Hart, C.L. and Deary, I.J. and MacKinnon, P.L. and Davey Smith, G. and Whalley, L.J. and Wilson, V. and Hole, D.J. and Starr, J.M. (2003) The Scottish Mental Survey 1932 linked to the Midspan studies: a prospective investigation of childhood intelligence and future health. *Public Health* 117(3):pp. 187-195.

The Scottish Mental Survey 1932 linked to the Midspan studies: a prospective investigation of childhood intelligence and future health

C.L. Hart[1] MA PhD, I.J. Deary[2] PhD FRCPE, M.D. Taylor[2] MSc PhD, P.L. MacKinnon[1] MA, G. Davey Smith[3] DSc MD, L.J. Whalley[4] MD FRCPsych, V. Wilson[5] MSc EdD, D.J. Hole MSc FFPHM[1], J.M. Starr[6] MA FRCPEd

[1]Department of Public Health

University of Glasgow

1 Lilybank Gardens

Glasgow

G12 8RZ

[2]Department of Psychology

University of Edinburgh

7 George Square

Edinburgh EH8 9JZ

[3]Department of Social Medicine

University of Bristol

Canynge Hall

Whiteladies Road

Bristol BS8 2PR

[4]Department of Mental Health

University of Aberdeen

Clinical Research Centre

Royal Cornhill Hospital

Aberdeen AB25 2ZH

[5]Scottish Council for Research in Education

61 Dublin St

Edinburgh EH3 6NL

[6]Royal Victoria Hospital

Craigleith Road

Edinburgh EH4 2DN

Correspondence and reprint requests:

For the Midspan studies:

Carole Hart

Department of Public Health

University of Glasgow

1, Lilybank Gardens

Glasgow G12 8RZ

Tel. 0141 330 4072

Fax. 0141 330 5018

Email c.l.hart@udcf.gla.ac.uk

For the Scottish Mental Survey 1932:

Ian J. Deary

Department of Psychology

University of Edinburgh

7, George Square

Edinburgh EH8 9JZ

Tel. 0131 650 3452

Fax. 0131 651 1771

Email I.Deary@ed.ac.uk

SUMMARY

The Scottish Mental Survey of 1932 (SMS1932) recorded mental ability test scores for nearly all of the age group of children born in 1921 and at school in Scotland on 1st June 1932. The Collaborative and Renfrew/Paisley studies, two of the Midspan studies, obtained health and social data by questionnaire and a physical examination in the 1970s. Some Midspan participants were born in 1921 and may have taken part in the SMS1932, so might have mental ability data available from childhood. The 1921-born Midspan participants were matched with the computerised SMS1932 database. The total numbers successfully matched were 1032 out of 1251 people (82.5%). Of those matched, 938 (90.9%) had a mental ability test score recorded. The mean score of the matched sample was 37.2 (standard deviation [SD] 13.9) out of a possible score of 76. The mean (SD) for the boys and girls respectively was 38.3 (14.2) and 35.7 (13.9). This compared with 38.6 (15.7) and 37.2 (14.3) for boys and girls in all of Scotland. Graded relationships were found between mental ability in childhood, and social class and deprivation category of residence in adulthood. Being in a higher social class or in a more affluent deprivation category was associated with higher childhood mental ability scores and the scores reduced with increasing deprivation. Future plans for the matched data include examining associations between childhood mental ability and other childhood and adult risk factors for disease in adulthood, and modelling childhood mental ability, alongside other factors available in the Midspan database, as a risk factor for specific illnesses, admission to hospital and mortality.

KEYWORDS: cohort; mortality; mental ability; Scotland

INTRODUCTION

The basis for associations between social position and health status is of considerable research and policy interest. Much social epidemiology has used different socioeconomic indicators as though they were interchangeable, and rather few studies have examined associations between different indicators and outcomes in the same database. Only analyses of this latter kind can address the different interpretations of the social patterning of health-related behaviours and disease outcomes which have been advanced. With respect to education and health, observed associations have been attributed to the direct effects of education. Explanations have included the acquisition of knowledge regarding health damaging behaviours, the ability to optimise use of health services, the development of time preferences favourable to health maintenance, an increasing willingness to invest in human capital, and the promotion of the psychological attributes of high self esteem and self efficacy[1-3]. Alternatively the associations could reflect education indexing socioeconomic circumstances in childhood and both indexing and influencing socioeconomic circumstances in adulthood. In the case of the health effects of occupational hazards in unskilled manual jobs, these may depend directly on work conditions, and reducing socioeconomic differentials consequent on such exposures requires changes to work environments. In the Collaborative Study, cigarette smoking was more strongly related to adulthood occupational social class than to age at leaving full time education[4]. This suggested that social environment in adulthood maintains, or initiates, smoking behaviour. Age at leaving full time education is, in this formulation, mainly related to smoking behaviour through its determination of occupational level in adulthood. However, age at leaving full time education may have different associations than intelligence (as measured by standard psychometric tests) to health-related behaviours such as smoking and excessive alcohol use. No studies to our knowledge have been able to examine intelligence and a wide range of lifetime socioeconomic measures in relation to health-related behaviours (such as smoking) and their physical concomitants (such as lung function and cholesterol levels).

