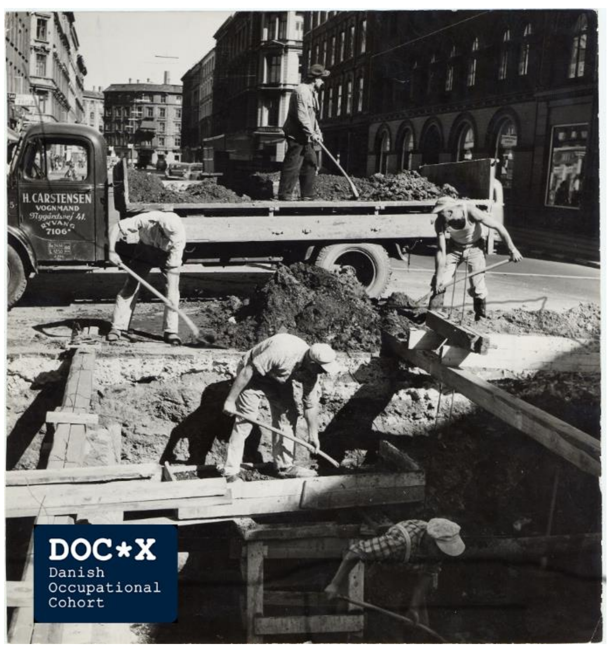
En landsdækkende dansk arbejdsmiljøkohorte med job- og eksponeringsdata: Etablering af en åben forskningsressource

DOC*X

Danish **O**ccupational **C**ohort with e**X**posure data



Slutrapport til Arbejdsmiljøforskningsfonden

Januar 2020

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Titel:	En landsdækkende dansk arbejdsmiljøkohorte med job- og eksponeringsdata: Etablering af en åben forskningsressource
Projekt:	Projektnummer: 43-2014-03 Startdato: 1. januar 2015 Slutdato: 30. juni 2019

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Indhold

Forord

Projektets overordnede formål var at etablere den Danske Arbejdsmiljøkohorte med Eksponeringsdata (DOC*X) i et tæt samarbejde mellem en række større forskningsenheder på arbejdsmiljøområdet i Danmark. DOC*X er i dag en åben international forskningsressource beliggende på en platform i Danmarks Statistik (www.doc-x.dk).

DOC*X omfatter alle erhvervsaktive i bosiddende I Danmark perioden 1970-2017 med oplysninger om jobtitel og branche gennem livet. På grundlag af jobtitel og branche tilføjes specifikke oplysninger om den enkeltes livslange udsættelse for arbejdsmiljøpåvirkninger via Job-Eksponerings-Matricer (JEM). Dermed kan DOC*X være med til at fremme tids- og kosteffektive undersøgelser af sammenhængen mellem arbejdsmiljø og helbred samt bidrage til at samle arbejdsmiljøforskningen indenfor forskellige områder.

DOC*X indeholder i dag JEM for følgende eksponeringer: psykosociale- og biomekaniske faktorer, partikler, kemiske stoffer, lys, støj, våde hænder i arbejdet samt JEM for forskellige livsstilsfaktorer. Perspektivet er med tiden at koble flere og flere specifikke arbejdsmiljø- og miljøpåvirkninger til databasen og på denne måde skabe en værdifuld forskningsressource, som fremadrettet også skal være åben over for andre forskere nationalt og internationalt.

Projektet er inddelt i flere casestudier som illustrerer anvendeligheden af databasen og brugen af JEM, og som belyser aktuelle problemstillinger om sammenhængen mellem arbejdsmiljøpåvirkninger og helbredsforhold. Derudover indeholder projektet et afsluttende hovedprojekt, der undersøger sammenhængen mellem fysisk krævende arbejde og risikoen for hjertekarsygdom. Hovedprojektet skildrer, hvordan man kan bruge databasen til at undersøge sammenhængen mellem arbejdsmiljøpåvirkninger og helbredsforhold uden i forvejen at have adgang til individuelle eksponeringsdata.

I denne rapport gives en kortfattet samlet redegørelse for projektet, herunder en redegørelse for hvert casestudie, med henvisning til forskningsmæssig dokumentation i publicerede tidskriftsartikler, færdige manuskripter, samt præsentationer ved både nationale og internationale konferencer.

Koordinationsgruppen for DOC*X retter en stor tak til alle samarbejdspartnere, der har været involveret i eller støttet projektet.

DOC*X koordinationsgruppen, Januar, 2020

Resumé

DOC*X er en database sammensat af registerdata fra Danmarks Statistik med arbejdshistorik for hele den danske befolkning siden 1970. Databasen indeholder desuden 16 forskellige Job-Eksponerings-Matricer (JEM) med data for eksponeringer i arbejdsmiljøet, der gør det muligt at gennemføre epidemiologiske studier om sammenhængen mellem arbejdsmiljøeksponering og risiko for sygdom.

Vi har oprettet og dokumenteret fagregisteret i DOC*X med kronologiske oplysninger om fag og branche for alle personer med erhvervsarbejde i Danmark i perioden fra 1970-2017 (1971-75 undtaget). Oplysninger om fag og branche er ensartet over tid, hvilket muliggør lang opfølgningstid. De ensartede fagkoder i DOC*X er blevet valideret særskilt, hvor selvrapporteret fagtitel er blevet omskrevet til en DISCO-88 kode og sammenholdt med den registrerede DISCO-88 kode i DOC*X. Valideringen viste god overensstemmelse mellem eksponeringsniveauer ved inddeling via JEM, men varierende overensstemmelse når DISCO-88 grupperne sammenlignes direkte én til én.

En åben forskningsressource

DOC*X er etableret som en åben forskningsressource. Information omkring ansøgning til dataadgang ligger tilgængelig på hjemmesiden www.doc-x.dk. Ansøgningsproceduren er sat i system, så der forholdsvis hurtigt kan gives adgang til data fra DOC*X's styregruppe. Derefter er det Danmarks Statistik, der skal godkende projekt og dataadgang, hvilket sker efter Danmarks Statistiks egne forskrifter. Processen er løbende blevet tilpasset og justeret, så arbejdsgangene lettes både for DOC*X's to databaseadministratorer ved Bispebjerg-Frederiksberg Hospital og Danmarks Statistik.

Delprojekter

DOC*X projektet er underinddelt i otte delprojekter med hver sit hovedformål. Resultater er publiceret i peer-review videnskabelige tidsskrifter (se Bilag 3). Herunder præsenteres kort konklusionerne i de otte delprojekter:

(1) Psykosocialt og fysisk arbejdsmiljø: I projektet blev udviklet en JEM for psykosocialt arbejdsmiljø (kvantitative og følelsesmæssige krav, indflydelse, job-strain, job usikkerhed, og arbejdsrelateret vold) og for fysisk arbejdsmiljø (sumscore baseret på 8 spørgsmål om arbejdsaktiviteter, herunder arbejdsstillinger, skub og træk, løft, og gående/stående arbejde). For hver eksponering blev på basis af spørgeskema oplysninger i landsdækkende undersøgelser af tilfældige udsnit af lønmodtagere udført af NFA beregnet køns- og alders- og DISCO-88 fagspecifikke kvantitative mål for eksponeringsniveau. Disse JEM blev anvendt til at undersøgelse indvirkning af psykosocialt arbejdsmiljø på muskelskeletbesvær. Resultaterne viste, at der var god overensstemmelse mellem de sammenhænge der blev fundet for psykosocialt arbejdsmiljø og smerter ved brug af eksponeringsmål fra JEM henholdsvis selvrapporterede data.

(2) Biomekaniske påvirkninger: Projektet inkluderede validering og videreudvikling af JEM for ryg-ben (Lower body JEM) og skulder (Shoulder JEM). Ryg-ben JEM blev valideret ved sammenligning mellem ekspertvurderede værdier og spørgeskemabaserede eksponeringsestimater, målte arbejdsstillinger og observerede løftemængder. Resultaterne underbyggede validiteten af de ekspertvurderede eksponeringer i Ryg-ben JEM. Skulder JEM blev anvendt til at identificere sikre eksponeringsniveauer hen over 10-års perioder via en ny statistisk analysetilgang. Præliminære analyser af isolerede versus kombinerede effekter af forskellige skuldereksponeringer pegede på kraftbetonet arbejde som den vigtigste faktor. Endvidere er begge JEM er præliminært koblet med en jobgruppering fra USA (O*Net).

(3) Partikulære påvirkninger: I projektet blev udviklet semi-kvantitative JEM for organisk og uorganisk støv samt kvantitative delvist målebaserede køns- og aldersspecifikke JEM for henholdsvis træstøv og endotoxin (en komponent i gramnegative bakteriers cellevæg, en dokumenteret indikator for inhaler bart organisk støv i PM_{10} størrelse). Disse JEM indgik som eksponeringsmål i analyser med det formål at undersøge sammenhængen mellem aktuel organisk støveksponering og genindlæggelse for kronisk obstruktiv lungesygdom (KOL) eller astma. Analyserne tyder ikke på at organisk støveksponering er en væsentlig årsag til genindlæggelse for personer med astma. Den nedsatte risiko, der blev set for genindlæggelse for KOL blandt personer med organisk støvudsættelse tilskrives selektionsmekanismer.

(4) Fysiske påvirkninger: I Projektet blev udviklet kvantitative JEM for støj, synligt lys og UV baseret på en kombination af arbejdspladsmålinger og a priori ekspertvurderinger (såkaldte Best Linear Unbiased Predictors, BLUP). Støj-JEM havde en forskel på 20 dB mellem de højest og lavest eksponerede fag. Maskinarbejdere var blandt de højest og medarbejdere indenfor økonomi og salg blandt de lavest eksponerede. JEM for lys estimerede lysintensitet for time på dagen og måned på året. Bygningsarbejdere var blandt de højest- og hospitalsteknikere blandt de laveste eksponerede. Fremover vil støj-JEM blive brugt til at prioritere forebyggende indsatser i støjende fag og brancher og i epidemiologiske studier af helbredseffekter, som potentielt er forbundet med støjeksponering. Lys-JEM vil også blive anvendt i flere epidemiologiske undersøgelser af lyseksponering, affektive lidelser og andre sygdomme, der potentielt er forbundet med lyseksponering.

(5) Kemiske påvirkninger: Projektet undersøgte sammenhængen mellem udbredte kemiske erhvervspåvirkninger og risiko for kroniske sygdomme på basis af opdatering og tilpasning af eksisterende JEM udarbejdet i regi af en nordisk forskergruppe. Positive associationer blev fundet mellem eksponering for formaldehyd, dieseludstødning, bly, organiske opløsningsmidler og visse tungmetaller og risikoen for udvikling af ALS, dog uden observation af væsentlige dosis-respons sammenhænge. Forældres udsættelse for organiske opløsningsmidler og tungmetaller viste ingen stærke associationer med sønners risiko for testikelkræft. Svage associationer blev dog observeret for fars udsættelse for hexavalente kromforbindelser og toluen. Fars og mors udsættelse for maling, organiske opløsningsmidler, og dieseludstødning viste at være associeret til kræft i hjernen hos børn samt børneleukæmi.

(6) Livsstilsfaktorer: I projektet blev på basis af spørgeskemadata fra omkring 260.000 personer indhentet i perioden fra 1981-2013 udviklet JEM for livsstilsfaktorer, herunder for rygning, alkoholindtag, frugt- og grønt indtag, fysisk aktivitet i fritiden samt bodymass indeks (BMI, kg/m^2), som kan anvendes til justering for at imødegå skævvridning i registerbaserede arbejdsmedicinske kohortestudier. En analyse af dødelighed prædikteret ved JEM for rygning med og uden justering for uddannelse illustrerer, at denne JEM giver yderligere uafhængig information i forhold uddannelse som ofte bruges som surrogatmål. Endvidere viser resultater for iskæmisk hjertesygdom, at eksponeringsmål fra JEM for rygning, BMI og til dels fysisk aktivitet prædikterer hinanden uafhængigt risikoen for iskæmisk hjertesygdom som forventet. Validiteten af disse JEM anvendt til kontrol af livsstil i registerbaserede studier vurderes derfor at være god.

(7) Biostatistisk metodeudvikling: Et hovedproblem ved brug af JEM er misklassifikation af eksponering, som skyldes at ikke alle personer i et givet fag er udsat for samme eksponering men desuagtet i statistiske analyser behandles som om de er. Det vil ofte men ikke altid medføre en risiko for at overse sande sammenhænge. I projektet blev udviklet det teoretiske grundlag for vurdering af de situationer hvor denne misklassifikation ikke medfører svækkede risikoestimater samt hvilke statistiske metoder, der kan anvendes til beregning af unbiased (eller næsten unbiased) risikoestimater i JEM data, herunder udvikling af formler for beregning af tilhørende usikkerhed (standard-fejl).

(8) Hovedprojekt – hjertekarsygdom: Projektet havde til formål at illustrere brugen af JEM i DOC*X ved at belyse den arbejdsrelaterede risiko for iskæmisk hjertekarsygdom som følge af fysisk krævende arbejde målt som omfang af henholdsvis tunge løft og stående/gående arbejde med kontrol for livsstilsfaktorer (tobaksrygning, bodymass indeks og fysisk aktivitet i fritiden) på basis af JEM udviklet som en del af projektet. Der blev der ikke fundet tungtvejende evidens for hypotesen om at fysisk aktivitet på arbejde i form af mangeårige tunge løft og langvarigt gående stående arbejde er forbundet med en øget risiko for akut blodprop i kranspulsårerne (akut myokardie infarkt) hos hverken kvinder og mænd. Mulige effekter af pludselige markante fysiske belastninger belyses ikke, og man kan ikke helt afvise at resultaterne kan have undervurderet en reel risiko som følge af fejlagtig klassifikation af tungt løftearbejde og manglende adskillelse af stående og gående arbejde.

English Summary

DOC*X is a database composed of register data from Statistics Denmark with work history for the entire Danish population since 1970. The database also contains 16 different Job Exposure Matrices (JEM) with data for exposures in the working environment that allow for epidemiological studies occupational exposure and risk of disease.

