ever working night shifts ($p=7.3 \times 10^{-8}$). There was nominal evidence for an inverse association between current shift and rotating work with accelerated ageing (EAA) (mean difference=-0.98 (-1.93, -0.39); p=0.041 and −1.11 (−2.19,–0.04); p=0.041, respectively).

Conclusion Shift work was associated with differential methylation in blood, including a CpG site in *PPARG*. This CpG site is specific to the Illumina EPIC array, not being present on the predecessor 450 K array, and represents a potentially novel finding. PPAR-gamma has been implicated in the pathology of obesity, diabetes and cancer, although further work is required to appraise the causal effect of methylation on health outcomes. Furthermore, there was some evidence that current shift workers had decelerated methylation age compared with non-shift workers. However, the number of shift workers in this study was relatively small and further validation of findings is required.

P9 DOES CHILDHOOD SOCIO-ECONOMIC DISADVANTAGE MODERATE HEALTH BEHAVIOURS AND OCCUPATIONAL AND ENVIRONMENTAL HAZARDS ASSOCIATION'S WITH ADULT LUNG FUNCTION; A CROSS SECTIONAL ANALYSIS USING THE UK HOUSEHOLD LONGITUDINAL STUDY

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Background Lung function is lower in people with disadvantaged socio-economic position (SEP) and is associated with certain health behaviours and exposures. The effects are likely to be interactive, for example socially patterned environmental tobacco smoke (ETS) in childhood is associated with an increased effect of smoking in adulthood. We hypothesise that disadvantaged childhood SEP increases susceptibility to the effect of hazards for lung function in adulthood. We test whether disadvantaged childhood SEP moderates smoking, physical activity, obesity, occupational exposures, ETS and air pollution's associations with lung function.

Methods Data are from the Nurse Health Assessment (NHA) in waves two and three of United Kingdom Household Longitudinal Study (UKHLS). The NHA is drawn from the UKHLS General Population Sample, a stratified, clustered, equal probability sample, and from the British Household Panel Survey sample which began in 1991 as a stratified random sample. Analysis is restricted to English residents aged at least 20 for women and 25 for men; an analytical sample of 16 328. Lung function is measured with forced expiratory volume in the first second (FEV_1) and standardised to the percentage of expected FEV_1 for a healthy non-smoker of equivalent age, gender, height and ethnicity (FEV_1%). A multilevel approach was used with individuals nested in households in neighbourhoods. Using STATA14, a mixed linear model was fitted with interaction terms between childhood SEP and health behaviours and occupational exposures. Cross level interactions tested whether childhood SEP moderated household ETS and neighbourhood air pollution's associations with FEV_1%.

Results SEP, smoking, physical activity, obesity, occupational exposures and air pollution were associated with lung function. Interaction terms indicated a stronger association between disadvantaged childhood SEP and currently smoking (coefficient (_b) −6.506%, 95% confidence intervals (95% CI): −9.561%, −3.451%), formerly smoking (_b −2.331% 95% CI −3.674%, −0.988%) and occupational exposures, (_b −1.436% 95% CI −2.725%, −0.147%). Significant interactions were not found with physical activity, obesity, ETS and air pollution.

Conclusion The findings suggest that disadvantaged SEP in childhood may make people more susceptible to the negative effect of smoking and occupational exposures in adulthood. This is important as those most likely to encounter these exposures are at greater risk to their effects. Policy to alleviate this inequality requires intervention in health behaviours and via health and safety legislation.

P10 LONG TERM HEALTH EFFECTS OF NEET EXPERIENCES: EVIDENCE FROM SCOTLAND

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Background Reducing the number of young people not in employment, education or training (NEET) is high in political agenda in many countries. The Europe 2020 flagship initiative Youth on the Move introduce a number of programmes that tackle this problem. Although NEET young people have been identified as one of the most vulnerable groups since the 1990s, little is known about the long-term effect of NEET experiences, especially the health consequences. This paper investigates whether experiences of NEET young people are associated with poor health.

Methods We used the Scottish Longitudinal Study (SLS), which collates information from the 1991, 2001, and 2011 censuses as well as from vital events, for a 5.3% representative sample of the Scottish population. Linked health data such as hospital admissions and prescribing in general practice are also available. We followed around 14 000 young people who were aged 16–19 in 1991 up to 2010. We explored whether NEET young people in 1991 displayed higher risks of poor physical and mental health in the follow-up period. Three health outcomes are used in the analysis: mortality, hospitalisation and prescription of anti-depressant and anti-anxiety medication. We used logistic regression to model the probability of hospitalisation and poor mental health. We fitted a Cox proportional hazards model to model time to death. Covariates include a number of individual socioeconomic characteristics and local area characteristics.