We now describe how two established research teams have combined with the aim of studying risk factors for specific diseases and mortality. The first team is responsible for the Midspan prospective cohort studies conducted in the west of Scotland on adult men and women in the 1970s. These studies have generated novel findings on the use of social, lifestyle and health factors to predict mortality[4-8], hospital admissions[9; 10], and specific disease outcomes such as cardiorespiratory illness[11], stroke[12] and cancer[13]. The participants have been followed up for mortality and cancer since inception, and have recently been linked with the Scottish Morbidity Records (SMR) system, enabling data on physical and mental illness to be investigated.

The second team is responsible for follow-up studies of the Scottish Mental Survey 1932 (SMS1932). The SMS1932 contains mental ability test scores for children born in 1921 and at school in Scotland on 1st June 1932. Follow-up studies of the SMS1932 have so far traced and examined psycho-social factors and health in participants of the SMS1932 in Aberdeen and Lothian. IQ at age 11 proved moderately stable to age 77[14], related to birth weight[15], related to health status at age 77[16], related to lifetime psychiatric contact[17], and a risk factor for mortality[18] and for senile but not pre-senile dementia in later life[19].

The age ranges of the Midspan studies were such that they included men and women born in 1921. Some of the participants could therefore have mental ability data available from age 11 years. By collaborating and sharing data, the SMS1932 and Midspan research teams anticipate improved understanding of risk factors for diseases and mortality. This paper describes the process and outcomes of the matching exercise.

METHODS

THE SCOTTISH MENTAL SURVEY 1932

The SMS1932, conducted under the auspices of the Scottish Council for Research in Education (SCRE), sought to quantify the number of people in Scotland who were "mentally deficient". The survey aims were broadened to "obtain data about the whole distribution of the intelligence of Scottish pupils from one end of the scale to the other" [20]. On June 1 1932, children born in the calendar year 1921 and attending schools in Scotland were given the same, well-validated mental ability test. A small number were tested slightly later. The children were tested in classrooms by teachers who followed detailed printed instructions. A very small number of private schools, deaf and blind children, and those children absent owing to sickness or some other cause were not tested.

The group mental ability test used in the SMS1932 is referred to in the original publication as the “Verbal Test”[20]. The verbal test has 71 numbered items, 75 items in total, and has a maximum score of 76. It contains several general, spatial, and numerical reasoning items which include: following directions (14 items), same-opposites (11 items), word classification (10 items), analogies (8 items), practical (6 items), reasoning (5 items), proverbs (4 items), arithmetic (4 items), spatial (4 items), mixed sentences (3 items), cipher decoding (2 items), and other items (4 items). The test was closely related to the Moray House Test No.12, which was used in ‘eleven-plus’ examinations in England. We shall hereinafter refer to it as the Moray House Test. From the original report of the SMS1932 the mean (SD) Moray House Test Score was 38.6 (15.7) for boys and 37.2 (14.3) for girls. The scores on the Moray House Test have criterion validity. Validation was established by individually re-testing a representative sample of 1,000 of the children on the Stanford Revision of the Binet-Simon scale. The correlation between the Moray House Test scores and the Stanford Binet test was 0.81 for boys (n = 500) and 0.78 for girls (n = 500)[20].

The Scottish Council for Research in Education made the complete computerised data set of 86,520 records for the 1932 Scottish Mental Survey available to the authors. The computerised records had been compiled from area-based ledgers that contained handwritten details of schoolchildren with and without scores from the Moray House Test. There were some missing ledgers (for Fife, Wigtown and Angus) which could not, therefore, be computerised. These three counties had an estimated 7,542 children born in 1921[20] and an unknown number of these would have been absent from school on the day of the test. The total number of children who sat the Moray House Test was 87,498 (44,210 boys and 43,288 girls). The number of Moray House Test scores that were available for matching was 81,140, which together with 5,380 computerised records where the Moray House Test score was missing, totalled 86,520.