We have created and documented the DOC*X database with chronological information on job title and industry for all Danish citizens during the period from 1970 -2017 (1971-75 excluded). The codes for job title and industry have been harmonized across the entire time span, thus allowing for long-term follow-up. The codes in DOC * X have been separately validated, where self-reported job titles manually have been converted to a DISCO-88 code and compared to the registered DISCO-88 code in DOC * X. The validation showed good agreement between exposure levels when subdivided via JEM, but varying agreement when the DISCO-88 codes are directly compared one by one.

An open research resource

The DOC*X is established as an open research resource. Information about applying for data access is available on the website www.doc-x.dk. The application procedure is managed by the DOC*X's steering committee, but Statistics Denmark must approve project and data access, which is done in accordance with Statistics Denmark's own regulations. The process has been continuously adapted and adjusted so that the workflow is facilitated for the two DOC*X's database administrators at Bispebjerg-Frederiksberg Hospital and the contact officer at Statistics Denmark.

Case studies

The DOC*X project includes eight case studies, each with its own purpose. Results are published in peer-review scientific journals (see Appendix 3). Below the eight case-studies are briefly presented.

(1) Psychosocial and physical work environment: The project developed a JEM for psychosocial work environment (quantitative and emotional demands, influence, job-strain, job insecurity, and work-related violence) and for physical work environment (sum score based on 8 questions on work activities, including posture, push and pull, lifting, and walking/standing work). For each exposure, on the basis of questionnaires in nationwide surveys of random samples of employees performed by the NFA, we calculated gender-, age- and DISCO-88 job code-specific quantitative measures of level of exposure. These JEM were used to investigate the impact of psychosocial work environment on musculoskeletal disorders. The results showed good agreement between the relationships found for psychosocial work environment and pain using exposure data from JEM and self-report, respectively.

(2) Biomechanical exposure: The project included validation and further development of JEM for lower-body and shoulder. The Lower body JEM was validated by comparing expert-assessed values with questionnaire-based exposure estimates, measured postures, and observed lift volumes. The results substantiated the validity of the expert assessed exposures in the lower body JEM. Shoulder JEM was used to identify safe exposure levels over 10-year periods via a new statistical analysis approach. Preliminary analyzes of isolated versus combined effects of different shoulder exposures pointed to forceful work as the most important factor. Furthermore, both JEM are preliminarily coupled to a job grouping from the United States (O*Net).

(3) Particulate exposure: The project developed a semi-quantitative JEM for organic and inorganic dust as well as quantitative partly measurement-based gender- and age-specific JEM for wood dust and endotoxin (a component of the cell wall of gram-negative bacteria, a documented indicator of inhalable organic dust of approximately PM_{10} size). These JEM were used in analyses aimed at investigating the association between current organic dust exposure and re-hospitalization for chronic obstructive pulmonary disease (COPD) or asthma. These analyses did not indicate that exposure to organic dust is a major cause of re-hospitalization for people with asthma. The reduced risk that was seen for re-hospitalization of COPD among people with organic dust exposure is attributed to selection mechanisms.

(4) Physical exposure: The project developed quantitative JEM for noise, visible light and ultraviolet light (UV) based on a combination of workplace measurements and a priori expert assessments (so-called Best Linear Unbiased Predictors, BLUP). The noise JEM had a difference of 20 dB(A) between the highest and lowest exposed job groups. Machine operators were among the highest and employees in finance and sales among the lowest exposed. JEM for light estimated light intensity for hour of day and month of year. Construction workers were among the highest and hospital technicians among the lowest exposed. In the future, the noise JEM be use t to prioritize preventive actions in noisy occupations and industries and in epidemiological studies of health effects potentially associated with noise exposure. The light JEM will be used in epidemiological studies on light exposure, affective disorders and other diseases potentially associated with light exposure.

(5) Chemical impacts: The project investigated the association between widespread chemical occupational exposures and the risk of chronic diseases based on updating and adaptation of existing JEM established by a Nordic research group. Positive associations were found between exposure to formaldehyde, diesel exhaust, lead, organic solvents and certain heavy metals, and the risk of developing amyotrophic lateral sclerosis (ALS, a specific serious type of sclerosis), however, without observing significant dose-response relationships. Parental exposure to organic solvents and heavy metals showed no strong associations with risk of testicular cancer in sons. Weak associations were, however, observed for the father's exposure to hexavalent chromium compounds and toluene. Parental exposure to paint, organic solvents, and diesel exhaust was associated with cancer of the brain and leukemia in children.

(6) Lifestyle factors: Based on questionnaire data from about 260,000 people gathered in the period from 1981 to 2013, we developed JEM for lifestyle factors, including smoking, alcohol intake, fruit and vegetable intake, physical activity during leisure time and bodymass index (BMI, kg/m^2), which can be used for adjustment to counter confounding due these factors in registry-based occupational cohort studies. An analysis of mortality predicted by JEM for smoking with and without adjustment for education illustrates, that this JEM provides independent prediction in addition to education, which is often used as surrogate. Furthermore, results for ischemic heart disease show that exposure estimates from JEM for smoking, BMI and, partly, physical activity mutually independently predict risk of ischemic heart disease as expected. Therefore, the validity of these JEM used to control lifestyle in registry-based studies is considered to be good.

(7) Biostatistical method development: A major problem using JEM in register-based epidemiological health research is exposure misclassification, which is due to the fact that not all persons in a given job are exposed at the same level even in statistical analyzes they are treated as if they were. Often, but not always, this will entail a risk of overlooking true risks. The project developed the theoretical basis for assessing the situations where this misclassification does not lead to attenuated risk estimates and statistical methods that can be used to calculate unbiased (or almost unbiased) risk estimates in JEM data, including the development of formulas for calculating associated uncertainty (standard error).

(8) Cardiovascular disease: The objective of this case study was to illustrate the use of JEM in the DOC*X by a study of work-related risk for ischemic heart disease according to physically demanding work in terms of heavy lifting and standing/walking work with control for lifestyle factors (tobacco smoking, bodymass index and physical activity in leisure time) on the basis of JEM developed as part of the DOC*X project. No conclusive evidence was found for the hypothesis that physical activity at work in terms of long-term heavy lifting and standing/walking at work is associated with an increased risk of acute coronary artery thrombosis (acute myocardial infarction) in neither women nor men. Possible effects of sudden significant physical stress are not elucidated, and one cannot entirely rule out that the results may have underestimated a real risk due to incorrect classification of heavy lifting at work and failure to separate standing and walking at work.

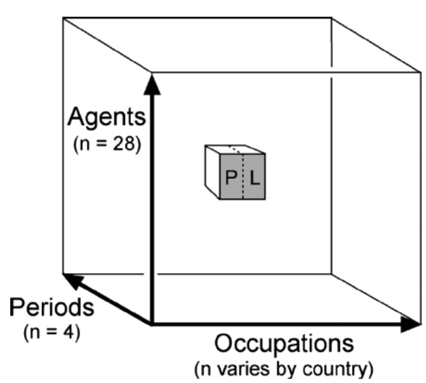
Baggrund

Introduktion

Det fremhæves gang på gang, at der i Danmark er unikke muligheder for sundhedsforskning baseret på nationale befolknings- og sundhedsregistre med komplet dækning og høj datakvalitet (1-5). I takt med at spørgeskemaundersøgelser bliver vanskeligere at gennemføre på grund af lave deltagelsesprocenter og store omkostninger, vil registerbaseret forskning fremover kunne blive endnu vigtigere. På arbejdsmiljøområdet har den registerbaserede forskning imidlertid haft et mindre omfang, hvilket kan skyldes, at de offentlige registre ikke indeholder detaljerede oplysninger om erhvervseksponeringer, og at der internationalt er peget på metodologiske mangler ved arbejdsmiljøundersøgelser baseret på job-eksponeringsmatricer (JEM) [for en oversigt se (6)]. Mulighederne er dog langt fra udtømte og i takt med stigende fokus på fysiske, biomekaniske og psykosociale arbejdsmiljøpåvirkninger har JEM fået en renæssance blandt danske forskergrupper (7-13) og et par internationale JEM for kemiske påvirkninger er tilpasset danske forhold (14,15). Tiden er derfor nu inde til en målrettet koordinering og styrkelse af denne forskning ved oprettelse af en internationalt åben forskningsressource, hvor de grundlæggende oplysninger om fag og branche for hele den danske befolkning er dokumenterede, og hvor forskere på tværs af discipliner kan drage nytte af data om arbejdsmiljøeksponeringer.

Tidligere erfaringer

En JEM er en krydstabulering af jobtitler (fag, eksempelvis 2.227 jobtitler i DISCO 88 klassifikationen) med gennemsnitligt eksponeringsniveau for bestemte veldefinerede arbejdsmiljøpåvirkninger i givne tidsperioder og geografiske områder. Et eksempel på strukturen i en omfattende JEM udviklet i Finland i 1990'erne vises i Figur 1. For hvert fag og tidsperiode findes data om sandsynlighed (P – probability) og niveau (L – level) for eksponering (agents) (15,16). En videreførelse af principperne herfra er NOCCA-JEM, hvor der er suppleret med eksponeringer fra de fire andre Nordiske lande (14).



Figur 1: Grafisk afbildning af en JEM struktur (15)

Data om eksponering kan være baseret på målinger, observationer, ekspertvurderinger, selvrapporterede oplysninger og kombinationer heraf. JEM som redskab for eksponerings-vurdering har været anvendt siden 1980 og blev i starten især brugt i forbindelse med case-kontrol studier med behov for vurdering af eksponering på tværs af mange forskellige fag (17). JEM har gennem tiden overvejende været anvendt til vurdering af eksponering for kemiske forbindelser (6,18), men der er også eksempler på JEM til vurdering af udsættelse for psykosociale faktorer (23), biomekaniske påvirkninger (21), elektromagnetiske felter (20), natarbejde (21) og elektrisk chok (24).

Fordele og ulemper

Der er mange åbenbare fordele ved eksponeringsvurdering baseret på JEM: omkostnings- og tidseffektive studier, komplette objektive data, ingen informationsbias og store populationer med mulighed for at studere mindre prævalente eksponeringer og sjældne sygdomme. Særligt findes et uudnyttet potentiale for studier af stress og smertetilstande, hvor der er et stort behov for at supplere undersøgelser baseret på selvrapporterede data om eksponering med personuafhængige data (25). JEM kan dog kun anvendes til eksponeringer, som varierer tilstrækkeligt mellem forskellige faggrupper. Hertil kommer flere andre begrænsninger.

For det første er der problemer knyttet til selve krumtappen i en JEM, nemlig oplysningen om fag gennem hele den erhvervsaktive periode i livet. Dette har især været en begrænsning i tidligere brug af JEM, hvor oplysning om fag og dermed eksponering kun var tilgængelig på en enkelt dag, fx datoen for folketælling. I Danmark indrapporteres jobtitel årligt til Danmarks Statistik af de enkelte virksomheders personaleafdelinger, og der er kun indberetningspligt for virksomheder med 10 eller flere ansatte. De anvendte klassifikationer har ændret sig over tid fra 1980 og enkelte valideringer, hvor den registerbaserede oplysning er sammenholdt med alternative data om fag, har vist god overensstemmelse på hovedgruppeniveau, men ringere overensstemmelse på højt detaljeringsniveau [note Steen Pedersen, DS (26)]. Der er dog muligheder for at forbedre validiteten af jobtitel-oplysninger ved at inddrage supplerende data som oplysninger om branche, virksomhedsstørrelse og en række alternative kilder med oplysninger om fag.

For det andet er misklassifikation af eksponering et problem, særligt non-differentiel misklassifikation, der skyldes, at jobgrupper med helt homogene eksponeringer ikke kan konstrueres, og at en JEM ikke tager højde for variationen i eksponering mellem personer inden for et fag. Dette vil som hovedregel, men ikke altid tendere til en bias mod nul-hypotesen – altså en undervurdering af sand risiko. Faktorer, der bestemmer størrelsen af denne undervurdering af effekt, er i det store og hele kendte og omfatter typen af eksponeringsmålefejl [klassisk eller Berkson fejl, (27)], prævalens af eksponering, risikoens størrelse og ikke mindst JEM sensitivitet (andelen af eksponerede, der vurderes som eksponerede) og specificitet (andelen af ikke-eksponerede, der korrekt vurderes som sådan) (6,20,28-32).

I registerbaserede studier savner man som regel også data om personlig livsstil, som kan have markant indvirkning på helbredet og tillige være relateret til fag og erhvervsmæssig eksponering. Det er dog muligt at vurdere effekten af nogle af livsstilsfaktorer ved at estimere risikoen for sygdomme, der er tæt forbundet med disse påvirkninger, men uden primær interesse i et givet studie. En anden mulighed er at udvikle matricer for livsstil baseret på fag, branche, geografisk region, køn og alder og kalendertid.

