

FeNO and pulmonary functions. Three studies were not significant correlation. The various results of studies were effected by characteristics of the patients (COPD severity, smoking status, treatment status) and differences in FeNO measurement methods.

Conclusions The studies includes in this review highlight the difficulties of correlation between FeNO and pulmonary function. So, the role of add-on monitoring of FeNO to pulmonary function test is less clear because of the absence of conclusive double-blind, randomised, control studies concerning potential clinical benefits in the management of COPD. Further randomised controlled trials are required.

0441 **PARENTAL INCOME IS MORE IMPORTANT THAN PARENTAL EDUCATION TO CHILDREN'S HEALTH AND WELLBEING IN ADULTHOOD: EVIDENCE FROM THE TROMSØ STUDY**

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Objectives The aim of this research was to estimate and compare the direct and indirect influence (mediated by respondents' education) of three indicators of CSES (childhood financial conditions, mothers' education, fathers' education) on: i) the generic health dimensions included in the EQ-5D; ii) self-rated health (SRH), iii) age-comparative self-rated health (ASRH), and; iv) subjective wellbeing.

Method The data was analysed using Stata command Paramed. Log-linear regression was used for the health and life satisfaction outcomes to estimate the natural direct effects (NDE), natural indirect effects (NIE) and marginal total effects (MTE) as risk ratios (RR). Statistically significant interaction ($p < 0.05$) was observed between the CSES exposures and gender, regressed on the health and wellbeing outcomes, therefore the analysis was conducted separately for men and women.

Results Childhood financial conditions was associated (NDE) with all health measures. Men had a higher risk of being unhealthy on the composite EQ-5D measure, and the anxiety/depression dimension, but women had a higher risk of being unhealthy on the dimensions self-care, usual activities, pain/discomfort, as well as on SRH. Childhood financial conditions had no statistically ($p > 0.05$) significant NIE mediated by respondents' education, on any health measure. While almost all NDEs of parental education on health outcomes were not statistically significant ($p > 0.05$), most of the NIEs of parental education were statistically significant ($p < 0.05$).

Conclusions Childhood financial conditions have a strong direct effect on later health and wellbeing, independent of respondents' education, while parental education has an indirect effect on later health mediated by respondents' education.

Symposiums

0112 **COMPONENTS OF THE HEALTHY WORKER EFFECT WITH QUANTIFICATION FOR DIFFERENT REFERENT COMPARISONS**

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Objectives The healthy worker effect (HWE) is widely known to bias standardised risk estimates from occupational cohort studies. Multiple factors contribute to HWE bias that is commonly characterised as confounding due to the selection of individuals with "better health status" who are more likely to gain and retain employment relative to a general population including non-employed persons. Comparisons between standardised mortality ratios (SMRs) estimated from reference population rates with different characteristics allow for quantitative evaluation of different components of the HWE.

Method Data from over five decades for a company-wide mortality registry comes from life insurance claims, and deaths are validated against the U. S. National Death Index. Average person-years at risk during five-year calendar periods for the occupational cohort population are estimated. The expected mortality counts are specific to age, sex, race, and calendar-time period strata. SMRs are calculated based on the mortality rates for the general U. S. population and the company-wide population.

Results From 1956 through 2012, the annual US employee population has ranged from 29 000 to 108 000 workers. The mortality registry includes over 80 000 deaths validated through 2010, 25% due to malignant neoplasms and 37% due to cardiovascular diseases.

Conclusions The HWE influences the interpretation of standardised estimates from occupational studies. Comparisons for different reference populations can evaluate differential HWE bias of associations between occupational exposure and mortality. Analyses based on company reference rates identify contributions from components of the HWE based on comparable demographic characteristics, a similar likelihood of obtaining and retaining employment, and an equivalent potential for ascertainment of mortality outcomes.

0114 **A BAYESIAN APPROACH TO ACCOUNT FOR THE HEALTHY WORKER SELECTION EFFECT**

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Objectives We propose a Bayesian method to adjust for the component of the healthy worker effect that arises from selection of healthier individuals into workforce to allow correct estimation of the standardised mortality ratio (SMR) and associated credible intervals.

Method Information on general populations is typically used to generate expected counts for outcomes in SMR calculations but an occupational cohort is not a random sample of the general population. The alternative is to use the expected number of outcomes from industrial cohorts known to experience the outcome of interest but free of the exposures that defined the observed cohort. In Bayesian terms, we can view "expected counts of outcomes given the observed age-sex-period structure" as the target of inference for which we seek a posterior distribution. We show that the problem reduces to elucidation of a prior distribution: we propose using expert opinions about relative rates of mortality outcomes of interest in the observed cohort relative to general population rates and direct estimation of reference rates from occupational cohort studies.