MIDSPAN STUDIES

The Midspan studies were large cardiorespiratory studies carried out in Scotland in the 1960s and 1970s. Two studies are included in this analysis, the Collaborative study and the Renfrew/Paisley study. The Collaborative study was conducted between 1970 and 1973 in 27 workplaces in the west and central belt of Scotland[4]. The full sample consisted of 6022 men and 1006 women of working age. The Renfrew/Paisley general population study was carried out between 1972 and 1976 and involved 7052 men and 8354 women aged 45 - 64 years who were resident in the towns of Renfrew and Paisley, close to the city of Glasgow[11]. A response rate of 79% in Renfrew and 78% in Paisley was achieved.

In both Midspan studies, participants completed a questionnaire and underwent a physical examination. The physical examination included measurement of blood pressure, height, weight, cholesterol, forced expiratory volume in 1 second (FEV1) and a six lead electrocardiogram. The questionnaire collected information about smoking, angina from the Rose questionnaire[21], severe chest pain lasting half an hour or more, bronchitis, diabetes, age, home address and the participant's own occupation. The Collaborative, but not Renfrew/Paisley, study included questions on alcohol consumption, age at leaving full time education, number of siblings, regular car driving, main occupation of the participant's father and participant's first occupation. The Renfrew/Paisley, but not the Collaborative, study measured non-fasting blood glucose.

Blood pressure was measured with the subject seated, and diastolic pressure was recorded at the disappearance of the fifth Korotkoff sound. Blood samples were taken for the measurement of whole cholesterol and glucose. Body mass index in kg/m^2 was calculated from the weight and height.

The adjusted FEV1 was defined as the actual FEV1 as a percentage of the expected FEV1, derived from sex-specific linear regressions of age and height from healthy subsets of the study populations[4; 22]. Units of alcohol consumed per week were calculated from responses to the questionnaire about usual weekly consumption of beer, spirits and wine[8]. Angina was defined as definite grades I and II from the Rose Angina Questionnaire[23]. A six lead electrocardiogram (ECG) was made with the subject seated. The ECG was coded according to the Minnesota system with any of codes 1.1-1.3, 4.1-4.4, 5.1-5.3 and 7.1 being considered as evidence of ischaemia, encompassing diagnoses of definite myocardial infarction, myocardial ischaemia and left bundle branch block[11; 24]. Bronchitis was as defined as having persistent and infective phlegm and being breathless[4; 25]. Diabetes was defined by a positive answer to the question in the questionnaire.

The home address at the time of screening was retrospectively postcoded, enabling deprivation category as defined by Carstairs and Morris to be ascertained[26]. This measure is an area-based measure of deprivation, obtained from four census variables - male unemployment, overcrowding, car ownership and the proportion of heads of households in social classes IV and V. A deprivation score for each postcode sector is obtained which is converted to seven categories ranging from 1 (least deprived) to 7 (most deprived). None of the postcode sectors in the Renfrew/Paisley area were in deprivation category 2. Social class was coded according to the Registrar General's Classification[27] for each occupation. The social class of women was allocated according to their own occupation, except for those women in the Renfrew/Paisley study who gave their occupation as housewives. In these cases, the social class was that of their husband.

The age ranges of the studies were such that they included men and women born in 1921 who may have taken part in the Scottish Mental Survey of 1932. Therefore, some of the participants in the Midspan studies might have mental ability data available from age 11 years. Ethical permission was obtained from the Multi-Centre Research Ethics Committee for Scotland to link the SMS1932 data set with the 1921-born participants of the Midspan data sets.

MATCHING OF DATA SETS

Variables available in the SMS1932 data set for matching were

- surname (at age 11)
- forename
- date of birth
- gender
- school
- region

Variables available in the Midspan data sets for matching purposes were

- surname (or maiden name for ever-married women)
- forename(s)
- date of birth
- gender
- place of birth
- place at time of screening

The 86,520 cases in the SMS1932 data set were matched with the 884 members of the Renfrew/Paisley data set born in 1921 (412 male and 472 female). The first stage of the matching used the computer package SPSS[28] to exactly match for surname, forename, day of birth and month of birth. The computerised match achieved 464 unique matches. Additionally there were six people who each matched directly to two different people on the SMS1932 data set with the same name and date of birth. These duplicates were checked manually and it was clear in all six cases which individual was the correct match, using information on the location of the school, place of birth and location of residence at the time of the Midspan study.