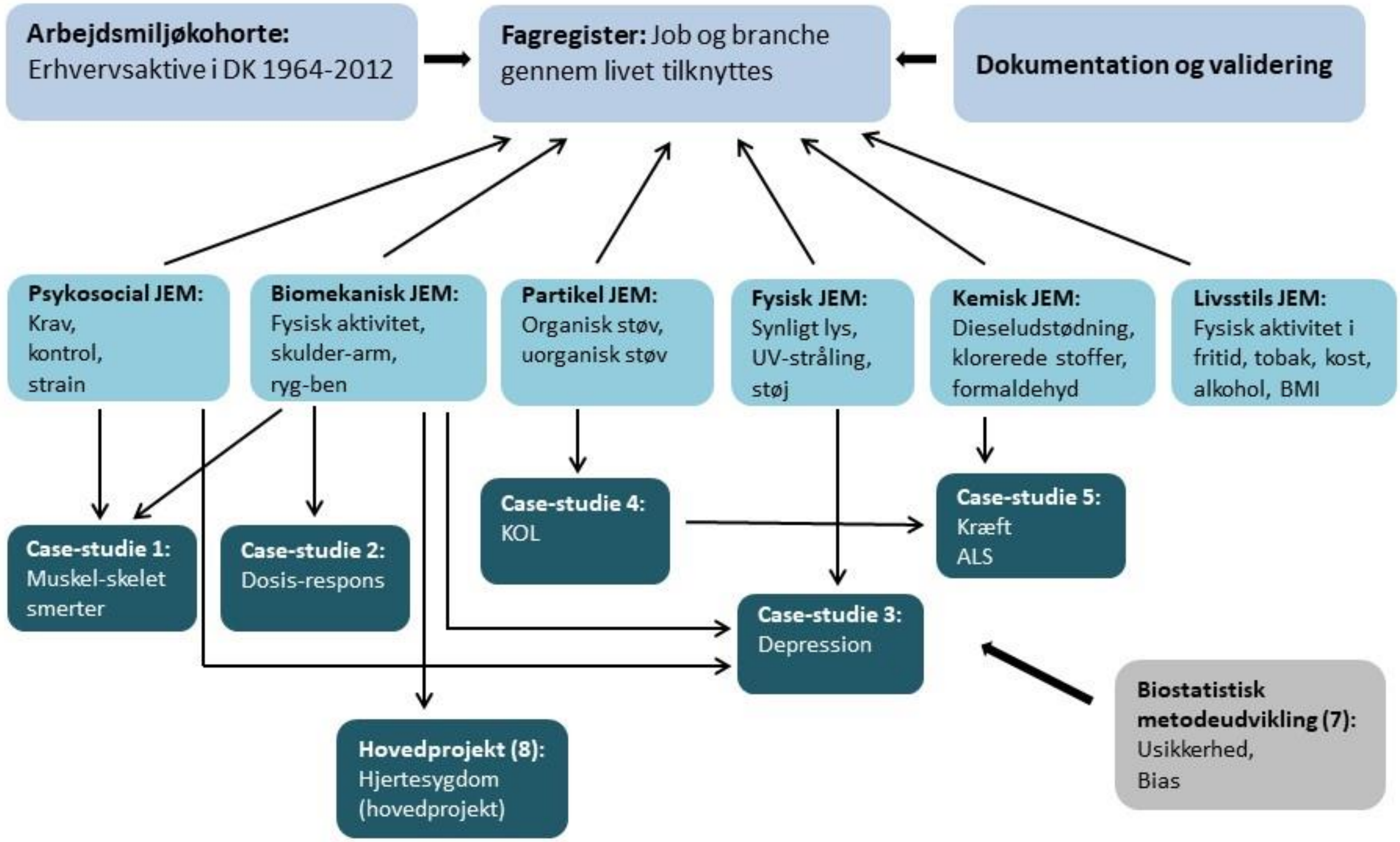
Muligheder for optimering

Det vil i en række tilfælde være muligt at begrænse misklassifikation og opnå bedre sensitivitet og specificitet ved at inddrage andre register-tilgængelige determinanter for eksponering end fag, branche og kalendertid, nemlig faktorer som køn, alder, geografisk region og social klasse. Et andet perspektiv, der kan eksploreres, er at tilføre data om job- og branche specifikke livsstilsforhold på basis af de store undersøgelser af tilfældige befolkningsudsnit som Statens Institut for Folkesundhed (SIF) og det Nationale Forskningscenter for Arbejdsmiljø (NFA) har gennemført siden henholdsvis 1985 og 1995 (33). Arbejdsmiljøkohorten kan med tiden også inkludere eksterne miljøeksponeringer (på basis af bopæl) som fx trafikstøj og partikulær luftforurening og vil dermed kunne bidrage til en mere sammenhængende vurdering af risici knyttet til disse eksponeringer. Der er dermed mange gode grunde til at genoplive og forstærke brugen af JEM i dansk arbejdsmiljøforskning, og dette er baggrunden for dette internationalt unikke projektforslag, som samler og styrker dansk arbejdsmiljøforskning på tværs af discipliner, institutioner og landsdele.

Nyhedsværdi og betydning for arbejdsmiljøet

Projektet forventes omkostnings-effektivt at kunne danne basis for store og robuste undersøgelser af sammenhæng mellem arbejdsmiljø, helbred og erhvervstilknytning og vil kunne imødekomme behovet for personuafhængige eksponeringsdata. Den Danske Arbejdsmiljøkohorte (DOC*X) vil kunne suppleres i takt med, at nye årgange af erhvervsaktive indrulleres og kan optimeres i takt med, at der udarbejdes nye og mere og mere specifikke JEM. Projektet er unikt og kan give et løft for dansk arbejdsmiljøforskning til gavn for et sundt arbejdsmiljø.

Oversigt over projektets grundelementer



Figur 2: Oversigt over delstudier i DOC*X projektet

Delprojekter

Hovedprojektet danner rammen om otte delprojekter, som alle på de respektive områder bidrager med eksponeringsdata til DOC*X, og som endvidere illustrerer brugen af DOC*X til belysning af en række aktuelle problemstillinger (*proof of concept).*

Projekt	**Domæne**	**Specifikke eksponeringer***	**Datagrundlag**	**Hovedansvarlig**
1a	Psykosocial eksponering	Krav, indflydelse	Selvrapporterede oplysninger	Reiner Rugulies, Ida Elisabeth Huitfeldt Madsen
1b	Fysisk aktivitet	Arbejdsaktiviteter, energiforbrug	Selvrapporterede oplysninger og målinger	Andreas Holtermann
2	Biomekanisk eksponering	Skulder og ryg-ben belastninger	Ekspertvurdering, observation og måling	Susanne Wulff Svendsen,
3	Fysisk eksponering	Synligt lys, UV-stråling, støj	Personbårne målinger	Henrik Kolstad, Zara Stockholm
4	Partikulær luftforurening	Uorganisk støv, organisk støv	Ekspertvurdering: personbårne målinger	Vivi Schlünssen
5	Udvalgte kemiske eksponeringer	Dieseludstødning, klorerede organiske opløsningsmid-ler, benzen, asbest, kvarts, metaller, bly, formaldehyd	Historiske arbejdspladsmålinger fra Danmark og andre Nordiske lande og ekspertvurdering.	Johnni Hansen
6	Livsstils eksponering	Rygning, alkohol indtag, kost, body mass index, fysisk aktivitet i fritiden	Selvrapporterede oplysninger, kliniske målinger	Sesilje Bondo Petersen, Jens Peter Bonde, Esben Flachs
7	Biostatistisk metodeudvikling		Registerdata	Esben Budtz-Jørgensen
8	Hovedprojekt	Arbejdsmiljøpåvirkninger og risikoen for hjertekarsygdom	DOC*X	Jens Peter Bonde

Projektkoordinering

DOC*X koordinationsgruppe

Koordinationsgruppen har omfattet medarbejdere ved Arbejds- og Miljømedicinsk Afdeling, Bispebjerg Hospital, Dansk Ramazzini center, NFA, Kræftens Bekæmpelse samt Biostatistisk Afdeling KU og Danmarks Statistik. Koordinationsgruppen drøftede løbende fremdriften i projektet og indstillede og godkendte ansøgninger om brug af data fra både interne og eksterne forskere.

Medlemmer:

TITEL	NAVN	ORGANISATION
Professor	Jens Peter Bonde (Projektleder og formand)	Arbejds- og Miljømedicinsk Afdeling, Frederiksberg og Bispebjerg Hospitaler
Statistiker	Esben M. Flachs (Projektkoordinator)	Arbejds- og Miljømedicinsk Afdeling, Frederiksberg og Bispebjerg Hospitaler
Statistiker	Esben Budtz-Jørgensen	Biostatistisk Afdeling, Københavns Universitet
Professor	Henrik A. Kolstad	Dansk Ramazzini Center, Arbejdsmedicinsk klinik, Aarhus Universitetshospital
Seniorforsker	Johnni Hansen	Kræftens Bekæmpelses Forskningscenter
Forskningsdirektør	Nils Fallentin	Det Nationale Forskningscenter for Arbejdsmiljø
Afløst af: Suppleant	Vivi Schünssen den 01.11 2016	Det Nationale Forskningscenter for Arbejdsmiljø
Professor	Susanne W. Svendsen	Dansk Ramazzini Center, Arbejdsmedicinsk Klinik, Hospitalsenheden Vest – Universitetsklinik
Suppleanter:		
Professor	Johan Hviid Andersen	Dansk Ramazzini Center, Arbejdsmedicinsk Klinik, Hospitalsenheden Vest – Universitetsklinik
Forskningschef	Elsa Bach	Det Nationale Forskningscenter for Arbejdsmiljø
Afløst af: Seniorforsker	Ida Elisabeth Huitfeldt Madsen den 31.01.2018	Det Nationale Forskningscenter for Arbejdsmiljø
Professor	Vivi Schlünssen	Institut for Folkesundhed, Aarhus Universitet

Videnskabeligt panel

Et videnskabeligt panel blev sammensat af forskere som internationalt er toneangivende på arbejdsmiljøområdet. Panelet faciliterede kontakten til internationale forskergrupper og bidrog til den faglige udvikling af DOC*X:

TITEL	NAVN	ORGANISATION
Professor	Alex Burdorf	Dept. of Public Health, Erasmus University Medical Center, Rotterdam, Holland
Assistant Professor	Susan Peters	Institute of Risk Assessment Sciences, Utrecht University, Holland
Professor	Hans Kromhout	Institute of Risk Assessment Sciences, Utrecht University, Holland

DOC*X følgegruppe

Følgegruppen blev ledet af NFAs direktør og med en ledende repræsentant fra Danmarks Statistik, Arbejdstilsynet, Arbejdsskadestyrelsen, Arbejdsmiljørådet, DA, DI, LO, FTF, AC, Kræftens bekæmpelse, Dansk Ramazzini Center, IFSV ved KU samt projektleder Esben M. Flachs:

TITEL	NAVN	ORGANISATION
Chefkonsulent	Jens Skovgaard Lauritsen	Dansk Arbejdsgiverforening
Arbejdsmiljøchef	Anders Just Pedersen	Dansk Industri
Konsulent	Niels Sørensen	Landsorganisationen i Danmark (LO)
Konsulent	Lars Granhøj	FTF
Chefkonsulent	Malene Amby	Akademikerne
Arbejdsmiljøchef	Lars Andersen	Lederne
Chefrådgiver	Malene Vestergaard	Danske Regioner
Chefkonsulent	Preben Meier Pedersen	Kommunernes Landsforening
Hovedkasserer	Ulla Sørensen	3F
Afdelingsdirektør	Niels Ploug	Danmarks Statistik
Overlæge	Palle Ørbæk	Arbejdstilsynet
Vicedirektør	Jesper Hartvig Pedersen	Arbejdsskadestyrelsen
Forskningschef	Jørgen H. Olsen	Kræftens Bekæmpelse
Institutleder	Søren Kjærgaard	Dansk Ramazzini Center
Professor, ph.d.	Lisbeth E. Knudsen	Københavns Universitet
Professor	Ulla B. Vogel	Det Nationale Forskningscenter for Arbejdsmiljø

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Formål

Det overordnede formål er at etablere en registerbaseret landsdækkende dansk kohorte af erhvervsaktive med historiske og tidsspecifikke data om arbejdsmiljøpåvirkninger med henblik på aktuelle og fremtidige studier af arbejdsmiljø, helbred og arbejdsmarkedstilknytning. Kohorten skal:

- have karakter af en åben international forskningsressource på arbejdsmiljøområdet, skal fremme samarbejde mellem forskere fra forskellige forskningsfelter og discipliner og skal kunne tiltrække højt kvalificerede forskere fra udlandet til dansk arbejdsmiljøforskning

- være omkostningseffektiv ved brug af befolknings- og sundhedsregistre og data om arbejdsmiljøpåvirkninger baseret på specifikke job-eksponeringsmatricer

- fremme integrerede studier af risikofaktorer som ellers oftest undersøges isoleret – fx effekt af henholdsvis erhvervsmæssig udsættelse for partikler, støv og fysisk krævende arbejde

- skabe bedre muligheder for at kunne levere robuste svar på kort tid, når medier, myndigheder, organisationer og virksomheder rejser nye spørgsmål.

Centralt for den foreslåede nationale forskningsressource er tilførsel, samling og harmonisering af validerede data om arbejdsmiljøpåvirkninger på individniveau til de eksisterende befolkningsregistre, herunder Landspatientregisteret. Krumtappen er faget (jobbet: murer, sygeplejerske etc.) og branchen (fx medicinalindustrien).

De specifikke formål er derfor:

(1) at oprette et dokumenteret erhvervshistorie-register med kronologiske oplysninger om fag og branche for alle personer med erhvervsarbejde i Danmark i perioden fra 1964-2013. Oplysninger om fag og branche skal så vidt muligt være ensartede over tid og være på det højst mulige detaljeringsniveau

(2) at foretage en ensartet beskrivelse af sandsynlighed for udsættelse og eksponeringsintensitet for forskellige arbejdsmiljøpåvirkninger. Arbejdet skal munde ud i en fælles databasestruktur, men respektere at niveau og metoder for eksponerings-dokumentation varierer mellem de forskellige

områder (fx psykosociale stressorer og biomekaniske påvirkninger).

(3) at opdatere og/eller udvikle samt validere jobeksponeringsmatricer på udvalgte områder, nemlig:

a. Psykosociale påvirkninger (krav, indflydelse, kontrol og jobstrain)
b. Biomekaniske påvirkninger (skulder-arm belastninger, ryg-ben belastninger og fysisk aktivitet)
c. Fysiske påvirkninger (synligt lys, UV-stråling, støj)
d. Organisk og uorganisk støv, kvarts og asbest
e. Udvalgte kemiske stoffer (dieseludstødning, klorerede organiske opløsningsmidler, benzen, formaldehyd, bly, metaller, asbest, kvarts)

Disse arbejdsmiljøpåvirkninger er selvfølgelig langt fra udtømmende, men er valgt med henblik på at belyse aktuelle problemstillinger om arbejdsmiljø og helbred. Perspektivet er at tilknytte flere specifikke data om job-relateret eksponering og med tiden opbygge omfattende Job-Eksponerings-Matrice (JEM) med synergi på tværs af områderne.

(4) at udvikle det teoretiske biostatistiske grundlag for konstruktion og anvendelse af JEM

(5) at demonstrere DOC*X's potentiale for tids- og omkostningseffektive analyser, der inddrager flere relevante eksponeringsdomæner i casestudier af blandt andet risikoen for hjertesygdom ved udsættelse for henholdsvis stress (jobstrain), fysisk belastning, stillesiddende arbejde, partikulær luftforurening og støj.

