely different, however. Diagnosis of asthma was associated with a reduced likelihood of being employed in high risk occupations (adjusted OR = 0.78; 95% CI 0.59-1.02). In particular, the reduction was more marked among new emerging cases (adjusted OR = 0.68; 95% CI 0.31-1.49). Of note, those who reported to have asthma in the CCS but not in the CCT questionnaire had a significantly increased likelihood of engagement in high risk jobs (adjusted OR = 2.20; 95% CI 1.35-3.58).

Table 31 Association between pre-existing asthma and employment in high risk occupations

	n	n (%) in high risk jobs	Adjusted OR* (95% CI)
Completed at 16 years			
Ever had asthma			
No	1921	537 (28.0)	1.00
Yes	683	208 (30.5)	1.14 (0.94-1.40)
Onset of asthma (between 15 and 16 years)			
Non-case	1184	329 (27.8)	1.00
Persistent case	343	96 (28.0)	0.98 (0.74-1.30)
Emerging	113	39 (34.5)	1.39 (0.91-2.13)
Remitting	51	13 (25.5)	0.63 (0.30-1.32)
Completed at 18 years			
Ever had asthma			
No	1451	352 (24.3)	1.00
Yes	467	95 (20.3)	0.78 (0.59-1.02)
Onset of asthma (between 16 and 18 years)			
Non-case	1142	258 (22.6)	1.00
Persistent case	335	70 (20.9)	0.88 (0.64-1.20)
Emerging	50	9 (18.0)	0.68 (0.31-1.49)
Remitting	88	32 (36.4)	2.20 (1.35-3.58)

* Adjusted for sex, ethnicity, parental social class, health status, tobacco use, and cannabis use

Discussion

The number of studies examining occupational health among young people is limited. Most of the available data, majority from national routine reporting sources, focused on accidents and injuries among young workers. There is a lack of research on the impact of existing illnesses and conditions in new entrants to the workplace on job selection, as well as on the onset of occupational diseases in this vulnerable group.

Based on the data from the renowned ALSPAC birth cohort, the APPRENTICE study analyses data collected from the participants at the ages of 13, 15, 16 and 18 years to investigate the effects of health and other parameters on job selection, and the immediate effects of work on health.

By the age of 18 only a quarter or so of the cohort had left full time education and so the number of person years available for analysis in connection with work is limited. Nevertheless, the initial analyses are very informative but some areas covered by our initial aims have not yet been addressed because of these issues. In particular, issues around mental health are particularly complex and further discussion with those involved in the ALSPAC study who have been involved in mental health issues to date in the cohort is ongoing about how best to analyse the data. Few subjects have developed skin disease on starting work and so analysis after a few more years exposure and with a greater number at work will be more profitable. Lastly, aim 5 intended to look at the influence of pre-existing conditions on new incidence of work related ill health. At this stage, numbers are too small to address this aspect of the work but in time this will become possible as the number of person years increases.

Substance use

While the APPRENTICE study is not intended to focus on the personal particulars of the young people, the way how they lead their life is nonetheless very important in influencing their decision making (including job selection) later on, as well as their work performances and attitudes. The results reveal that many ALSPAC participants by the age of 16 had already become regular users of tobacco, alcohol and cannabis and the prevalence of substance use increased further at 18 years.

Although the data available did not allow the investigation of whether these risky lifestyles had indeed negative impact on their daily activities, one might expect a heavy health burden later in the course of life among these young people, leading to a huge societal cost in terms of disability, healthcare utilisation and loss of productivity [63]. Existing evidence has estimated smoking, alcohol and illicit drugs together contributed 12.4% of all deaths worldwide in 2000 [64]. Results from this study have already pointed to a possible association between school leavers and prevalence of smoking and cannabis use.

Attitude towards employment

Important sex differences exist in the attitude towards job and the relative weightings of various attributes of job. Whether these could be attributed to conventional stereotype of the "roles" of males and females remain to be investigated, for example men are bread winners and therefore are more conscious about their earnings. This is potentially very relevant to further research as while sexual equality has been advocated and mandated by the recent Equality Act 2010, little from the employees' perspectives (and particularly from the young generation yet to enter the labour market) have been studied.