The same procedure was done for the 369 members of the Collaborative study born in 1921 (324 male and 45 female). Maiden names were not available for four out of the 37 ever-married women. The computerised match achieved 205 unique matches. Additionally there were four people with two matches. These duplicates were checked manually. It was clear in three cases which was the correct match, but there was not sufficient information available to distinguish which was the correct match for the fourth case.

The second stage matched the 414 Renfrew/Paisley study members who had not matched with the SMS1932 data at the first stage, using SPSS to exactly match for surname, day of birth, month of birth and sex (i.e. not using forename). It found 248 matches, but this included several duplicate matches including several with more than two matches for the same Renfrew/Paisley person. Manual checking of the 248 matches identified 150 definite matches. Reasons for accepting the matches included use of a different forename in the two studies (where the person had two forenames), either the SMS1932 or Midspan studies using an abbreviation or a diminutive forename, and misspellings.

Similarly, for the 160 Collaborative study members who had not been matched at the first stage, 89 matches were found, including duplicates. Manual checking found 53 definite matches.

The third stage was to check the remaining unmatched 264 Renfrew/Paisley participants and 108 Collaborative study participants manually against the SMS1932 data set. Decisions on matching were made using all available information where necessary (e.g. place of birth, extra forename). In some instances, this involved checking information on the original Midspan handwritten questionnaires and index cards, and checking the SMS1932 ledgers. There were several cases where the date of birth differed slightly between the two studies, but the match was accepted if all other information suggested a correct match. Any uncertainties were discussed by three of the authors (CH, PM, ID). The manual matching produced 120 extra Renfrew/Paisley matches and 33 extra Collaborative matches.

Table 1 presents the breakdown of reasons for accepting matches with the SMS1932 data set. A total of 1034 matches were made, 740 from the Renfrew/Paisley study and 294 from the Collaborative study. These matches included two men who had taken part in both the Renfrew/Paisley and Collaborative studies, so the final number of individuals in the Midspan studies who were born in 1921 and were matched to a record on the SMS1932 data set was 1032.

Some of the 219 Midspan cases (18%) who were not matched (144 [16%] from the Renfrew/Paisley study and 75 [20%] from the Collaborative study) might not have been resident in Scotland in 1932, and so would not have been attending a school in Scotland. Some might not have been registered at a school or they might have attended one of the very few (mostly private) schools which did not take part. Some might have attended schools in the areas for which the ledgers containing the results of the Moray House Test were missing.

MISSING SCORES

There were 79 out of 740 cases (10.7%) where the Moray House Test score was missing for the participants of the Renfrew/Paisley study and 16 out of 294 (5.4%) for the Collaborative study. A missing score normally indicated that the child was absent from school on the day. In view of the substantially higher proportion of missing scores in the Renfrew/Paisley study compared to the Collaborative study, the cases with missing scores in the Renfrew/Paisley study were further investigated. It was found that 42 attended a particular school in the Renfrew area. None of the 129 pupils from that school had a Moray House Test score. Excluding the 42 from the totals gave a similar proportion (5.3%) with a missing score to the Collaborative study. This compares to 6.2% of cases on the entire SMS1932 computerised data set which had a missing score.

CORRECTION FOR AGE

The children who took part in the SMS1932 were all born in the year 1921, so their ages at the time of the test varied by 12 months. The Moray House Test scores were corrected for age by performing a regression analysis with Moray House Test score as the dependent variable and age in days at the time of the test as the independent variable. The standardised residuals were then converted to usual IQ-type scores with mean 100 and standard deviation 15.

RESULTS

Analyses were conducted on the Collaborative and Renfrew/Paisley studies together. Only one record each was included for the two men who were in both of these studies and this was chosen to be their first attendance at a Midspan study, which was the Collaborative study. The total numbers finally matched with an SMS1932 record were 1032 out of 1251 people (82.5%). Of those matched, 938 (90.9%) had a Moray House Test score recorded. The mean score was 37.2 (standard deviation [SD] 13.9) and the range was from 0 to 69, out of a possible score of 76[20]. The mean (SD) for the boys and girls respectively was 38.3 (14.2) and 35.7 (13.9). This compared with 38.6 (15.7) and 37.2 (14.3) for boys and girls in the whole of Scotland.

Overall, 17.5% of Midspan participants were not matched with the SMS1932 database: 17.7% of men and 17.2% of women were not matched. Table 2 compares Midspan study variables in participants who were successfully matched with the SMS1932 database with participants who were not matched. Most variables were similar in the two groups. However, men not matched were taller, heavier, had fewer siblings, were less likely to have had a father with a manual occupation and more likely to be regular car drivers. Women not matched were younger than women who were matched. It should be noted that those variables available only in the Collaborative study were from only 45 women: 36 matched and 9 unmatched. Putting the men and women together showed that the unmatched were younger at screening, heavier, had fewer siblings, were less likely to have had a father with a manual occupation and were less likely to have left school at the age of 14 or under.