Projektet er organiseret i et hovedprojekt [projektledelse, koordination samt formålene (1), (2) og (4)] samt otte delprojekter [formål (3) og (5)].

Etablering af DOC*X

Fremgangsmåde

DOC*X kohorten er bygget op som en sammenstilling af allerede eksisterende registre ved Danmarks Statistik, der samler oplysninger om arbejdsmarkedstilknytning og fag i perioden fra 1970 til 2015. DOC*X bygger på registrene Folke- og Boligtællingen 1970 (1) og serien af registre i Arbejdsmarkedsklassifikationsmodulet 1976 til 2016 (2). Arbejdsmarkedsklassifikationsmodulet er dannet på basis af indberetninger fra virksomheder og offentlige lønsystemer (Lønstatistikregisteret) og ved en maskinel proces, hvor hver enkelt person tildeles erhvervs- og stillingskoder på grundlag af oplysninger fra en lang række registre, bl.a. COR (Det Centrale Oplysningsseddelregister) og CSR (Det Centrale Skatteyderregister). Fra Arbejdsmarkedsklassifikationsmodulet er udtrukket årlige informationer om beskæftigelsesstatus (ansat, selvstændig, ikke beskæftiget), og for ansatte og selvstændige information om fag og branche, på nær 1970, der kun indeholder information om fag. Kohorten er derefter afgrænset til kun at omfatte personer, der fylder mindst 16 i løbet af året.

DOC*X kohorten indeholder desuden en serie af JEM, der karakteriserer eksponeringer i arbejdsmiljøet efter fag og/eller branche. De inkluderede eksponeringer er biomekaniske faktorer (tunge løft, siddende og eller stående/gående arbejde, skulderbelastninger, fysiske og ergonomiske krav), psykosociale faktorer (job strain, følelsesmæssige krav i arbejdet), støv og partikel eksponering, støj, lys og udvalgte kemiske faktorer (formaldehyd, dieseludstødning og opløsningsmidler). Desforuden er der konstrueret matricer, der beskriver livstilsfaktorer (rygning, BMI, alkohol, fysisk aktivitet i fritiden og indtag af frugt og grønt), der har sammenhæng med fag for at kunne tage højde for disse faktorer i undersøgelser af sammenhænge mellem arbejdseksponeringer og helbred.

DOC*X kohorten er derudover beriget med et antal supplerende informationer om demografi (køn, fødselsdag, bopæl, emi- og immigration, død, civilstand, familierelationer), uddannelse, indkomst, overførselsindkomster, morbiditet (hospitalskontakter, sygesikringskontakter) og mortalitet (dødsårsager) i den udstrækning Danmarks Statistiks registre dækker perioden fra 1970 til 2016.

DOC*X Kohorten opdateres løbende med nye årlige oplysninger om både arbejdsmarkeds-tilknytning, fag og branche, og med yderligere supplerende informationer som nævnt ovenfor. DOC*X hjemmesiden indeholder yderligere oversigter over inkluderede registre og informationer og de perioder, der er dækket.

DOC*X Kohorten er oparbejdet som en åben forskningsressource, og er placeret under Danmarks Statistiks Forskerservice, så den kan benyttes af forskere med interesse for arbejdsmiljøforskning centreret omkring helbred og sundhed.

DOC*X kohorten: indhold og dokumentation

DOC*X kohorten indeholder årlige fag og branche oplysninger for alle personer fra det fyldte 16 år med bopæl i Danmark i perioden 1970 og 1976 til 2016 i alt ca. 6.4 millioner personer. En oversigt over disse til og med 2015 findes i tabel 1 (3).

De årlige oplysninger om fag og branche er i Danmarks Statistiks registre klassificeret efter varierende systemer gennem perioden. For fag findes fire primære systemer: Et særskilt for 1970, En tilpasset udgave af Dansk Fagkode fra 1976 til 1990, DISCO-88 fra 1991 til 2009, og DISCO-08 fra 2010 og fremefter. De to DISCO-systemer er fordanskede versioner af de internationale klassifikationssystemer ISCO-88 og ISCO-08 udarbejdet af IOL og i langt overvejende grad identisk med disse. Klassifikationssystemet benyttet i 1970 er helt særskilt, og det har ingen umiddelbar generel oversættelse til de efterfølgende systemer, hvorfor dette blot er bevaret i sin oprindelige form i DOC*X, omend det selvfølgelig er muligt for udvalgte specifikke fag at finde disse på tværs af alle klassifikationssystemerne. Den af Danmarks Statistik tilpassede udgave af Dansk fagkode, der er benyttet fra 1976 til 1992, er væsensforskellig fra de efterfølgende DISCO-systemer, men der er i DOC*X-projektet lavet en generel oversættelse til DISCO-88. Der er ligeledes lavet en generel oversættelse fra DISCO-08 til DISCO-88, således at det alt i alt er muligt at følge fag fra 1976 til 2016 i et ensartet klassifikationssystem (DISCO-88) i DOC*X kohorten. Brancheoplysningerne er opgjort i fire systemer: Dansk Branchenomenklatur 77 (DSE-77), Dansk Branchekode version 1993 (DB-93), version 2003 (DB-03) og version 2007 (DB-07). Danmarks Statistik har lavet oversættelse mellem de fire systemer, så det er muligt at følge Brancher fra 1976 til 2016 i et ensartet klassifikationssystem (DB-07) i DOC*X kohorten. De ikke-oversatte primære kilder til fag og branche er også bevaret i DOC*X kohorten.

I perioden varierer hyppigheden af angivelse af fag for personer i beskæftigelse væsentligt (se figur 1), ligesom der er betydelige forskelle i detaljeringsgraden af de oplyste fag. Der er generelt lavere hyppighed af oplyst fag i 1980’erne, ligesom der typisk findes et dyk omkring skift af klassifikationssystem. Generelt har mænd en lavere hyppighed end kvinder, hvilket formentlig bunder i det noget kønsopdelte arbejdsmarked med flere kvinder ansat i specielt den offentlige sektor, hvor indberetningsgraden er større end fra den private sektor, primært fordi der kun kræves lovpligtig indberetning for virksomheder med mindst 10 ansatte.

De inkluderede JEM i DOC*X er listet i oversigtsform i tabel 2, der er gengivet fra Flachs et al. 2019 (3). Yderligere information kan findes på DOC*X hjemmesiden www.doc-x.dk eller i de i tabel 2 angivne referencer.

De supplerende data i DOC*X kohorten indeholder demografiske oplysninger (køn, fødselsdag, bopæl, emi- og immigration, død, civilstand, familierelationer) om personer i kohorten og deres slægtninge, og desuden uddannelse, indkomst, overførselsindkomster, morbiditet (hospitalskontakter, sygesikringskontakter) og mortalitet (dødsårsager) i den udstrækning Danmarks Statistiks registre dækker i perioden fra 1970 til 2018. Figur 2 indeholder en skematisk fremstilling af disse. Yderligere dokumentation af indhold og dækkede perioder kan findes på DOC*X kohortens hjemmeside www.doc-x.dk. Dokumentation af indhold og validitet af oplysningerne kan findes på Danmarks Statistiks hjemmeside www.dst.dk.

Tabel 1: Nøgletal for DOC*X kohorten.

Unikke personer (N[a])	**Manglende DISCO kode[b,c]**		**Oplyst DISCO kode**		
	Alle	%	Alle	Mænd	Kvinder
Total (N = 6,399,000)	1,002,000	16	5,398,000	2,984,000	2,414,000
Alder in 1976 (år)					
P10 - P90 (median)	17.9-55.3 (30)		22.3-57.8 (35)	22.9-59.2 (37)	21.6-54.8 (32)
Age in 2015 (år)					
P10 - P90 (median)	19.5-66.2 (40)		22.7-59.4 (42)	22.8-60.1 (43)	22.6-58.7 (42)
Follow-up længde (år)					
Min – Max (median)	1 – 40 (2)		1 – 39 (15)	1 – 40 (15)	1 – 40 (15)
Follw-up tid (person-år[a])					
Total (T = 114,831,000)	23,550,000	21	91,281,000	49,396,000	41,885,000
Tidsperiode					
1970[d]	2,079,000	100	-	-	-
1976 - 1985	6,090,000	23	20,883,000	12,371,000	8,511,000
1986 - 1995	6,467,000	21	24,716,000	13,425,000	11,291,000
1996 - 2005	4,288,000	17	21,503,000	11,241,000	10,261,000
2006 - 2015	4,626,000	16	24,179,000	12,358,000	11,821,000
Alder					
16 - 25	8,799,000	36	15,936,000	8,358,000	7,578,000
26 - 35	4,304,000	16	22,819,000	11,921,000	10,898,000
36 - 45	3,667,000	14	22,744,000	12,012,000	10,732,000
46 - 55	3,297,000	15	18,791,000	10,190,000	8,600,000
56 - 65	2,362,000	20	9,609,000	5,819,000	3,790,000
66 - 75	866,000	41	1,235,000	971,000	264,000
76 - 85	220,000	62	136,000	116,000	20,000
86 - 105	35,000	79	9,000	7,000	2,000
DISCO-88 overgrupper[b]					
0: Forsvar	-	-	1,364,000	1,281,000	83,000
1: Ledelse på øverste plan	-	-	3,079,000	2,474,000	605,000
2:https://www.dst.dk/da/Statistik/dokumentation/nomenklaturer/disco-88	-	-	12,929,000	7,626,000	5,302,000
3: Arbejde, færdigheder på mellemniveau	-	-	15,293,000	6,357,000	8,936,000
4: Kontorarbejde	-	-	12,080,000	3,131,000	8,950,000
5: Salgs-, service- og omsorgsarbejde	-	-	13,982,000	3,952,000	10,029,000
6: Uddannet landbrug og fiskeri	-	-	927,000	790,000	137,000
7: Håndværkspræget arbejde	-	-	11,774,000	11,140,000	634,000
8: Proces- og maskinop, transport- og anlæg	-	-	7,203,000	5,163,000	2,040,000
9: Ufaglært arbejde	-	-	12,651,000	7,483,000	5,168,000
Hovedbranchegrupper (DB-07[e])					
Land- og skovbrug og fiskeri	-	-	1,939,000	383,000	1,556,000
Fremstillingsvirksomhed	-	-	15,766,000	4,831,000	10,935,000
Bygge- og anlæg	-	-	5,124,000	498,000	4,626,000
Handel og transport	-	-	22,280,000	8,715,000	13,565,000
Information og kommunikation	-	-	1,849,000	641,000	1,208,000
Finans og forsikring	-	-	3,224,000	1,663,000	1,562,000
Ejendomssalg, udlejning	-	-	1,279,000	456,000	823,000
Service	-	-	7,154,000	3,426,000	3,728,000
Offentlig sector	-	-	33,385,000	22,837,000	10,548,000
Kunst, underholdning	-	-	3,767,000	2,121,000	1,646,000
Ukendt	-	-	19,063,000	7,067,000	11,996,000

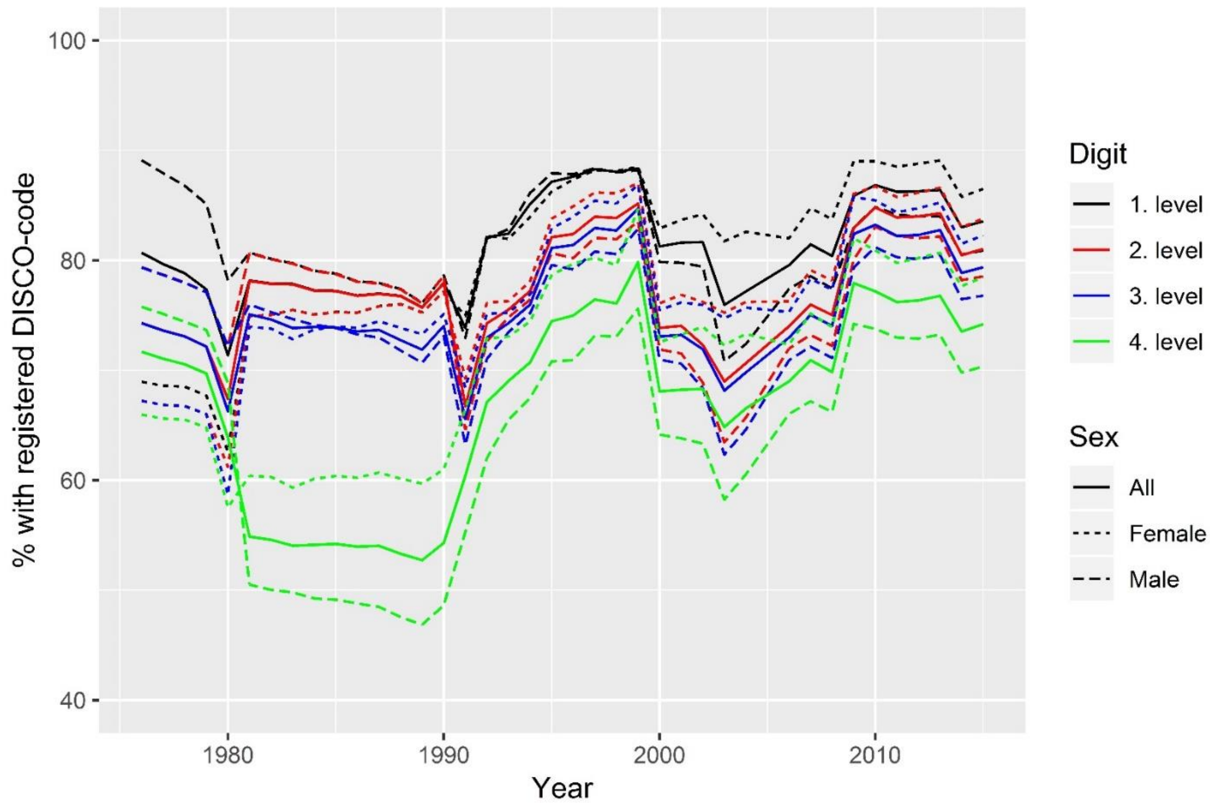
a: Afrundet til nærmeste tusinder.

b: DISCO-88 er den danske version af International Classification of Occupations 88 (ISCO-88).