Results Over 40% of the cohort members have been admitted into hospital, while over 15% have been prescribed with anti-depressant and anti-anxiety drugs, and 1% died in the follow-up period. The NEET status in 1991 appears to be associated with hospitalisation with adjusted odds ratio (OR) of 1.24 (95% Confidence Intervals (CIs): 1.08–1.42). Also the NEET experiences are associated with poor mental health with OR of 1.47 (95% CI 1.27 to 1.71). The hazard ratio of death for NEETs is more than twice that for non-

NEETs (HR: 2.5 95% CI 2.2 to 2.9). The elevated risk remained even when the models were fitted separately by gender.
Conclusion We found that NEET experiences are associated with elevated risks of mortality, hospitalisation and poor mental health. Disengagement from employment and education during transition from school to work may lead to long term negative health effects which in turn results in social and economic costs to society. Policy intervention is necessary in assisting NEET young people to re-engage in education or employment.

P11 MATHEMATICAL COUPLING AND CAUSAL INFERENCE THROUGH EXAMPLE

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Background In health studies, proportions and percentages can often seem more informative than raw counts and therefore appear to be of more interest to analysts. However, it has long been acknowledged that their use is problematic in correlation and regression analyses where they comprise common components that are present in both the dependent and independent constituents of a model (exposure and outcome), as in the regression analysis of proportions with common denominators. We demonstrate this so-called mathematical coupling with real-world examples aided by directed acyclic graphs (DAGs) and simulations.
Methods We consider three possible real-world scenarios: (1) the population size (N) of a geographical area causes both the number of people living in detached houses (X) and the number of people living in care homes (Y), within each area, but the number of detached houses (X) does not cause the number of care homes (Y) within any area, or vice versa; (2) the population size (N) of a geographical area causes both the number of people with no formal qualifications (X) and the number of people with poor self-reported health (Y), while both the population size (N) and number of people with no formal qualifications (X) are causes of the number of people with self-reported poor health (Y); and (3) within a geographical area, the area wealth (X) causes the number of elderly people (N), while both area wealth (X) and the number of elderly people (N) cause social care expenditure (Y).
Results We show how historical solutions to the issue of mathematical coupling caused by a common denominator hold under the situation when the denominator is a confounder of the exposure outcome relationship; i.e. the results of the simulated examples under scenarios 1 and 2 result in expected regression coefficients. The same solution does not hold in scenario 3, when the denominator is a mediator (i.e. lies on the causal path) between the exposure and outcome.
Conclusion We show how DAGs and accompanying causal graph theory can be used to understand a problem first presented over a century ago. We highlight the issue of mathematical coupling when analysing proportions with a common denominator, showing under which circumstances historical solutions are valid or invalid. By using real-world examples to inform simulations, we demonstrate the utility of DAGs and causal graph theory in health geography and observational research to understand statistical problems and to verify proposed solutions.

P12 HOW TO BUILD THE 'RIGHT' DIRECTED ACYCLIC GRAPH (DAG): A SYSTEMATIC, TRANSPARENT AND ACCESSIBLE METHOD FOR EVIDENCE SYNTHESIS

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Background Causal inference methods are increasingly popular in health research, with directed acyclic graphs (DAGs) being notably prominent. Theoretically, DAGs are powerful tools for minimising bias in quantitative analysis, however their transition into practice has been problematic. Lack of guidelines for generating the 'right' DAG for research questions have been cited as a central reason. This study presents a solution in the form of 'evidence synthesis for constructing directed acyclic graphs' (ESC-DAGs). The approach embeds DAGs in a procedural evidence synthesis method which focuses on how to derive and integrate DAGs from research evidence in a transparent and systematic fashion.
Methods For studies meeting inclusion criteria: 1) *Appraisal* of study quality with split focus on the degree of explicit causal thinking employed and on more generic study quality issues such as study design, sample size, etc; 2) *Mapping* of conclusions for each study using causal inference theory to produce an 'implied graph'; 3) *Translation* of implied graphs into DAGs through procedural application of four 'causal criteria' to each relationship in the implied graph (temporality, plausibility, recourse to theory, counterfactual thought experiment); 4) *Integration* of DAGs, starting with those with the highest appraisal scores until all DAGs are integrated. The output is an 'integrated-DAG'. ESC-DAGs is demonstrated on the exposure-outcome relationship of parental influences on adolescent alcohol harm.
Results 30 studies were included. Study appraisal produces a scale with scores ranging from 0 to 5 (median=2). The DAGs produced for individual studies are substantially less comprehensive than the integrated-DAG (covering between 5% and 40% of causal pathways). Over 90% of the implied graphs were changed during the translation process. The most common changes reflect a strong tendency in research to either mistakenly control for mediation or for unjustified control of parallel risk factors.
Conclusion As a methodological contribution to an increasingly popular form of health research, ESC-DAGs has broad relevance to population health. Through its systematic treatment of research evidence, ESC-DAGs is a reproducible and transparent process that is suitable for use by researchers with only minimal training on the causal inference methods. Compared to how DAGs have been constructed elsewhere, those generated from ESC-DAGs are more comprehensive and have greater potential to reduce bias. In meeting the need for guidelines on generating DAGs in such a way, ESC-DAGs represents an important step towards realising the potential of DAGs to improve the practice of health research.