Men and women who were matched with the SMS1932 database and who had a Moray House Test score showed graded relationships of IQ with occupational social class in adulthood (table 3). Men in social class I had the highest mean score and men in social class

V had the lowest, with a gradual decrease in score with declining social class and a highly significant downward trend ($p<0.0001$) (obtained from a regression analysis with IQ score as the dependent variable and social class as the independent variable). Women in non-manual social classes had higher scores than women in manual social classes. Mean IQ was also calculated by social class for deprivation categories 1-5 and deprivation categories 6-7 separately. Within each social class, IQ was generally lower for men and women who lived in more deprived areas in adulthood compared to more affluent. Trends additionally adjusted for deprivation were highly significant. Table 4 presents mean IQ by deprivation category, subdivided into non-manual and manual social classes. Men and women living in the most affluent deprivation categories had the highest scores and the scores reduced with increasing deprivation, with significant downward trends. In most instances, within each deprivation category, mean IQ was lower for people in manual social classes compared to non-manual social classes. Trends also adjusted for social class were highly significant.

DISCUSSION

This paper describes the bringing together of data from two valuable Scottish surveys. Their combined data offers unique opportunities for the study of psychosocial factors in early life and how they contribute to health inequalities in later life. As far as we are aware, no other country collected information about the childhood mental ability differences of almost an entire year-of-birth cohort. These IQ-type data were collected in Scotland in 1932 for children aged 10½-11½ years, before compulsory education was completed. Therefore, they provide cognitive data prior to any effect that different durations of education might bring about. Because the SMS1932 was so comprehensive we were able to add childhood mental test data to the rich social and health information already collected on participants in the Midspan studies. The IQ scores for the Midspan participants were slightly below those of Scotland as a whole, reflecting the relatively high average levels of social deprivation among the study sample[11].

The small percentage of subjects for whom matches could not be made is likely to include migrants to the Midspan areas after age 11. We found that the non-matched Midspan subjects had fewer siblings, were heavier, and their fathers were less likely to have a manual occupation; also non-matched men were taller. The Scottish Mental Survey of 1947[29] found that children who had changed their place of residence between birth and age 11 years were higher in intelligence, taller, heavier, had fewer siblings, and their fathers were more likely to be in professional occupations. These factors are ones that have been related to social and geographical mobility, which would lead to people not residing in the place where they were born[30; 31].

Most of the matches between the SMS1932 and the Midspan studies were exact. Many others were extremely close, involving only the use of a diminutive of a forename, an alternative forename, a misspelling or a small error in date of birth when all other information was identical.

IQ in childhood was strongly related to social class in adulthood and deprivation category of residence in adulthood. We also found differing levels of IQ for manual and non-manual groups within each deprivation category, and for affluent and deprived groups within each social class. Similar results have been seen for cardiovascular risk factors such as smoking, FEV1 and bronchitis[7].

FUTURE USES OF THE DATA

The SMS1932 data are uniquely relevant to lifecourse research because they provide a population reference for samples on an important predictor of later life variables. These include not only mortality[18] and disability[16], but also occupational exposures[32]. Moreover, mental ability at age 11 is itself related to events earlier in life including those before birth[15]. Hence we can relate morbidity and risk factors measured in middle age in one cohort to mortality and disability in another, estimating how much of health inequalities are attributable to IQ-associated causes in each sample. This in turn allows inferences to be drawn about whether there are critical periods during the lifecourse when IQ-associated factors exert their influence. Identifying the period when IQ-associated health inequalities arise is important not only for the timing of possible interventions, but also allows inferences to be drawn about which mechanisms are involved. Previously, we hypothesised four pathways along which childhood IQ might affect survival: 1) as a record of bodily insults in early childhood, 2) as an indicator of system integrity, 3) as a predictor of health behaviours, and 4) as a predictor of entry into safer environments[18]. The first pathway implies that individual differences in health arise early in life and the second favours an increase with age as degenerative processes become more important. The linkage of SMS1932 and Midspan data, which are rich in health behaviour and socio-environmental measures, is particularly relevant to a better understanding of the third and fourth pathways.