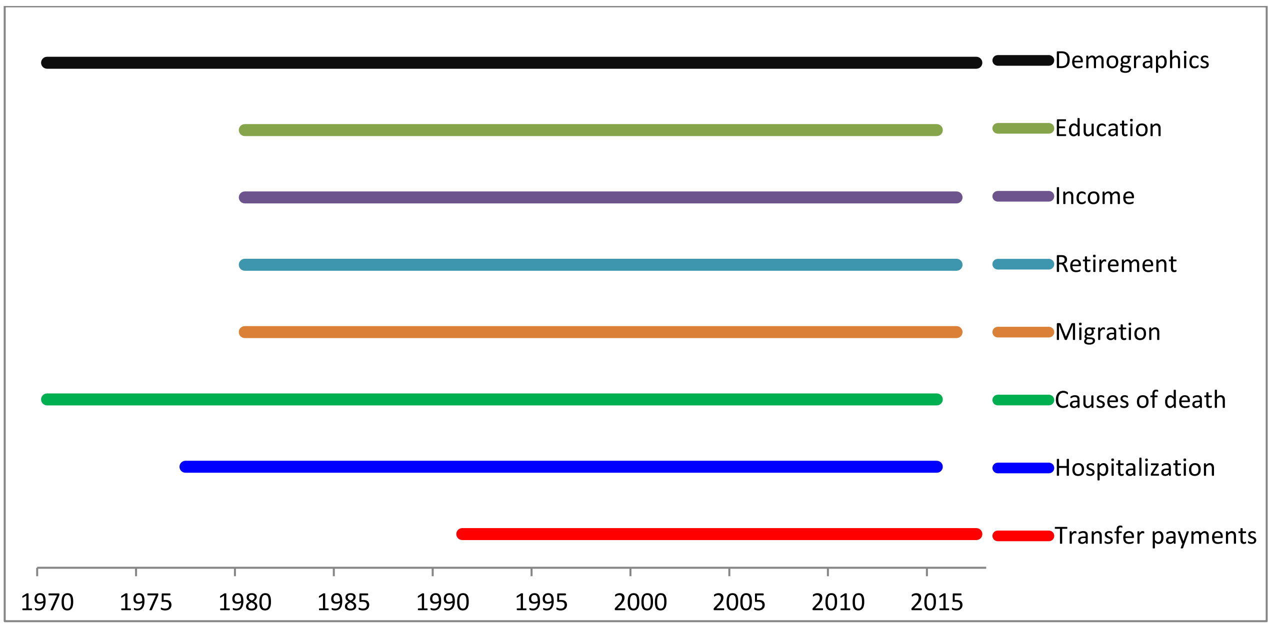
c: Manglende DISCO-88 kode selv om personen er angivet som i beskæftigelse (ansat eller selvstændig).

d: Klassificeringen i 1970 er ikke generelt oversættelig til DISCO-88.

e: DB-07 (Dansk Branchekode 2007) er den danske version version af "Nomenclature statistique des Activités économiques dans la Communauté Européenne".



Figur 1: Andel beskæftigede med DISCO-88 kodes fra 1976 til 2015 på første til fjerde ciffer niveau (3).



Figur 2: Supplerende data I DOC*X Kohorten med angivet periode (3).

Tabel 2: JEM inkluderet i DOC*X kohorten med eksempler på eksponeringer (3).

Data source	**Time-period Stratification**	**Exposure dimensions**	**Unit(s)**	**Average probability of exposure across occupations and range within deciles**		**Average intensity of exposure across occupations and range within deciles.**		**Reference**
				Upper decile	Lower decile	Upper decile	Lower decile	
Psychosocial exposures Self-reported data in a random sample of the employed Danish population, n = 15,207 (best linear unbiased prediction)	2012 Sex, age	Quantitative demands Emotional demands Decision authority Violence Job insecurity Job strain	Mean summed item values (range 0 - 5/6) Exposure yes/no	 31% (11 - 82) 32% (26 - 55) 41% (33 - 53)	 < 0.01% < 0.01% < 0.01%	3.5 (3.4 - 3.7) 4.0 (3.8 - 4.2) 4.4 (4.4 - 4.6)	2.7 (2.3 - 2.8) 2.2 (1.8 - 2.3) 3.8 (3.2 - 4.0)	(4)
Shoulder exposures Expert ratings, postures and movements validated against measurements	1990-2016 None	Upper arm elevation >90° Repetitive shoulder movements Forceful shoulder exertions	Hours/day Hours/day Score value (0-4)			1.2 (0.5 - 2.8) 4.0 (2.6 - 6.8) 1.8 (1.4 - 3.0)	0.0 0.0 0.0 0.0 0.0 0.0	(5)
Lower body exposures Expert ratings	1990-2016 None	Total load lifted Standing/walking Sitting Kneeling/squatting	Kg/day Hours/day Hours/day Hours/day			2,640 (1,940 – 3,500) 6.8 (6.6 - 7.5) 5.5 (4.1 - 7.1) 1.6 (1.1 - 3.5)	80 (0 - 280) 2.4 (0.9 - 3.8) 0.7 (0.6 - 0.9) 0.0 0.0	(6)
Physical exertion and body position Random population sample, n = 15,207, predicted probabilities based on self-report	2012 Sex, age	Score based on sitting, standing/walking, kneeling, repetition, twisted back, lifted arms, lifting/carrying, pushing/ pulling	Exposure yes/no	46% (34 - 79)	< 0.01			(4)
Noise Expert ratings calibrated by measurements	2001-2010 None	Noise	dB(A) intensity score: 0: <80 dB(A) 1: 80-85 dB(A) 2: >85 dB(A)			2.0	1.0	(7)
Vibration Occupational expert ratings	1990-2016 None	Whole-body vibration	Hours/day			1.1 (0.4 - 4.8)	0.0 0.0	(6)
Particulate airborne exposures Expert ratings For wood and endotoxin quantitative JEM based on measurements (wood, n = 12,704; endotoxin, n = 3,350)	Expert rating: None Wood: 1978-2007 Endotoxin: 1992-2008 Country, calendar-time	Mineral dust, organic dust, fumes and vapor Wood dust Endotoxin	Intensity score: 0, 1, 2 ug/m^3 ambient air ug/m^3 ambient air			2.0 1.59 (95-percentile) 39.2 (95-percentile)	1.0 (0.0-1.0) 0.0 (0.0-0.0) 0.0 (0.0-0.0)	(8-11)
Chemical agents Expert ratings calibrated by measurements	1945-1994 15-year periods	Diesel-exhaust Formaldehyde Organic solvents	mg/m^3 ambient air mg/m^3 ambient air mg/m^3 ambient air	87% (85 - 90) 18% (5 - 90) 10% (1 - 70)	0.0 0.0 0.0	0.69 (0.69 - 0.69) 0.18 (0.00 - 0.50) 5.44 (0.01 - 0.00)	 0.0 0.0	(12)
Lifestyle Random population sample, n = 299,150 (best linear unbiased prediction)	1970-2013 Sex, age, calendar-time	Tobacco smoking Body mass index Alcohol consumption Leisure time physical activity Fruit/vegetables consumption	% smokers kg/m^2 Item values (range 0-4) Item values (range 0-4) Item values (range 0-4)	55% (46 - 74)	13% (6-16)	 26.9 (26.5 - 28.4) 2.0 (1.9 - 2.3) 2.7 (2.5 - 3.2) 2.9 (2.8 - 3.0)	 22.8 (21.0 - 23.3) 1.0 (0.5 - 1.1) 2.0 (1.7 - 2.0) 2.3 (2.1 - 2.4)	(13)

Validering af job-koder

Jobkoderne i DOC*X (fag_samlet) er valideret imod selvrapporterede oplysninger om fag fra selvudfyldte spørgeskemaer brugt i hhv. Østerbroundersøgelsen (14, 15) og ASUSI kohorten (16):

- Fra Østerbroundersøgelsen indgik selvskrevet jobtitel fra tre forskellige spørgeskemaer med i alt 30.991 mænd og kvinder brugt ved kliniske undersøgelser i hhv. 1976-94 (n=11.688), 1981-83 (n=10.311) og 1991-94 (n=8992). I 2016 blev jobtitlerne omskrevet til DISCO-88 koder. Studiedeltagerne var i aldersgruppen 35-70 år (14, 15).
- Fra ASUSI kohorten indgik 14.266 mænd og kvinder for året 2004, som havde været ansat i mindst 80% af tiden gennem det seneste år, og som havde været ansat 6 ud af 12 uger siden 1. juli 2004 (16).

Til valideringen anvendte vi 6 JEM fra DOC*X med eksponeringer for metalstøv, træstøv, løft, stå/gå, løftede arme >90° og støj. Vi analyserede kun DISCO-88 grupper med min. 10 observationer, hvilket betød at antallet af inkluderede grupper lå mellem 29-56% med det laveste antal i 1991-93 og højeste antal i 2004.

Overordnet var der god overensstemmelse mellem eksponeringsniveauerne baseret på hhv. DISCO-88 koden oversat fra selvrapporteret jobtitel og DISCO-88 koden registreret i DOC*X (Tabel 3) vurderet ud fra beregnede kappa koefficienter (κ) fortolket ud fra følgende inddelinger: <0=Ingen, 0.00-0.20=dårlig, 0.21-0.40=svag, 0.41-0.60=moderat, 0.61-0.80=god og 0.81-1.00=næsten perfekt (17): Derudover var der også god overensstemmelse ved den direkte sammenligning af DISCO-88 koden oversat fra selvrapporteret jobtitel og DISCO-88 koden registreret i DOC*X også baseret på κ koefficienter (tabel 4). Sensitiviteten varierede mellem 51,5-73,2%, og var højest ved laveste DISCO-88 niveau. For hver job-gruppe med min 10 observationer kan man på www.doc-x.dk finde sensitiviteter for overensstemmelse mellem DISCO-88 koder baseret på hhv. selvrapporteret og registreret-kode. Resultaterne for valideringsanalyserne er sammenfattet i artiklen af Petersen *et al.*, 2019 (18).

Tabel 3. Sensitivitet, specificitet, og overensstemmelse mellem arbejdsmiljø-påvirkninger tildelt via job-eksponeringsmatricer for hhv. selvrapporterede job-titler omskrevet til DISCO-88 koder og DOC*X registrerede DISCO-88. Den endelige population inkluderede for hver eksponering og tidsperiode kun personer med et sæt af koder, dvs. både en DISCO-88 kode baseret på selvrapporteret job-titel og en DISCO-88 kode registreret i Den Danske Arbejdsmiljøkohorte med eksponeringsdata (DOC*X).

Eksponering Tidsperiode	Selvrapporteret n lav/medium/høj	Registreret n lav/medium/høj	Sensitivitet*	Specificitet #	Overensstemmelse vægtet κ, 95% CI
Træstøv[c]	6448/ - /119	6446/ - /121	90.9	99.9	0.91 (0.88-0.95)[f]
1976-1978[d]	4295/ - /37	4294/ - /38	63.2	99.7	0.64 (0.51-0.76)[f]
1981-1983[d]	1712/ - /14	1710/ - /16	85.7	99.8	0.80 (0.64-0.96)[f]
1991-1994[d]	9465/ - /230	9479/ - /216	76.1	99.7	0.78 (0.74-0.82)[f]
2004[e]					
Tunge løft					
1976-1978[d]	2854/2755/944	2655/2695/1203	60.3	89.6	0.71 (0.70-0.72)
1981-1983[d]	2196/1638/465	2108/1785/406	47.3	88.9	0.64 (0.63-0.66)
1991-1994[d]	904/585/198	817/665/205	76.6	94.6	0.78 (0.75-0.81)
2004[e]	4358/2777/1783	4383/2826/1371	80.2	84.8	0.72 (0.70-0.73)
Stå/gå					
1976-1978[d]	2776/2032/1745	2619/2698/1236	78.8	89.5	0.68 (0.67-0.70)
1981-1983[d]	2160/1242/897	2070/1140/1089	61.5	89.4	0.68 (0.66-0.70)
1991-1994[d]	882/507/298	811/575/301	76.4	94.6	0.78 (0.75-0.80)
2004[e]	4347/3224/1347	4379/3122/1417	68.2	84.8	0.69 (0.67-0.70)
Løftede arme >90°					
1976-1978[d]	2790/2646/1083	2645/2988/886	86.0	91.4	0.78 (0.77-0.80)
1981-1983[d]	2235/1503/594	2090/1344/898	57.9	89.8	0.70 (0.68-0.72)
1991-1994[d]	941/624/179	891/632/179	71.9	92.1	0.78 (0.75-0.80)
2004[e]	4875/3379/1384	5146/3016/1476	73.8	82.2	0.69 (0.68-0.70)
Støj					
1976-1978[d]	4713/1516/387	4568/1663/385	75.1	94.0	0.75 (0.73-0.76)
1981-1983[d]	3482/777/73	3251/954/127	29.9	93.8	0.56 (0.53-0.58)
1991-1994[d]	1345/386/15	1319/400/27	73.3	94.3	0.78 (0.75-0.81)
2004[e]	6504/2634/587	6703/2473/549	60.8	93.2	0.72 (0.70-0.73)

[a] Sensitivitet: Andelen af sande registreringer ved største grad af eksponering.

[b] Specificitet: Andelen af sande registreringer ved laveste grad af eksponering.

[c] Dikotomiseret (ikke-eksponeret/eksponeret)

[d] Observationer fra Østerbroundersøgelsen.

[e] Observationer fra ASUSI-kohorten.

[f] For træstøv er κ og 95% CI ikke vægtet.

Forkortelser: CI=Konfidensinterval; DISCO-88=Dansk version af "International Standard Classification of Occupations" fra 1988; κ=kappa koefficient

Tabel 4. Sensitivitet og overensstemmelse mellem selvreporteret jobtitler omdannet til DISCO-88 koder og DISCO-88 koder registreret i den Danske Arbejdsmiljøkohorte DOC*X (DOC*X) for hvert niveau af DISCO-88. Populationen inkluderede kun personer med begge sæt koder.