Employment

At 16 years, 58% of the study participants were engaging in paid work, despite the fact that majority of them were still enrolled in full time education. According to the data from Labour Force Survey during similar time as the CCS questionnaire (September-November 2008), among the 1,577,000 youths aged 16-17 years (including those "economically inactive"), 504,000 (32%) were employed [65].

There were over 100 different job codes derived from the job titles reported by the respondents, although most of them, both males and females, worked in the retail and catering trades as sales assistants, waiting staff and kitchen assistants. This is hardly surprising given the low skill levels required for these occupations. On the other hand, skilled trade occupations were more popular among males, while females were more likely to take up caring and leisure occupations (for example childminders).

Comparing between years 16 and 18, the spread of occupations did not appear to be different significantly. In fact, jobs in the retail and catering trades remained to be top choice by the respondents at 18 years. Nevertheless, the proportion engaged in elementary occupations fell while the professional and associate professional occupations saw a slight increase.

Employment and health

In terms of health, those participants who engaged in paid employment tended to have a poorer self-perceived health than those who were in education and did not work. We acknowledge that self-rated health status is a crude way of measuring health. Using a validated health-related quality of life questionnaire, we found that there was no material difference in physical health, albeit an insubstantial betterment in mental health among the workers. It is not clear whether this was in fact due to a higher level of stress at school and hence deteriorated the mental health.

Asthma, a very common paediatric condition with considerable data having been collected in ALSPAC, was used as an example to study the impact of work on health and *vice versa*. At the age of 16, there was a non-significant positive association between asthma diagnosis, particularly new diagnosis between 15 and 16 years and employment in high risk occupations. While we could not determine the temporality of the two events (i.e. asthma

onset and employment), we could not rule out the possibility that exposures in the workplace might have rapidly sensitised the young workers. It is also possible that work exposures might have aggravated existing mild asthma that had not been severe enough to seek medical attention, and hence leading to the diagnosis. The non-significant negative association between remission and high risk job employment might be explained by a likely active avoidance of high risk jobs due to the fear that a recently remitted asthma might relapse.

On the other hand, at 18 years both persisting and emerging cases were associated with a reduced likelihood of being employed in high risk occupations. We speculated that this could be a result of job selection, as the teenagers, now older, might have a few years of work experience and realised they might not be suitable in certain high risk jobs. The increased likelihood of high risk job employment among the remitted cases is difficult to interpret, however, and warrants further thorough investigation.

A very intriguing finding was that 10% of those with either prevalent or emerging asthma reported symptoms which were better when away from work. In the clinical setting a positive response to either of the two questions we included in the questionnaires would result in referral to a specialist centre for occupational lung disease to rule out occupational asthma. This is a high prevalence of work related symptoms in such a young group and suggests that there may well be significant numbers of cases of occupational asthma in the young work force.

Strengths and limitations

The ALSPAC is a successful and resourceful birth cohort study that has been running since the early 1990s. The prospective longitudinal design, general population base and large sample size, coupled with frequent repeated measurements (through postal questionnaires and clinic visits) from foetus through puberty has allowed thorough characterisation of the participants in terms of physical and mental health, as well as various psychosocial parameters.

A few limitations are worth mentioning. While the main aim of ALSPAC is to investigate modifiable influences on child health and development and the cohort has since been used as a sampling frame to study subpopulations based on genotypic, phenotypic, environmental and/or socio-demographic characteristics, it was not specifically designed for any particular exposure and/or outcome. As such, despite the large sample size, ALSPAC lacks power to study relatively uncommon exposures and outcomes. For example in this report, it was not possible to analyse the individual occupational unit groups as the number in each group was small.

Not surprisingly, ALSPAC suffers from a declining response rate and attrition of participants over time, particularly in the more recent questionnaire sweeps. As a result, both the power and the availability of measures across multiple time points have been reduced. The differential attrition might have also introduced biases, as suggested by an increasing unbalance in sex, an over-representation of the more affluent groups and an under-representation of non-White minority ethnic groups compared with the national population.