CONCLUSION

Through the linking of the Midspan studies and the SMS 1932 data, we have successfully matched 75% of the 1921-born Midspan participants with their IQ at age 11. The mean Moray House Test scores for boys and girls were similar to those for the whole of Scotland. Addition of the childhood mental ability test data to the rich social and health data available in the Midspan studies will help in producing novel insights concerning relationships between childhood IQ, social factors, and health and mortality in adult life. Initial analyses, presented here, of IQ with social class and deprivation category in adulthood show promising results.

Acknowledgements: We thank the staff of the Scottish Council for Research in Education for making the data from the Scottish Mental Survey 1932 available to the authors. Victor Hawthorne was responsible for the original Midspan studies. IJD is the recipient of a Royal Society-Wolfson Research Merit Award. LJW is supported by a career development award from the Wellcome Trust.

Funding: Funding was provided by the Chief Scientist's Office of the Scottish Executive

Reference List

1. Winkleby M, Jatulis D, Frank E, Fortmann S. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health* 1992;**82**:816-820.

2. Fuchs V. Economics, health, and post-industrial society. *Millbank Memorial Fund Qtr* 1979;**57**:153-182.

3. Pincus T, Callahan L. Associations of low formal education level and poor health status: behavioural, in addition to demographic and medical, explanations? *J of Clin Epidemiology* 1994;**47**:355-361.

4. Davey Smith G, Hart C, Hole D, MacKinnon P, Gillis C, Watt G, et al. Education and occupational social class: which is the more important indicator of mortality risk? *Journal of Epidemiology & Community Health* 1998;**52**:153-160.

5. Davey Smith G, Hart C, Blane D, Gillis C, Hawthorne V. Lifetime socioeconomic position and mortality: Prospective observational study. *BMJ* 1997;**314**:547-552.

6. Macleod J, Davey Smith G, Heslop P, Metcalfe C, Carroll D, Hart C. Are the effects of psychosocial exposures attributable to confounding? Evidence from a prospective observational study on psychological stress and mortality. *Journal of Epidemiology & Community Health* 2001;**55**:878-884.

7. Davey Smith G, Hart CL, Watt G, Hole D, Hawthorne VM. Individual social class, area-based deprivation, cardiovascular disease risk factors and mortality : the Renfrew and Paisley study. *Journal of Epidemiology & Community Health* 1998;**52**:399-405.

8. Hart CL, Davey Smith G, Hole DJ, Hawthorne VM. Alcohol consumption and mortality from all causes, coronary heart disease and stroke: results from a prospective cohort study of Scottish men with 21 years of follow up. *BMJ* 1999;**318**:1725-1729.

9. Hanlon P, Walsh D, Whyte BW, Scott SN, Lightbody P, Gilhooly MM. The link between major risk factors and important categories of admission in an ageing cohort. *Journal of Public Health Medicine* 2000;**22**:81-89.

10. Metcalfe C, Davey Smith G, Sterne J, Heslop P, Macleod J, Hart C. Individual employment histories and subsequent cause specific hospital admissions and mortality: a prospective study of a cohort of male and female workers with 21 years of follow up. *Journal of Epidemiology & Community Health* 2001;**55**:503-504.

11. Hawthorne VM, Watt GCM, Hart CL, Hole DJ, Davey Smith G, Gillis CR. Cardiorespiratory disease in men and women in urban Scotland: baseline characteristics of the Renfrew/Paisley (Midspan) Study population. *Scottish Medical Journal* 1995;**40**:102-107.

12. Hart C, Hole D, Davey Smith G. Risk factors and 20 year stroke mortality in men and women in the Renfrew/Paisley study in Scotland. *Stroke* 1999;**30**:1999-2007.

13. Hart CL, Hole DJ, Gillis CR, Davey Smith G, Watt GCM, Hawthorne VM. Social class differences in lung cancer mortality: risk factor explanations using two Scottish cohort studies. *International Journal of Epidemiology* 2001;**30**:268-274.

14. Deary IJ, Whalley LJ, Lemmon H, Crawford JR, Starr JM. The stability of individual differences in mental ability from childhood to old age: follow-up of the 1932 Scottish Mental Survey. *Intelligence* 2000;**28**:49-55.

15. Shenkin SD, Starr JM, Pattie A, Rush MA, Whalley LJ, Deary IJ. Birth weight and cognitive function at age 11 years: the Scottish Mental Survey 1932. *Archives of disease in childhood* 2001;**85**:189-197.

16. Starr JM, Deary IJ, Lemmon H, Whalley LJ. Mental ability age 11 years and health status age 77 years. *Age and Ageing* 2000;**29**:523-528.

17. Walker N, McConville P, Hunter D, Deary IJ, Whalley LJ. Childhood mental ability and lifetime psychiatric contact: A 66-year follow-up study of the 1932 Scottish Mental Ability Survey. *Intelligence* 2002;**30**:233-245.