	Selvrapporteret n	Registreret % (n)	Analyseret % (n)	Sensitivitet*	Overensstemmelse (κ, 95% CI)
1976-1978[A]					
Niveau 4	10443	73.8 (7708)	55.8 (5824)	66.3	0.77 (0.76-0.79)
Niveau 3	10933	74.3 (8124)	65.7 (7182)	61.4	0.71 (0.70-0.72)
Niveau 2	11335	71.7 (8128)	66.1 (7491)	67.1	0.71 (0.70-0.73)
Niveau 1	11688	72.1 (8430)	65.9 (7707)	70.6	0.73 (0.72-0.74)
1981-1983[A]					
Niveau 4	9319	55.8 (5204)	42.6 (3973)	59.4	0.74 (0.72-0.75)
Niveau 3	9744	69.8 (6804)	65.2 (6352)	54.4	0.69 (0.68-0.71)
Niveau 2	10041	69.8 (7012)	68.3 (6856)	60.8	0.69 (0.67-0.70)
Niveau 1	10311	69.8 (7199)	69.8 (7193)	65.5	0.69 (0.67-0.70)
1991-1994[A]					
Niveau 4	8186	28.4 (2322)	17.6 (1443)	71.4	0.81 (0.79-0.83)
Niveau 3	8552	28.6 (2447)	23.9 (2042)	65.5	0.72 (0.70-0.75)
Niveau 2	8753	28.8 (2522)	28.0 (2451)	69.4	0.72 (0.70-0.74)
Niveau 1	8992	29.7 (2668)	29.6 (2664)	73.2	0.73 (0.71-0.75)
2004[B]					
Niveau 4	13858	77.9 (10794)	65.4 (9064)	51.5	0.73 (0.72-0.74)
Niveau 3	13892	78.4 (10891)	72.9 (10134)	56.6	0.72 (0.71-0.73)
Niveau 2	13892	82.6 (11469)	75.9 (10540)	64.1	0.72 (0.71-0.73)
Niveau 1	14266	84.5 (12048)	82.6 (11782)	65.8	0.71 (0.70-0.72)

* Sensitivitet: Andelen af sande registreringer på hvert niveau af DISCO-88 (1-4).

[A] Overensstemmelse mellem registreret DISCO-88 koder i DOC*X og selvrapporteret jobtitler omdannet til DISCO-88 koder baseret på data fra Østerbroundersøgelsen.

[B] Overensstemmelse mellem registreret DISCO-88 koder i DOC*X og selvrapporteret jobtitler omdannet til DISCO-88 koder baseret på data fra ASUSI-kohorten.

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PSYKOSOCIAL EKSPONERING

Psykosocialt og fysisk arbejdsmiljø: Udvikling af jobeksponeringsmatricer samt undersøgelse af indvirkning på muskelskeletbesvær.

Projektledelse

Projektledere var Reiner Rugulies og Andreas Holtermann som er professorer for henholdsvis psykosocialt og fysisk arbejdsmiljø ved NFA. Det daglige projektarbejde blev udført af seniorforsker Ida Elisabeth Huitfeldt Madsen ansat ved NFA.

Formål

(1) At udvikle en job-eksponeringsmatrice (JEM) for psykosocialt og fysisk arbejdsmiljø

(2) At undersøge om den prospektive sammenhæng mellem psykosocialt og fysisk arbejdsmiljø og muskelskeletbesvær (MSB) er forskellig, afhængigt af om arbejdsmiljøet er målt med individuelle data eller med JEM

Baggrund og problemstilling

En meta-analyse fra 2011 viste, at en række psykosociale arbejdsmiljøfaktorer er forbundet med risiko for muskelskeletbesvær (MSB) (1). Det er muligt at denne sammenhæng ikke afspejler kausalitet, men skyldes, at både det psykosociale og fysiske arbejdsmiljø samt MSB næsten altid er målt ved selvrapportering (rapporteringsbias). Et nyt studie fra NFA blandt SOSU-medarbejdere viste, at psykosociale arbejdsmiljøfaktorer var stærkt associerede med MSB. Sammenhængen blev dog kraftig reduceret efter justering for depressive symptomer fra respondenter (2).

I dette projekt håndterede vi rapporteringsbias med brug af JEM. Vi undersøgte sammenhængen mellem det psykosociale og fysiske arbejdsmiljø og MSB på individniveau og med JEM, og udregnede forskellen i resultaterne fundet ved de to metoder. Vi definerede psykosocialt arbejdsmiljø ved følgende faktorer: Kvantitative og følelsesmæssige krav, indflydelse, job strain (høje krav og lav kontrol), job usikkerhed, og arbejdsrelateret vold. Det fysiske arbejdsmiljø blev målt med en sumscore baseret på 8 items om arbejdsaktiviteter, fx ugunstige arbejdsstillinger, skub og træk, løft, og gående/stående arbejde.

Metode

Studiepopulationen omfattede 8,132 respondenter, som udfyldte spørgeskemaet Arbejdsmiljø og Helbred i 2012 (AH2012) med opfølgning i 2014 (AH2014), og havde data på alle relevante variable for arbejdsmiljø og smerter. En beskrivelse af AH2012 findes på NFA's hjemmeside (3) og i en dansk rapport (4).

Arbejdsmiljø-variable omfatter:

i. Psykosocialt arbejdsmiljø: Kvantitative og følelsesmæssige krav, indflydelse, job strain, job usikkerhed, og arbejdsrelateret vold
ii. Fysisk arbejdsmiljø: sumscore baseret på 8 items om arbejdsaktiviteter (fx skub og træk, løft, gående/stående arbejde)

For at konstruere JEM for psykosocialt og fysisk arbejdsmiljø udregnede vi de gennemsnitlige prædikterede eksponeringsværdier for de forskellige arbejdsmiljøfaktorer vha. Best Linear Unbiased Predictors (BLUPs), som funktion af job (DISCO-08) og alder, for mænd og kvinder hver for sig. For de dikotomt definerede eksponeringer job strain (høje krav og lav kontrol), job usikkerhed og arbejdsrelateret vold, blev JEM beregnet som prædikterede sandsynligheder for eksponering, givet job og alder, for mænd og kvinder hver for sig. Job strain blev defineret som høje krav (over medianen) og lav kontrol (under medianen). For de faktorer som blev målt kontinuert, estimerede vi også dikotome matricer baseret på en identifikation af personer med de 10% højeste niveau af belastning for den pågældende faktor. Vi konstruerede dette mål for at tage højde for at matricerne muligvis var bedre til at identificere høj-risiko jobs, end at estimere gennemsnitlige niveauer af de undersøgte faktorer. Eksponeringsværdierne blev tildelt hver enkelt deltager afhængig af deres jobgruppe, køn og alder.

Resultater

Resultaterne af analyserne af sammenhængen mellem arbejdsmiljø og smerter er opsummeret i tabel 5. Vi fandt, at der i overvejende grad var sammenlignelige sammenhænge mellem arbejdsmiljø og smerter, uanset om arbejdsmiljøet blev målt med selvrapporterede data eller eksponeringsmatricerne. For begge typer af eksponeringsmål var der højere niveauer af smerte ved opfølgningstidspunktet for medarbejdere med høje fysiske krav i arbejdet, kvinder som var udsat for vold, og mænd med lav indflydelse. For høje kvantitative krav i arbejdet, var der dog et lavere niveau af smerte ved opfølgningstidspunktet, hvis de kvantitative krav blev målt med en eksponeringsmatrice. Hvis de kvantitative krav blev målt med selvrapporterede data, var der ingen sammenhæng med smerter ved opfølgningstidspunktet. For de faktorer, hvor vi havde konstrueret både kontinuerte JEM og dikotome JEM sås lignende performance med de to tilgange – de faktorer som fungerede godt som kontinuerte JEM (vurderet ud fra ICC værdier) fungerede generelt også godt som dikotome JEM (vurderet ud fra ROC-analyser).

Tabel 5. Sammenhæng mellem arbejdsmiljø i 2012 og smerter i 2014, når arbejdsmiljøet måles ved henholdsvis individniveau data eller job eksponeringsmatricer

	Måling på individniveau		**Måling med jobeksponeringsmatricer**	
	Forskel i gennemsnitligt antal kropsdele med smerter (0-5)	**P-værdi**	**Forskel i gennemsnitligt antal kropsdele med smerter (0-5)**	**P-værdi**
Kontinuerte eksponeringer				
Fysiske krav, per 1 point højere score (8-48)				
Mænd	0.03	<0.001	0.03	<0.001
Kvinder	0.02	<0.001	0.02	<0.001
Kvantitative krav, per 1 point højere score (1-5)				
Mænd	-0.00	0.9291	-0.49	<0.001
Kvinder	-0.00	0.9895	-0.26	0.0105
Følelsesmæssige krav, per 1 point højere score (1-5)				
Mænd	0.01	0.9436	-0.07	0.1937
Kvinder	0.04	0.0483	0.05	0.1353
Indflydelse, per 1 point højere score (1-5)				
Mænd	-0.12	<0.001	-0.44	<0.001
Kvinder	-0.06	0.0251	-0.18	0.1924
Dikotome eksponeringer				
Job strain				
Mænd	0.07	0.0756	-0.20	0.3052
Kvinder	0.07	0.2202	0.10	0.7264
Høj job usikkerhed				
Mænd	0.08	0.1931	0.80	0.0009
Kvinder	0.07	0.1915	0.27	0.3046
Vold				
Mænd	0.18	0.0866	0.09	0.7041
Kvinder	0.16	0.0280	0.67	<0.001

Analyserne er justeret for alder, uddannelse og smerter i 2012.
Sammenhængene for dikotome eksponeringer angiver i analyserne med målinger på individniveau niveauet af smerter blandt eksponerede personer sammenlignet med ueksponerede personer. I analyserne med målinger på JEM niveau, angiver de det forøgede niveau forbundet med en 1% højere risiko for eksponering. Tabellen er tilpasset fra Madsen et al, 2018 (5).

Konklusion

De sammenhænge mellem arbejdsmiljø og smerter der ses, hvis arbejdsmiljøet måles ved brug af job eksponeringsmatricer, er i overvejende grad sammenlignelige med de sammenhænge, der ses for selvrapporterede data. Man skal dog være opmærksom på, at sammenhængende ikke altid er ens, og det vil være væsentligt at sammenholde resultater fra analyser, hvor arbejdsmiljøet måles med eksponeringsmatricer, med resultater fra analyser, der måler arbejdsmiljøet på anden vis.

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Populær formidling	Nyheder: • ”Fysiske krav i arbejdet og psykosociale arbejdsmiljøfaktorer som risikofaktorer for muskelskelet-smerter: en sammenligning af selv-rapporterede data og job eksponeringsmatricer som eksponeringsmål”. Nyhed sendt ud via nyhedsbrev fra Københavns Stressforskningscenter, november 2018.
Møder	5 møder i 2017-2018 om udvikling af job eksponeringsmatricer med forskere fra NFA og AMK Bispebjerg
Præsentationer	Konferencer: • Ida E. H. Madsen, Nidhi Gupta, Esben Budtz-Jørgensen, Jens Peter Bonde, Elisabeth Framke, Esben Meulengracht Flachs, Sesilje Bondo Petersen, Annemette Coop Svane-Petersen, Andreas Holtermann, Reiner Rugulies (2018). Comparing self-reported and job exposure matrix measurements: A cohort study examining physical work demands and psychosocial working conditions as predictors of musculoskeletal pain. Abstract fra Den 15. Stressforskningskonference, København, Danmark. Andet • Ida E. H. Madsen “Prediction of low back pain by work related psychosocial factors using self-reports versus JEM”. Præsentation ved closing seminar for DOC*X, d. 22/11-2018.

BIOMEKANISK EKSPONERING

Biomekaniske påvirkninger: Validering og videreudvikling af jobeksponeringsmatricer for ryg-ben og skulder-arm

Projektledelse

Arbejdet vedrørende formål 1 blev ledet af Nils Fallentin og siden af Andreas Holtermann og Mette Korshøj. Arbejdet vedrørende formål 2 blev ledet af Susanne Wulff Svendsen, og post doc Annett Dalbøge foretog analyserne.

Formål

Formålet var at validere og videreudvikle eksisterende jobeksponeringsmatricer (JEM) for ryg-ben og skulder:

(1) Validering af centrale eksponeringsmål i ryg-ben JEM (tid med stående/gående arbejde og tid med knæliggende/hugsiddende arbejde samt samlede daglige løftemængder) mod direkte målinger og observation i udvalgte jobgrupper.

(2) Videreudvikling af eksponeringsvariable i skulder-JEM med fokus på at afdække betydningen af enkeltvise og kombinerede eksponeringer samt eksponeringsintensitet og varighed for risikoen for pladsgørende skulderoperation.

Baggrund og problemstilling

I de senere år er der i Danmark opnået gode resultater ved at kombinere JEM for specifikke kropsregioner med kliniske udfaldsmål (se hovedprojekt-beskrivelsen). Ekspertvurderingerne i JEM for ryg-ben har vist god prædiktiv værdi (1-3), men er kun i begrænset omfang valideret mod eksponeringsestimater baseret på selvrapport, observation og tekniske målinger. For skulder-matricen er der sket validering og kalibrering baseret på tekniske målinger (4). En videreudvikling af disse matricer vil gøre det muligt at belyse, hvilken risiko de enkelte eksponeringer bidrager med, og hvilken rolle de forskellige eksponeringstyper (fx kraft og stilling) og -dimensioner (tid, niveau, variation) spiller enkeltvist og i kombination. Specielt vil det være muligt at se på tidsvinduer for kumulering af relevant eksponering, herunder betydningen af henholdsvis intensitet og varighed, hvilket er vigtigt for at kunne fastlægge sikre niveauer til brug i forebyggelsen.