For this particular study, despite the relatively large sample size, the number of young people leaving full time education was small, falling short of our previous expectation. In addition, due to the restriction in questionnaire length, we were unable to include questions on presenteeism and absenteeism among other assessments as originally proposed. All these have restricted the scope of analysis in the present report.

Further plans

The APPRENTICE Study has demonstrated the possibility of using data from a birth cohort to describe the characteristics of new entrants into the workplace. In order to unleash the full potential of the study, a thorough profiling of the young in terms of physical and mental well-being and other psychosocial parameters using data from all questionnaires and clinic visits people from childhood through adolescence, coupled with further follow-up of the participants to university graduation would greatly expand the scope of this project. Given the current economic environment, relevant questions could be included to assess the impact on these youths.

Conclusions

In summary, we have largely addressed the main aims of our original proposal but over time more analyses will be possible. In the meantime, these data represent a unique dataset in the context of work and health in young individuals and suggest areas for intervention both in terms of education of the young workforce and their employers and clinically.

References

1. International Labour Office. Joint ILO/WHO Committee on industrial hygiene: report of the first meeting; Aug 28-Sept 2 1950. Geneva: International Labour Office, 1950.

2. Health and Safety Executive. Incidence - for people employed in the last 12 months. http://www.hse.gov.uk/statistics/lfs/wriage2w12.xls (accessed 6 May 2013)

3. Health and Safety Executive. Top level data from THOR-GP for 2011 - Number of diagnoses, calculated incidence rates, associated sickness absence and secondary referral by broad diagnostic category of work-related ill-health. http://www.hse.gov.uk/statistics/tables/thorgp02.xls (accessed 6 May 2013)

4. Health and Safety Executive. Cost to Britain of workplace injuries and work-related ill health: 2010/11 update. http://www.hse.gov.uk/statistics/pdf/cost-to-britain.pdf (accessed 6 May 2013)

5. Office for National Statistics. Employment, unemployment and economic inactivity by age group. http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/april-2013/table-a05.xls (accessed 6 May 2013)

6. Office for National Statistics. Young people in work, 2012. http://www.ons.gov.uk/ons/dcp171776_257979.pdf (accessed 6 May 2013)

7. Gitterman BA, Bearer CF. A developmental approach to pediatric environmental health. Pediatr Clin North Am. 2001;48(5):1071-83.

8. Jackson LL. Non-fatal occupational injuries and illnesses treated in hospital emergency departments in the United States. Inj Prev. 2001;7 Suppl 1:i21-6.

9. Breslin FC, Smith P. Age-related differences in work injuries: a multivariate, population-based study. Am J Ind Med. 2005;48(1):50-6.

10. Chau N, Wild P, Dehaene D, Benamghar L, Mur JM, Touron C. Roles of age, length of service and job in work-related injury: a prospective study of 446 120 person-years in railway workers. Occup Environ Med. 2010;67(3):147-53.

11. European Commission. Health and safety at work in Europe (1999-2007) – A statistical portrait. Luxembourg: Publications Office of the European Union; 2010. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-31-09-290/EN/KS-31-09-290-EN.PDF (accessed 6 May 2013)

12. Schneider E (ed.). OSH in figures: Young workers – Facts and figures. Brussels: European Agency for Safety and Health at Work; 2007. https://osha.europa.eu/en/publications/reports/7606507 (accessed 6 May 2013)

13. Health and Safety Executive. Reported injuries to men employees by age of injured person and severity of injury, 2007/08 – 2011/12. http://www.hse.gov.uk/statistics/tables/ridagegen1.xls (accessed 6 May 2013)

14. Health and Safety Executive. Reported injuries to women employees by age of injured person and severity of injury, 2007/08 – 2011/12. http://www.hse.gov.uk/statistics/tables/ridagegen2.xls (accessed 6 May 2013)

15. Breslin FC, Day D, Tompa E, Irvin E, Bhattacharyya S, Clarke J, Wang A, Koehoorn, M. Systematic review of factors associated with occupational disease among young people. Toronto: Institute for Work & Health, 2006.