18. Whalley LJ, Deary IJ. Longitudinal cohort study of childhood IQ and survival up to age 76. *British Medical Journal* 2001;**322**:819-822.

19. Whalley LJ, Starr JM, Athawes R, Hunter D, Pattie A, Deary IJ. Childhood mental ability and dementia. *Neurology* 2000;**55**:1455-1459.

20. Scottish Council for Research in Education. *The intelligence of Scottish children: a national survey of an age-group*. London: University of London Press, 1933;

21. Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. *Bull World Health Organisation* 1962; **27**:645-658.

22. Hole DJ, Watt GCM, Davey Smith G, Hart CL, Gillis CR, Hawthorne VM. Impaired lung function and mortality risk in men and women: Findings from the Renfrew and Paisley prospective population study. *BMJ* 1996;**313**:711-716.

23. Hart CL, Watt GCM, Davey Smith G, Gillis CR, Hawthorne VM. Pre-existing ischaemic heart disease and ischaemic heart disease mortality in women compared with men. *International Journal Of Epidemiology* 1997;**26**:508-515.

24. Prineas RJ, Crow RS, Blackburn H. *The Minnesota Code Manual of Electrocardiographic Findings: standards and procedures for measurement and classification*. Boston, Massachusetts: John Wright, 1982;

25. Medical Research Council. Definition and classification of chronic bronchitis for epidemiological purposes. *Lancet* 1965;**i** :775-779.

26. Carstairs V, Morris R. *Deprivation and Health in Scotland.* Aberdeen: Aberdeen University Press, 1991;

27. General Register Office. *Classification of Occupations 1966*. London: HMSO, 1966;

28. SPSS Inc. *SPSS Base System Syntax Reference Guide*. USA: 1993;

29. Maxwell J. *The level and trend of national intelligence: the contribution of the Scottish mental surveys.* London: University of London Press, 1961;

30. Blane D, Davey Smith G, Hart C. Some social and physical correlates of intergenerational social mobility: evidence from the West of Scotland Collaborative Study. *Sociology* 1999;**33**:169-183.

31. Boyle P, Halfacree K, Robinson V. *Exploring Contempory Migration*. Harlow: Longman, 1998;

32. Schimdt FL, Hunter JE. The validity and utility of selection methods in personnel psychology: practical and theoretical implications of 85 years of research findings. *Psychological Bulletin* 1998;**124**:262-274.

TABLE 1 *Reasons for accepting matches between the Midspan studies and the Scottish Mental Survey 1932*

	Renfrew/Paisley	Collaborative	Total
Direct match	466	206	672
Diminutive name used	89	20	109
Two forenames	56	25	81
Abbreviation used for forename	16	9	25
Different spelling of surname or forename	40	15	55
Place of birth/location of school similar	4	3	7
Mc/Mac misspelling	6	6	12
Slight date of birth mismatch	61	10	71
Other	2	-	2
Total	740	294	1034

TABLE 2 *Comparison of variables in Midspan participants who were matched and not matched with the SMS1932 database*