Metode

(1) Validering af centrale eksponeringsmål i ryg-ben-JEM: I ryg-ben matricen (5) indgår blandt andet stående/gående arbejde og knæliggende/hugsiddende arbejde (timer/dag) og samlet daglig løftemængde (kg/dag). Eksponeringsmålene er i matricen kombineret med 121 jobkategorier med en forventet ensartethed i eksponeringer. Valideringen indeholdt:

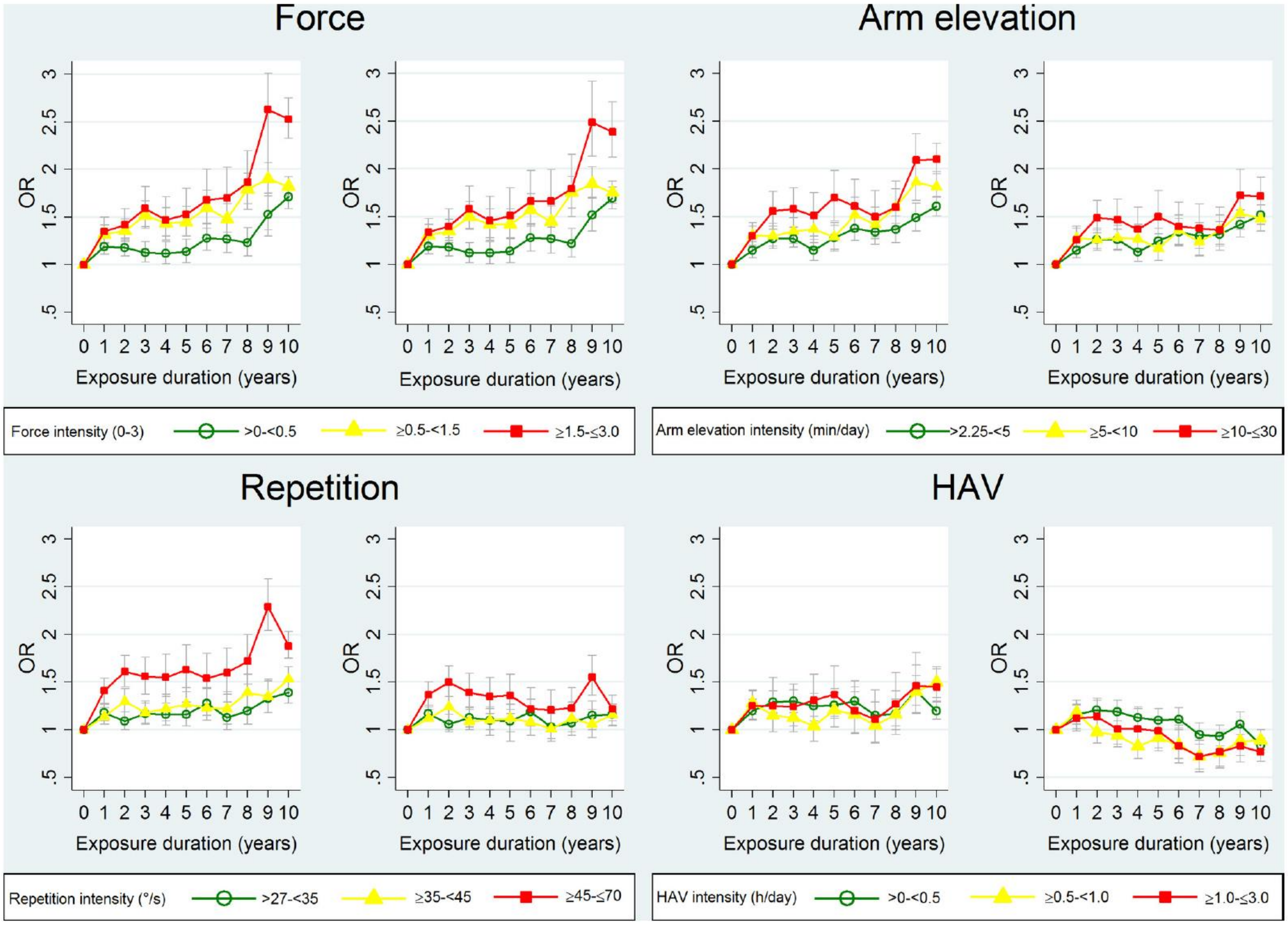
1. Præliminære oversættelser (cross-walks) mellem jobtitler/kategorier i ryg-ben JEM og O*Net fra USA med henblik på senere sammenligninger af eksponeringsestimater.
2. Sammenligning med selvrapporterede eksponeringsdata fra Arbejdsmiljø og Helbred 2012.
3. En validering af ekspertvurderede eksponeringer af stående/gående arbejde og knæliggende/hugsiddende arbejde mod tilsvarende eksponeringer målt med tri-axiale accelerometre (ActiGraph GT3X+)) via en særligt udviklet analysemetode (6) (16 udvalgte jobs) og validering af ekspertvurderet løftearbejde mod observationer (7) (8 udvalgte jobs).

(2) Videreudvikling af eksponeringsvariable i skulder-JEM: Ved anvendelse af skulder-JEM gøres analyser af:

1. Den isolerede versus den samvejede effekt af arbejde med højt løftede arme, kraftbetonet arbejde og repetitivt arbejde på risikoen for skulderoperationer.
2. Betydningen af skuldereksponeringernes intensitet og varighed for risikoen for skulderoperation. En ny analytisk tilgang er udviklet for at belyse dette.

Resultater

Der er etableret præliminære oversættelser (cross-walks) mellem jobtitler/kategorier i ryg-ben JEM og O*Net. Ryg-ben-JEM forklarede 15% af variansen i selvrapporteret tid med stående/gående arbejde, mens generelt helbred, lænderygsmerter, arbejdsevne, body mass index og rygning næsten ikke bidrog til at forklare variationerne. Der var høje korrelationer (≥0,55) mellem ekspertvurderede og observerede/målte værdier for stående/gående arbejde, knæliggende/hugsiddende arbejde og samlede daglige løftemængder. Eksperterne tenderede til at overvurdere de samlede daglige løftemængder, ellers var der ikke væsentlige systematiske forskelle. Arm-elevation, repetitive skulderbevægelser og kraftanvendelse betød mere i kombination end hver for sig, og især kombinationer med høj kraftanvendelse var forbundet med øget risiko for pladsgørende skulderoperation. I studiet af intensitet og varighed søgte vi efter sikre eksponeringsniveauer, dvs. eksponeringsniveauer uden ophobning af skadevirkninger over tid. Figur 3 nedenfor viser odds ratioer for pladsgørende skulderoperation i Danmark (2003-2008) i relation til varighed af eksponering (år) med forskellige intensiteter hen over 10-års eksponeringstidsvinduer. For hver eksponering er figuren til venstre justeret for bl.a. alder og køn, mens figuren til højre også er justeret for kumulerede effekter af de øvrige eksponeringer (fx er betydningen af varighed af kraftanvendelse justeret for kumuleret eksponering for arm-elevation >90°, repetition og hånd-arm-vibrationer).



Figur 3: Odds ratioer for pladsgørende skulderoperation i Danmark (2003-2008) i relation til varighed af eksponering (år) med forskellige intensiteter af kraft, arm elevation >90°, repetitive skulderbevægelser og hånd-arm-vibrationer (HAV) hen over 10-års eksponeringstidsvinduer.

Konklusion

Hvis koblingen mellem ben-jem og O*Net viser overensstemmende eksponeringsestimater, åbner dette for international anvendelse af DOC*X til studier af ryg-, hofte og knælidelser. Variationer i selvrapporteret tid med stående/gående arbejde blev i relativt høj grad forklaret af ben-jem, mens andre individuelle faktorer næsten ikke bidrog til at forklare variationerne. De høje korrelationer mellem ekspertvurderede og observerede/målte værdier for stående/gående arbejde, knæliggende/hugsiddende arbejde og samlede daglige løftemængder taler for brug af ben-jem i store epidemiologiske studier.

Kraftbetonede skulderbevægelser havde relativt stor betydning i kombination med andre skuldereksponeringer (arm-elevation og repetitive skulderbevægelser), hvilket peger på reduktion af kraftbetonede skulderbevægelser som fokus for interventioner, der skal nedsætte risikoen for afklemningssyndrom i skulderen.

Udsættelse for hånd-arm-vibrationer så ikke ud til at øge risikoen for afklemningssyndrom i skulderen, og repetitive skulderbevægelser med en median vinkelhastighed <45°/s indebar tilsyneladende ikke forøget risiko, ej heller ved lang tids eksponering (10 år). Vi fandt ikke sikre niveauer for kraftbetonede skulderbevægelser og arm-elevation >90°. For at forebygge afklemningssyndrom relateret til arm-elevation vil det derfor nok være nødvendigt at få vinklerne ned under 90°.

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PARTIKEL EKSPONERING

Partikulære påvirkninger: Udvikling af JEM for organisk og uorganisk støv

Projektledelse

Delprojektet blev ledet af Vivi Schlünssen. Post doc Ioannis Basinas og post doc Anne Vested har udarbejdet analyserne. CODUST projektets styregruppe, følgegruppe og internationale referencegruppe har været tilknyttet projektet (AMFF Projektnummer 29-2011-09, jnr. 200110081344).

Formål

Det oprindelige formål i ansøgningen var at udvikle JEM for landbrugsstøv, træstøv og andet organisk støv, samt kvarts og andet uorganisk støv for at afdække sammenhænge mellem erhvervsmæssig støveksponering og KOL. Dette delprojekt blev ikke tildelt midler fra AMFF. Det var imidlertid muligt at frigive ½ årsværk fra hovedprojektet til partikeleksponering. Formålet blev derfor ændret til at udvikle kvantitative populationsbaserede JEM for organisk støv og træstøv, samt afdække den prognostiske betydning af eksponering for organisk støv blandt personer med astma og KOL. Eksponering for uorganisk støv blev vurderet via brug af en eksisterende semikvantitativ populationsbaseret job eksponerings matrice, ALOHA-JEM (1)

Baggrund

Partikulær luftforurening på arbejdspladsen er en sandsynlig årsag til en række lungesygdomme, herunder KOL (2, 3, 4). Der er et stigende fokus på partiklers betydning for ikke-pulmonale sygdomme som iskæmisk hjertesygdom (5). Inden DOC-X projektet startede var der i en række undersøgelser antydet dosis-respons sammenhæng mellem støveksponering og KOL (3), men uden konsistens på tværs af studier eller støvtyper, bl.a. pga. upræcise oplysninger om eksponering og mangel på statistisk styrke.
Der er udviklet en række JEM for erhvervsmæssig partikulær luftforurening. Langt hovedparten giver kvalitative eller semikvantitative eksponeringsmål og bygger på ekspertvurderinger uden direkte inddragelse af målinger, for eksempel ALOHA JEM (1). Ambitionen i dette projekt var at udvikle populationsbaserede kvantitative JEM for organisk støv, præciseret som a) støv fra bearbejdning og håndtering af træ og b) endotoxin (en central del af organisk støv, se fakta boks 1). Afsættet for dette arbejde var industribaserede matricer udarbejdet i CODUST projektet, AMFF projektnr 29-2011-09 som også er tilgængelige via DOC*X platformen.

Hvordan erhvervsmæssig organisk støveksponering påvirker prognosen for personer med astma eller KOL er stort set ukendt. I dette delprojekt brugte vi de danske administrative sundheds- og industriregistre kombineret med kvantitative organiske støvindustriens eksponeringsmatricer (IEM) for at vurdere, om erhvervsmæssig organisk støvpåvirkning påvirker hospitalsindlæggelser for personer med diagnosen astma eller KOL.

Faktaboks 1: Hvad er endotoxin
Endotoxin findes i gram negative bakteriers cellememban og er en vigtig bestanddel af det meste organiske støv

Metode

Træ- og endotoxin JEM

Med udgangspunkt i industribaserede matricer udviklet i CODUST projektet (Vested et al 2019) udviklede vi én job eksponerings matrice (JEM) for træstøv og én for endotoxin (se Fakta boks 1) baseret på Den internationale jobklassifikation ISCO88 (International Standard Classification of Occupations 1988) som er næsten identisk med den Danmarks Statistiks fagkodeklassifikation (DISCO88). I CODUST projektet havde vi indsamlet 35.201 tidligere målinger fra træindustrien i en række europæiske lande og endte med at bruge 12.653 målinger fra Danmark, Finland, Norge, Holland, England og Frankrig fra perioden 1978-2007. Vi havde målinger fra 21 forskellige jobs, og derudover havde vi ekspertvurderinger på alle ISCO-koder. Vi brugte en statistisk model (mixed effekt model med BLUBS), så vi kunne udnytte information fra både målinger og ekspertvurderinger. Derfor kunne vi tildele alle ISCO koder et støvniveau, som var 0 for 486 ud af 503 job.

Vores IOM landbrugsmatrice fra CODUST blev gjort mere specifik idet vi fokuserede på endotoxin, den vigtigste aktive bestanddel af organisk støv. Matricen blev endvidere udvidet til også at indeholde information om organisk støv fra andre erhverv end landbrug, herunder målinger fra papirfabrikker, affaldsarbejdere og skovarbejdere. Vi brugte 3254 endotoxin målinger fra Danmark, Norge, Holland, Tyskland og Canada indsamlet i perioden 1992-2008. Vi brugte den samme statistiske metode som for træ, og kunne tildele alle 503 ISCO koder et endotoxin niveau, som var 0 for 478 ud af 503 jobs.

Organisk støvs betydning for prognose af astma og KOL

Baseret på oplysninger i ATP identificerede vi erhvervsaktive født 1933-1977, der nogensinde havde arbejdet i enten dansk landbrug eller træindustri 1964-2007. Vi identificerede alle med en første sygehusdiagnose af enten

astma eller KOL 1997-2007 i LPR. I alt blev 3982 personer diagnosticeret med astma (16 953 personår), og 2394 blev diagnosticeret med KOL (7762 personår).
Vi fulgte de to populationer fra året efter deres første astma- eller KOL-hospitalsdiagnose (tidligst 1998) og indtil næste KOL eller astma indlæggelse med censurering for død, udvandring, forsvinden, 65 år, pensionering eller senest 31. december 2007.

KOL blev defineret som en hospitalsdiagnose med følgende ICD-10 koder: Emfysem (J43, J43.0, J43.1, J43.2, J43.8, J43.9) eller andre kronisk obstruktiv lungesygdom (J44, J44.0, J44.1 J44.8, J44.9). Astma blev defineret ud fra ICD-10 koderne for astma (J45, J45.0, J45.1, J45.8, J45.9) eller status astmatikus (J46, J46.9).