16. Health and Safety Executive. Work-related mental ill-health: percentage age distribution of estimated cases reported by psychiatrists to SOSMI and occupational physicians to OPRA by sex and diagnostic category, 2007-2009. http://www.hse.gov.uk/statistics/tables/thorp02.xls (accessed 6 May 2013)

17. Health and Safety Executive. Work-related skin disease: percentage age distribution of estimated cases reported by dermatologists to EPIDERM 2009-2011 and by occupational physicians to OPRA 2008-2010, by sex and diagnostic category. http://www.hse.gov.uk/statistics/tables/thors02.xls (accessed 6 May 2013)

18. Health and Safety Executive. Work-related musculoskeletal disorders: percentage age distribution of estimated cases reported by rheumatologists to MOSS and by occupational physicians to OPRA, by sex and diagnostic category, for 2007-2009. http://www.hse.gov.uk/statistics/tables/thorm02.xls (accessed 6 May 2013)

19. Health and Safety Executive. Work-related respiratory disease: percentage age distribution of estimated cases reported by chest physicians to SWORD 2009-2011 and by occupational physicians to OPRA 2008-2010, by sex and diagnostic category. http://www.hse.gov.uk/statistics/tables/thorr02.xls (accessed 6 May 2013)

20. Rake C, Gilham C, Hatch J, Darnton A, Hodgson J, Peto J. Occupational, domestic and environmental mesothelioma risks in the British population: a case-control study. Br J Cancer. 2009;100(7):1175-83.

21. Jorm AF, Windsor TD, Dear KB, Anstey KJ, Christensen H, Rodgers B. Age group differences in psychological distress: the role of psychosocial risk factors that vary with age. Psychol Med. 2005;35(9):1253-63.

22. Jorm AF. Does old age reduce the risk of anxiety and depression? A review of epidemiological studies across the adult life span. Psychol Med. 2000;30(1):11-22.

23. Hertzman C, McGrail K, Hirtle B. Overall pattern of health care and social welfare use by injured workers in the British Columbia cohort. Int J Law Psychiatry. 1999;22(5-6):581-601.

24. Hendrick DJ, Burge PS. Asthma. In: Hendrick DJ, Burge PS, Beckett WS, Churg A (eds.) Occupational disorders of the lung. London: WS Sainders, 2002.

25. British Occupational Health Research Foundation. Occupational asthma: A guide for employers, workers and their representatives. London: British Occupational Health Research Foundation, 2010. http://www.bohrf.org.uk/downloads/OA_Guide-2.pdf (accessed 6 May 2013)

26. Riu E, Dressel H, Windstetter D, Weinmayr G, Weiland S, Vogelberg C, Leupold W, von Mutius E, Nowak D, Radon K. First months of employment and new onset of rhinitis in adolescents. Eur Respir J. 2007;30(3):549-55.

27. Wang ML, Wu ZE, Du QG, Petsonk EL, Peng KL, Li YD, Li SK, Han GH, Atffield MD. A prospective cohort study among new Chinese coal miners: the early pattern of lung function change. Occup Environ Med. 2005;62(11):800-5.

28. Wang ML, Wu ZE, Du QG, Peng KL, Li YD, Li SK, Han GH, Petsonk EL. Rapid decline in forced expiratory volume in 1 second (FEV1) and the development of bronchitic symptoms among new Chinese coal miners. J Occup Environ Med. 2007;49(10):1143-8.

29. Wang XR, Pan LD, Zhang HX, Sun BX, Dai HL, Christiani DC. A longitudinal observation of early pulmonary responses to cotton dust. Occup Environ Med. 2003;60(2):115-21.

30. Bakirci N, Kalaca S, Francis H, Fletcher AM, Pickering CA, Tumerdem N, Cali S, Oldham L, Niven R. Natural history and risk factors of early respiratory responses to exposure to cotton dust in newly exposed workers. J Occup Environ Med. 2007;49(8):853-61.

31. Krause N, Frank JW, Dasinger LK, Sullivan TJ, Sinclair SJ. Determinants of duration of disability and return-to-work after work-related injury and illness: challenges for future research. Am J Ind Med. 2001;40(4):464-84.

32. Marras WS, Ferguson SA, Burr D, Schabo P, Maronitis A. Low back pain recurrence in occupational environments. Spine (Phila Pa 1976). 2007;32(21):2387-97.