	Men			Women			All		
	Matched	Not matched	Test* for difference p	Matched	Not matched	Test* for difference p	Matched	Not matched	Test* for difference p
Number	604	130		428	89		1032	219	
Means of continuous variables									
Age at screening (yrs)	51.4	51.1	0.10	52.4	52.1	0.025	51.8	51.5	0.011
Systolic blood pressure (mmHg)	140.5	138.7	0.37	146.2	146.6	0.89	142.9	141.9	0.56
Diastolic blood pressure (mmHg)	84.2	85.3	0.32	85.0	85.4	0.78	84.5	85.4	0.37
Cholesterol (mmol/L)	5.94	6.01	0.46	6.49	6.49	0.97	6.17	6.20	0.63
Height (cm)	170.8	172.3	0.024	158.0	157.4	0.37	165.5	166.3	0.31
Weight (kg)	74.6	77.9	0.002	64.3	65.1	0.62	70.3	72.7	0.028
Body mass index (kg/m^2)	25.5	26.2	0.049	25.7	26.2	0.43	25.6	26.2	0.045
Adjusted FEV1 (%)	92.7	92.8	0.94	93.0	90.5	0.41	92.8	91.9	0.59
Blood glucose (mmol/L)†	5.1	5.2	0.83	4.9	5.4	0.31	5.0	5.3	0.09
Siblings‡	3.6	2.7	0.005	5.7	4.6	0.34	3.8	2.9	0.004
Units of alcohol/week‡	11.4	11.5	0.98	2.9	1.6	0.41	10.4	10.3	0.95
Percentages of discrete variables									
Never smoked	16.4	14.6	0.62	38.8	36.0	0.62	25.7	23.3	0.46
Current cigarette smokers	59.6	56.9	0.57	52.3	57.3	0.39	56.6	57.1	0.90
Ex-smokers	22.0	26.9	0.23	8.6	6.7	0.55	16.5	18.7	0.42
Definite angina	7.3	6.2	0.65	7.7	6.7	0.75	7.5	6.4	0.58
Severe chest pain	8.4	8.5	1.0	6.1	2.2	0.20	7.5	5.9	0.43
ECG ischaemia	8.8	8.5	0.91	6.1	10.1	0.17	7.7	9.1	0.46
MRC bronchitis	4.0	3.8	0.95	3.7	3.4	1.0	3.9	3.7	0.88
Diabetes	1.3	2.3	0.42	0	0	-	0.8	1.4	0.42
Deprivation category 6&7	25.0	19.2	0.16	22.5	19.3	0.51	24.0	19.3	0.13
Manual social class	61.3	56.2	0.28	58.4	61.0	0.67	60.1	58.0	0.57
Manual 1st social class‡	63.3	55.0	0.24	80.6	66.7	0.39	65.4	56.5	0.17
Manual father's social class‡	78.8	62.3	0.007	94.4	100	1.0	80.8	66.2	0.009
Left FTE age ≤14‡	59.5	47.0	0.07	88.9	75.0	0.30	63.1	50.0	0.039
Regular car driver‡	51.2	65.2	0.042	8.3	0	1.0	45.9	57.3	0.08

* t test for continuous variables, chi-squared test for discrete variables
† available only in Renfrew/Paisley study
‡ available only in Collaborative study

TABLE 3 *Mean IQ scores, corrected for age at time of testing, by social class and deprivation category in adulthood for males and females in the Midspan studies who were matched to a score on the SMS1932 data set* (n=922 excluding missing social class or deprivation category)

	Social class							
	I	II	IIINM	IIIM	IV	V	Trend	Trend (adjusted for deprivation category)
Men								
Number	41	109	66	211	102	20		
Mean IQ	114.9	110.4	102.0	97.7	95.1	89.8	p<0.0001	p<0.0001
Depcat 1-5	114.9	111.0	103.7	98.2	96.6	91.9		
Depcat 6-7	115.3	107.2	95.7	96.6	92.5	85.0		
Women								
Number	9	48	101	62	117	36		
Mean IQ	106.0	105.4	104.1	92.9	93.7	93.4	p<0.0001	p<0.0001
Depcat 1-5	106.0	106.2	105.1	93.2	94.4	92.2		
Depcat 6-7	-	98.3	100.8	91.7	92.3	96.9		
All								
Number	50	157	167	273	219	56		
Mean IQ	113.3	108.9	103.3	96.6	94.3	92.1	p<0.0001	p<0.0001
Depcat 1-5	113.2	109.5	104.5	97.0	95.4	92.1		
Depcat 6-7	115.3	105.2	98.8	95.7	92.4	92.1		

TABLE 4 *Mean IQ scores, corrected for age at time of testing, by deprivation category and social class in adulthood for males and females in the Midspan studies who were matched to a score on the SMS1932 data set* (n=922 excluding missing social class or deprivation category)

	Deprivation category								
	1	2	3	4	5	6	7	Trend	Trend (adjusted for social class)
Men									
Number	39	16	81	134	141	101	37		
Mean IQ	110.2	108.7	106.7	102.1	98.5	98.3	92.3	p<0.0001	p<0.0001
Non manual	112.3	114.4	109.1	109.2	107.6	105.3	91.0		
Manual	98.7	91.6	104.1	97.1	95.0	95.3	92.5		
Women									
Number	27	1	44	74	139	66	22		
Mean IQ	110.8	111.2	101.4	98.3	96.5	95.9	92.7	p<0.0001	p<0.0001
Non manual	114.9	111.2	105.9	103.3	102.8	101.7	92.3		
Manual	96.6	-	95.5	94.3	92.8	92.8	92.8		
All									
Number	66	17	125	208	280	167	59		
Mean IQ	110.5	108.8	104.8	100.8	97.5	97.4	92.4	p<0.0001	p<0.0001
Non manual	113.3	114.1	107.9	107.0	104.9	103.8	91.6		
Manual	97.6	91.6	101.4	96.1	94.0	94.4	92.6		