Results Data from DuPont on 320 000+ active and former employees with work histories in the US from 1955 will be used. This registry allows for the calculation of expected

mortality counts using adjusted rates for national and regional DuPont worker populations. Robust specification of priors will be sought. Implementation of the calculations will be developed in common software.

Conclusions We plan to develop a method for SMR calculation that accounts for the healthy worker selection effect both in the point estimate and uncertainty interval.

0310 NAPPING DURING NIGHT SHIFT AND SELF-REPORTED HYPERTENSION AMONG NURSING WORKERS

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Objectives Night and shift work are suggested risk factors for hypertension. Considering the relationship between sleep deprivation and blood pressure, this study focuses on self-reported hypertension and napping during night shift. Our aims are (1) to analyse the prevalence of hypertension among day and night workers and (2) to test the association between napping regularly during night shifts and prevalence of hypertension among night workers.

Method This cross sectional questionnaire study was carried out at 18 public Brazilian hospitals in 2010–2011 (N=3229 registered nurses). Only women workers were included in the analysis (N=1992). Statistical treatment of data was carried out in two steps: (i) assessing self-reported hypertension considering work schedule and (ii) analysing nap habits during night shifts and self-reported hypertension.

Results Mean age was 39.9 (SD= 10) years. Napping during the night shift (for up to three hours) increased the odds of self-reported hypertension 1.8-fold (95% CI 1.36–2.45) compared with day workers with no experience on night shifts, after adjusting for age, physical activity, smoking habits, and housework. Among night workers, sleeping during the night shift reduced the odds of reporting hypertension (OR=0.79; 95% CI 0.63–1.00), compared to those who reported not to sleep during the night shifts.

Conclusions The higher prevalence of hypertension among shift workers was confirmed. Dipping patterns and blood pressure control may be influenced by short periods of sleep in night shifts. The potential positive effect of naps on blood pressure deserves further investigation through automatic monitoring.

0341 COUNTERFACTUALS, QUANTUM MECHANICS AND G-ESTIMATION: CAUSALITY THREATENS EPIDEMIOLOGY

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Objectives Causal reasoning should have an explicit formal structure.

Method Such a structure can be provided with the help of counterfactuals. This approach allocates different versions (factual and non-factual) of exposures and responses to every basic study unit (e.g., a subject observed at one point of time). Comparisons of these versions within the unit imply causal statements about the effect of exposures. This approach may appear unusual and

strange but it is consistent to basic principles of modern physics (superposition principle of quantum mechanics).

Results The outline of causality in counterfactual terms is helpful to solve problems like defining and measuring direct and indirect causal paths or to specify biases and adjusting procedures. In contrast to experimental research observational studies (like those performed in epidemiology) suffer from missing randomization. A causal concept is important to understand the reliability of such studies: a strict counterfactual framework motivates to analyse observational studies in terms of generalised treatments (“G”). G-estimation is a procedure that defines the causal effect estimates on the individual level by counterfactual failure times. Causal models are nested within estimating models (“structurally nested failure time models”).

Conclusions Such a strict counterfactual reasoning challenges standard estimators and estimating procedures usually applied in epidemiology.

0348 THE HEALTHY WORKER SURVIVOR EFFECT DISSECTED: ADDRESSING COMPONENT PARTS

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Objectives The healthy worker survivor effect (HWSE) is a well-recognised bias usually described as a form of selection bias or confounding. A more precise epidemiologic explanation, however, has been elusive. We distinguish several components of the HWSE and suggest methods for bias correction in occupational cohort studies.

Method Although generally referred to a single effect, we demonstrate using simulation studies that there are in fact four distinct aspects of the HWSE. Two aspects, (1) time-varying confounding by variables on the causal pathway and (2) heterogeneity in susceptibility, are functions of the underlying process of the exposure and disease under study. The other two, (3) left truncation and (4) right truncation, are functions of how the data are collected, ie the study design. We quantify the bias induced by each aspect of HWSE on dose-response parameter estimates and apply methods designed to reduce the bias.

Results We find that causal techniques, eg, g-estimation and IPTW, can correct for time-varying confounding. Heterogeneous susceptibility in combination with either left or right truncation can be corrected using inverse probability of censoring weights. The health related variables needed to make either of these methods succeed in reducing the bias are often unmeasured.

Conclusions HWSE occurs due to the presence of any of four factors that may function separately or in concert to produce a downward bias if not accounted for. We provide guidance for methodologic approaches to reduce the bias.

0351 G-ESTIMATION: WHY DOES IT WORK AND WHAT DOES IT OFFER?

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