33. Oxenbridge S, Evesson J. Young people entering work: A review of the research. London: Advisory, Conciliation and Arbitration Service, 2012. http://www.acas.org.uk/media/pdf/5/2/Young-people-entering-work-a-review-of-the-research-accessible-version.pdf (accessed 6 May 2013)

34. Beck V, Fuller A, Unwin L. Safety in stereotypes? The impact of gender and 'race' on young people's perceptions of their post compulsory education and labour market opportunities. Br Educ Res J. 2006;32(5):667-686.

35. Meadows P. Young men on the margins of work: An overview report. York: Joseph Rowntree Foundation, 2001. http://www.jrf.org.uk/sites/files/jrf/1859354114.pdf (accessed 6 May 2013)

36. Spielhofer T, Golden S, Evans K. Young people's aspirations in rural areas. Slough: National Foundation for Education Research, 2011. https://www.nfer.ac.uk/nfer/publications/LYPA01/LYPA01.pdf (accessed 6 May 2013)

37. Li CY, Sung FC. A review of the healthy worker effect in occupational epidemiology. Occup Med (Lond). 1999;49(4):225-9.

38. Petsonk EL, Daniloff EM, Mannino DM, Wang ML, Short SR, Wagner GR. Airway responsiveness and job selection: a study in coal miners and non-mining controls. Occup Environ Med. 1995;52(11):745-9.

39. Le Moual N, Kauffmann F, Eisen EA, Kennedy SM. The healthy worker effect in asthma: work may cause asthma, but asthma may also influence work. Am J Respir Crit Care Med. 2008;177(1):4-10.

40. Radon K, Huemmer S, Dressel H, Windstetter D, Weinmayr G, Weiland S, Riu E, Vogelberg C, Leupold W, von Mutius E, Goldberg M, Nowak D. Do respiratory symptoms predict job choices in teenagers? Eur Respir J. 2006;27(4):774-8.

41. Orbon KH, van der Gulden JW, Schermer TR, van den Nieuwenhof L, Boot CR, van den Hoogen H, van Weel C, Folgering HT. Vocational and working career of asthmatic adolescents is only slightly affected. Respir Med. 2006;100(7):1163-73.

42. Wiebert P, Svartengren M, Lindberg M, Hemmingsson T, Lundberg I, Nise G. Mortality, morbidity and occupational exposure to airway-irritating agents among men with a respiratory diagnosis in adolescence. Occup Environ Med. 2008;65(2):120-5.

43. Olivieri M, Mirabelli MC, Plana E, Radon K, Antó JM, Bakke P, Benke G, D'Errico A, Henneberger P, Kromhout H, Norbäck D, Torén K, van Sprundel M, Villani S, Wieslander G, Zock JP, Kogevinas M. Healthy hire effect, job selection and inhalation exposure among young adults with asthma. Eur Respir J. 2010;36(3):517-23.

44. Dumas O, Smit LA, Pin I, Kromhout H, Siroux V, Nadif R, Vermeulen R, Heederik D, Hery M, Choudat D, Kauffmann F, Le Moual N; Epidemiological Study on the Genetics and Environment of Asthma (EGEA). Do young adults with childhood asthma avoid occupational exposures at first hire? Eur Respir J. 2011;37(5):1043-9.

45. Golding J. Children of the nineties. A longitudinal study of pregnancy and childhood based on the population of Avon (ALSPAC). West Engl Med J. 1990;105(3):80-2.

46. Boyd A, Golding J, Macleod J, Lawlor DA, Fraser A, Henderson J, Molloy L, Ness A, Ring S, Davey Smith G. Cohort Profile: the 'children of the 90s'--the index offspring of the Avon Longitudinal Study of Parents and Children. Int J Epidemiol. 2013;42(1):111-27.

47. Fraser A, Macdonald-Wallis C, Tilling K, Boyd A, Golding J, Davey Smith G, Henderson J, Macleod J, Molloy L, Ness A, Ring S, Nelson SM, Lawlor DA. Cohort Profile: the Avon Longitudinal Study of Parents and Children: ALSPAC mothers cohort. Int J Epidemiol. 2013;42(1):97-110.

48. Chalder T, Berelowitz G, Pawlikowska T, Watts L, Wessely S, Wright D, Wallace EP. Development of a fatigue scale. J Psychosom Res. 1993;37(2):147-53.

49. Ware JE Jr., Kosinski M, Bjorner JB, Turner-Bowker DM, Gandek B, Maruish ME. User's manual for the SF-36v2^{TM} Health Survey (2nd ed.). Lincoln, RI: QualityMetric Incorporated, 2007.

50. Office of National Statistics. Standard occupational classification. London: The Stationary Office, 1991.

51. Melotti R, Heron J, Hickman M, Macleod J, Araya R, Lewis G; ALSPAC Birth Cohort. Adolescent alcohol and tobacco use and early socioeconomic position: the ALSPAC birth cohort. Pediatrics. 2011;127(4):e948-55.

52. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Berry CC. Tobacco industry promotion of cigarettes and adolescent smoking. JAMA. 1998;279(7):511-5.

53. Donovan JE. Estimated blood alcohol concentrations for child and adolescent drinking and their implications for screening instruments. Pediatrics. 2009;123(6):e975-81.

54. Office for National Statistics. The Standard Occupational Classification (SOC) 2010 Volume 1. London: Palgrave Macmillan, 2010.

55. Asher MI, Keil U, Anderson HR, Beasley R, Crane J, Martinez F, Mitchell EA, Pearce N, Sibbald B, Stewart AW, Strachan D, Weiland SK, Williams HC. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. Eur Respir J. 1995;8(3):483-91.

56. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, van der Grinten CP, Gustafsson P, Jensen R, Johnson DC, MacIntyre N, McKay R, Navajas D, Pedersen OF, Pellegrino R, Viegi G, Wanger J; ATS/ERS Task Force. Standardisation of spirometry. Eur Respir J. 2005;26(2):319-38.

57. Quanjer PH, Stanojevic S, Cole TJ, Baur X, Hall GL, Culver BH, Enright PL, Hankinson JL, Ip MS, Zheng J, Stocks J; ERS Global Lung Function Initiative. Multi-ethnic reference values for spirometry for the 3-95-yr age range: the global lung function 2012 equations. Eur Respir J. 2012;40(6):1324-43.

58. Chinn S, Rona RJ. Height and age adjustment for cross sectional studies of lung function in children aged 6-11 years. Thorax. 1992;47(9):707-14.

59. Kotecha SJ, Watkins WJ, Heron J, Henderson J, Dunstan FD, Kotecha S. Spirometric lung function in school-age children: effect of intrauterine growth retardation and catch-up growth. Am J Respir Crit Care Med. 2010;181(9):969-74.

60. Quanjer PH, Tammeling GJ, Cotes JE, Pedersen OF, Peslin R, Yernault JC. Lung volumes and forced ventilatory flows. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. Eur Respir J Suppl. 1993;16:5-40.

61. Ghosh RE, Cullinan P, Fishwick D, Hoyle J, Warburton CJ, Strachan DP, Butland BK, Jarvis D. Asthma and occupation in the 1958 birth cohort. Thorax. 2013;68(4):365-71.

62. International Labour Office. International Standard Classification of Occupations: ISCO-88. Geneva: International Labour Organization, 1990. http://www.ilo.org/public/english/bureau/stat/isco/isco88/index.htm (accessed 6 May 2013).

63. Wickizer TM. State-level estimates of the economic costs of alcohol and drug abuse. J Health Care Finance. 2013;39(3):71-84.

64. World Health Organization. Management of substance abuse – The global burden. http://www.who.int/substance_abuse/facts/global_burden/en/index.html (accessed 6 May 2013).

65. Office for National Statistics. Labour marker statistics, January 2009. http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/january-2009/january-2009-stat-bulletin.pdf (accessed 6 May 2009).

Appendices

Table A1 Respondents' perception on various aspects in job selection process at 13 years

	Whole cohort	Male	Female	p (M v.F)
n (%)				
Attitude towards job				
Being employed	6189	2829	3360	
Mattered very much	3474 (56.1)	1719 (60.8)	1755 (52.2)	
Mattered a bit	2443 (39.5)	988 (34.9)	1455 (43.3)	
Didn't matter	272 (4.4)	122 (4.3)	150 (4.5)	<0.001
A job allowing progress in career	6271	2850	3421	
Mattered very much	5146 (82.1)	2409 (84.5)	2737 (80.0)	
Mattered a bit	1045 (16.7)	408 (14.3)	637 (18.6)	
Didn't matter	80 (1.3)	33 (1.2)	47 (1.4)	<0.001
Attributes of job				
To be able to help other people	6371	2897	3474	
Mattered very much	3077 (48.3)	1144 (39.5)	1933 (55.6)	
Mattered a bit	3030 (47.6)	1567 (54.1)	1463 (42.1)	
Didn't matter	264 (4.1)	186 (6.4)	78 (2.3)	<0.001
To have high earnings	6384	2907	3477	
Mattered very much	3844 (60.2)	1969 (67.7)	1875 (53.9)	
Mattered a bit	2361 (37.0)	875 (30.1)	1486 (42.7)	
Didn't matter	179 (2.8)	63 (2.2)	116 (3.3)	<0.001
To work for themselves	6341	2885	3456	
Mattered very much	1056 (16.7)	536 (18.6)	520 (15.1)	
Mattered a bit	2791 (44.0)	1342 (46.5)	1449 (41.9)	
Didn't matter	2494 (39.3)	1007 (34.9)	1487 (43.0)	<0.001
To be interesting with variety	6361	2895	3466	
Mattered very much	4652 (73.1)	2160 (74.6)	2492 (71.9)	
Mattered a bit	1567 (24.6)	668 (23.1)	899 (25.9)	
Didn't matter	142 (2.2)	67 (2.3)	75 (2.2)	0.03
To have promotion	6345	2887	3458	
Mattered very much	2910 (45.9)	1563 (54.1)	1347 (39.0)	
Mattered a bit	2708 (42.7)	1062 (36.8)	1646 (47.6)	
Didn't matter	727 (11.5)	262 (9.1)	465 (13.5)	<0.001
To work regular hours	6359	2886	3473	
Mattered very much	2919 (45.9)	1401 (48.5)	1518 (43.7)	
Mattered a bit	2719 (42.8)	1157 (40.1)	1562 (45.0)	
Didn't matter	721 (11.3)	328 (11.4)	393 (11.3)	<0.001

Table A2 Views on future career at 13 years

	Whole cohort	Male	Female	p (M v.F)
n (%)				
Important to have a career	6328	2863	3465	
Strongly agree	4447 (70.3)	2065 (72.1)	2382 (68.7)	
Agree a bit	1782 (28.2)	756 (26.4)	1026 (29.6)	
Disagree a bit	80 (1.3)	32 (1.1)	48 (1.4)	
Strongly disagree	19 (0.3)	10 (0.4)	9 (0.3)	0.023
Respondents did not think about what they might be doing	6314	2858	3456	
Strongly agree	486 (7.7)	272 (9.5)	214 (6.2)	
Agree a bit	1789 (28.3)	851 (29.8)	938 (27.1)	
Disagree a bit	2207 (35.0)	984 (34.4)	1223 (35.4)	
Strongly disagree	1832 (29.0)	751 (26.3)	1081 (31.3)	<0.001
More important to do something respondents enjoy rather than how it might help with their job later	6257	2828	3429	
Strongly agree	1480 (23.7)	674 (23.8)	806 (23.5)	
Agree a bit	2523 (40.3)	1141 (40.4)	1382 (40.3)	
Disagree a bit	1672 (26.7)	743 (26.3)	929 (27.1)	
Strongly disagree	582 (9.3)	270 (9.6)	312 (9.1)	0.850
Respondents wait and see where they end up	6281	2839	3442	
Strongly agree	408 (6.5)	186 (6.6)	222 (6.5)	
Agree a bit	1403 (22.3)	633 (22.3)	770 (22.4)	
Disagree a bit	2043 (32.5)	858 (30.2)	1185 (34.4)	
Strongly disagree	2427 (38.6)	1162 (40.9)	1265 (36.8)	0.001