Vi koblede IOMs udviklet i CODUST (6) til studiepopulationen og klassificerede aktuel eksponering i tre eksponeringsintensitetsgrupper (0,> 0-0,7 og> 0,7 mg/m3).

Vi brugte logistiske regressionsanalyser udført som diskrete overlevelsesfunktioner med person-år som analyse enhed til at undersøge sammenhæng mellem aktuel organisk støveksponering og genindlæggelse for KOL eller astma. Alle uafhængige variabler blev lagget ét år. Vi justerede for alder, køn, tid siden første diagnose, socioøkonomisk status og arbejdsmarkedstilknytning. Derudover brugte vi ALOHA-JEM (1) til at justere for uorganisk støv.

Resultater

Træ- og endotoxin JEM

I dette DOC-X delprojekt er der udviklet kvantitative job eksponeringsmatricer for henholdsvis træstøv og endotoxin. I matricerne er der tydelig kontrast i eksponeringsniveauer mellem forskellige industrier. Eksempler på 1995 aritmetiske støvniveauer i træ (mg/m3): Træemballage 3,1; møbelindustri 1,2; spånplade fabrik 1,1. Eksempler på 1995 niveauer i landbrug (mg/m3): Pelsdyr 1,4; fjerkræ 5,9; svin 4,9.
For træstøv fandt vi et 8% årligt fald for træ i perioden 1978-2007, hvorimod vi ikke så nogen klar tidstrend for endotoxin.

Organisk støvs betydning for prognose af astma og KOL

Der var en tendens til en øget risiko for genindlæggelse for astma (RRadj (95% CI) for lav og høj aktuel organisk støveksponering på henholdsvis 1,12 (0,81 til 1,54) og 1,18 (0,86 til 1,61) i forhold til den ikke-eksponerede gruppe, mest udtalte for personer med maksimalt 2 års eksponering i follow-up perioden, 2,11 (0,94 til 4,70). For KOL så vi en nedsat risiko for genindlæggelse for KOL, RRadj 0,63 (0,38 til 1,05) for den lavt og 0,54 (0,33 til 0,90) for den højt eksponerede gruppe.

Konklusion

Vi har udviklet nye populationsbaserede kvantitative job eksponeringsmatricer for træstøv og endotoxin, som er tilgængelige for forskere via DOC-X platformen. Industribaserede matricer for henholdsvis træstøv og organisk støv er ligeledes tilgængelige via DOC-X platformen.

Vores analyse tyder ikke på at organisk støveksponering er en væsentlig årsag til genindlæggelse for personer med astma. Den nedsatte risiko vi ser for genindlæggelse af KOL blandt personer med organisk støvudsættelse tilskriver vi selektionsmekanismer. I fremtidige undersøgelser er der behov for mere detaljerede oplysninger om sværhedsgrad af sygdom, og dette er muligt i DOC-X, for eksempel ved brug af medicinoplysninger.

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EKSPONERING FOR LYS OG STØJ

Fysiske påvirkninger: Udvikling af jobeksponeringsmatricer for støj, synligt lys og UV

Projektledelse

Projektleder er Henrik Kolstad og i projektgruppen indgår tillige Zara Stokholm, Jesper Medom Vestergaard, Anne Vested og Vivi Schlünssen.
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Formål

Det er delprojekts overordnede formål er at udvikle JEM for støj og lys for at undersøge mulige sammenhænge mellem eksponering for lys, støj og helbred.

Specifikke delformål:

(1) at indhente, tilrette og dokumentere eksisterende JEM for støj og lys

(2) at etablere kvantitative JEM for lys og støj målrettet den danske arbejdsstyrke baseret på eksisterende JEM og personbårne målinger af støj og lys gennem en hel arbejdsdag for en bred vifte af fag og brancher

(3) at analysere erhvervsmæssig støjeksponering og lyseksponering og risiko for henholdsvis kardiovaskulære sygdomme og depression i den danske arbejdsstyrke

Baggrund og problemstilling

Lysniveauet ved indendørsarbejde er hundredfold lavere end ved udendørsarbejde og 80-90 % af befolkningen i industrialiserede lande arbejder primært indendørs. Vinterdepression rammer 1-5 % af befolkningen og kan behandles effektivt med lysterapi (1). I sommerhalvåret er udendørs ultraviolet (UV) stråling den væsentligste kilde til vitamin D. Lavt vitamin D niveau er forbundet med forøget risiko for depression. Der er holdepunkter for at udsættelse for lave niveauer af sollys ved indendørs arbejde forøger risikoen for depression (2).

Der foreligger kvalitative JEM for udendørsarbejde og UV-eksponering fra USA, Canada, Sverige, Finland og Danmark, som alle bygger på ekspertvurderinger uden objektive målinger (3). I et igangværende projekt støttet af Arbejdsmiljøforskningsfonden (Luxarprojektet, projekt nr. 8210) har vi nyligt udført kontinuerlige lysstyrke målinger gennem syv døgn for 550 deltagere med natarbejde, indendørsarbejde, og udendørs arbejde, som vil indgå i den foreslåede lys-JEM.

Støjniveauerne på mange industri- og byggearbejdspladser er hundredfold højere end støjniveauerne fra trafik. En stribe epidemiologiske undersøgelser har vist forøget forekomst af kardiovaskulære sygdomme i populationer udsat for trafikstøj. Ved erhvervsmæssig støjeksponering ser man en akut stigning i blodtrykket, men det er begrænset dokumentation for forøget risiko for kardiovaskulære sygdomme. En afklaring af dette erhvervsstøj-miljøstøj-paradoks er et centralt forskningsspørgsmål i støjforskningen (4), se delprojekt 7 som blandt er baseret på støj-JEM etableret i dette delprojekt.

Internationalt foreligger der kun én enkelt svensk JEM for støj beregnet på den samlede arbejdsstyrke baseret på en kombination af målinger og ekspertvurderinger (5). Ved University of Michigan etablerer man aktuelt en støj-JEM baseret på et stort antal historiske personbårne målinger gennem en hel arbejdsdag. I Støjstress projektet (finansieret af Arbejdsmiljøforskningsfonden, projekt nr. 444 35 8474) og Audiometer projekterne finansieret af Arbejdstilsynet har vi mellem 2001 og 2010 indsamlet 1233 støjmålinger gennem et helt arbejdsdøgn fra 10 industribrancher, børnehaver og finanssektoren, som vil indgå i den foreslåede støj-JEM.

Metode

Lys JEM: Vi rekrutterede 695 arbejdere fra 71 forskellige fag og målte lysintensitet i dagtimerne mellem 06: 00 og 17: 59 i løbet af 1-7 forstløbende dage med Philips Actiwatch Spectrum® lysmålere (Actiwatch). Vi kodede alle fag i henhold til DISCO-88. Dataindsamlingen foregik året rundt for at tage højde for årstidsvariationen. I alt indsamlede vi 15.272 1-times målinger af lysintensitet angivet som antal lux. Vi analyserede de log-transformerede værdier som den afhængige variabel i *mixed effects regression models.* Tre eksperter vurderede sandsynlighed og varighed af udendørs arbejde for alle 372 job i DISCO-88 klassifikationen. Ud fra deres vurderinger konstruerede vi en score, som indgik i de statistiske modeller sammen med måned og klokketime. Fag, branche og arbejder indgik som *random effects*.

Støj JEM***:*** Vi udviklede en kvantitativ støj-JEM med data og metoder, som svarede til Lys-JEM. Vi anvendte målinger vi allerede havde indsamlet mellem 2001 og 2010. Det drejede sig om 1342 personlige *full-shift* støjmålinger fra 1140 arbejdere ansat i virksomheder inden for de 10 brancher med den højeste rapportering af støjinduceret høretab ifølge Arbejdstilsynet. De repræsenterede 100 forskellige fag i henhold til DISCO 88. Fire eksperter vurderede støjniveauer med støtte måleresultater fra 35 *benchmark* fag. Vi modellerede støjniveauer for alle 372 DISCO-88 fag baseret på disse data ved hjælp af *mixed effects regression models.*

Resultater

Lys-JEM estimerede lysintensitet for time på dagen og måned på året for alle 372 DISCO-88 fag. Lysintensiteten steg monotont med stigende ekspert score, og der var en 30-fold forskel mellem højeste og laveste eksponerede fag. Bygningsarbejdere var blandt de højest og hospitalsteknikere blandt de laveste eksponerede. Støj-JEM estimerede tilsvarende støjniveauet for mænd og kvinder og årstal for alle DISCO-88 fag. Der var en forskel på 20 dB mellem de højest og lavest eksponerede fag. Maskinarbejdere var blandt de højest og medarbejdere indenfor økonomi og salg blandt de lavest eksponerede.

Konklusion

Dette er de første kvantitative dagslys-JEM og heldags støj-JEM, som dækker alle fag. Vi analyserer nu om mængden af lys man udsættes for på jobbet nedsætter risikoen for, at man udløser recepter på antidepressiv medicin i DOC-X populationen. Endelige resultater foreligger endnu ikke. Det er ambitionen, at JEM også vil blive anvendt i flere epidemiologiske undersøgelser af lyseksponering, affektive lidelser og andre sygdomme, der potentielt er forbundet med lyseksponering. Det er vores håb at støj-JEM vil blive brugt til at prioritere forebyggende indsatser i støjende fag og brancher og i epidemiologiske studier af helbredseffekter, som potentielt er forbundet med støjeksponering. Den anvendes aktuelt i analyser af risikoen for iskæmisk hjertesygdom i DOC-X Hovedstudiet, som inkluderer en række overlappende eksponeringer ud over støj.

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KEMISK EKSPONERING

Kemiske påvirkninger: Udbredte kemiske erhvervspåvirkninger og risiko for kroniske sygdomme

Projektledelse

Projektet ledes af Johnni Hansen

Formål

At tilpasse og yderligere udbygge eksisterende JEM (NOCCA) for udvalgte udbredte kemiske påvirkninger i arbejdsmiljøet, samt at undersøge følgende aktuelle hypoteser:

1. Erhvervsmæssig udsættelse for bly øger risikoen for amyotrofisk lateral sklerose (ALS).
2. Udsættelse for *dieseludstødningsgas* øger risiko for amyotrofisk lateral sklerose (ALS).
    a. Fars og mors udsættelse omkring graviditeten øger risiko for børnekræft.
    b. Kvinders udsættelse øger risikoen for brystkræft.
3. Fars og mors udsættelse for *maling, farvestoffer og organiske opløsningsmidler* omkring graviditeten øger risiko for børnekræft
4. Fars og mors udsættelse for *organiske opløsningsmidler og metaller* omkring graviditeten øger risiko for testikelkræft hos sønner
5. Erhvervsmæssig udsættelse for *formaldehyd* og risiko for kræft i næsehule, næsesvælg, leukæmi og amyotrofisk lateral sklerose (ALS)
6. Erhvervsmæssig udsættelse for *organiske opløsningsmidler* og risiko for kræft i bryst, lever, blære og livmoderhals, non-Hodgkin's lymfom og leukæmi.

Valget af ovennævnte påvirkninger og sygdomme er prioriteret på basis af fire kriterier: 1) Påvirkning er relativt udbredt i arbejdsmiljøet såvel i dag som tidligere. 2) Øget sygdom er vist i dyremodeller mv., hvorimod dokumentation hos mennesker er mangelfuld. 3) Der eksisterer tilgængelige velunderbyggede JEM for de pågældende påvirkninger. 4) Der er væsentlig international interesse i yderligere afklaring af sammenhæng mellem den kemiske påvirkning og alvorlig livstruende sygdom.

Baggrund og problemstilling

Over 10.000 forskellige kemiske stoffer mv. findes fortsat i arbejdsmiljøet i Danmark (1), og mange hundrede tusinde danske arbejdere er dagligt udsat herfor (2). Samtidig vokser andelen af kemiske påvirkninger, der er mistænkt som medvirkende årsag til kroniske, ofte dødelige sygdomme, herunder neurologiske lidelser og især kræft (3). Mistanken er imidlertid ofte baseret på dyreforsøg og små utilstrækkelige epidemiologiske undersøgelser, og yderligere afklaring af årsagssammenhæng til brug i forebyggelsessammenhæng og vurdering af arbejdsskadeerstatning er hæmmet af mangel på epidemiologiske resultater (4).

Der findes en række relativt nye JEM for kemiske påvirkninger, der primært er udviklet til at vurdere risiko for kræft (5). Det er oplagt at udnytte synergien fra disse JEM til også at belyse andre sygdomme med samme mistænkte kemiske påvirkninger (3). Endelig er der mistanke om, at forældres udsættelse for visse kemikalier, herunder organiske opløsningsmidler under graviditeten kan medvirke til kræft hos børnene.

Metode

Vi har allerede udviklet 30 forskellige JEM (”NOCCA DANJEM”) for kemiske påvirkninger mv. efter samme principper som for FINJEM. (3). Disse er baseret på over 100.000 historiske arbejdspladsmålinger fra de fem Nordisk lande (5), der via ekspertvurderinger og historiske danske målinger, udført af Arbejdstilsynet (1947-89), er tilpasset danske arbejdsmiljøforhold. De udviklede JEM rummer både estimerede eksponeringsniveauer i over 300 jobgrupper og -sandsynlighed på jobniveau for hver af fire tidsperioder indenfor tidsrummet 1945-99. Sidstnævnte underbygger estimering af dosis-respons sammenhænge. Disse JEM tilpasses yderligere mht. jobkodning, køn til de øvrige DKJEM (fx støv, stress osv.), således at alle JEM får samme klassifikation af job og branche, og umiddelbart kan kobles med erhvervshistorie. Der kobles via det individuelle CPR-nummer til helbredsudfald i henholdsvis Landspatientregistret (ALS) for perioden 1982-2013 og for kræftsygdomme til Cancerregisteret (1970-2017). Endelig har vi via CPR-registret og det Medicinsk Fødselsregister søgt relationer mellem forældre og børn med og uden kræft.

Styrker og svagheder: Det er undersøgelsens styrke at kunne udnytte synergien ved at belyse flere velunderbyggede mistænkte sammenhænge for udbredte kemiske påvirkninger for både mænd og kvinder i forhold til en række væsentlige sygdomme via velanskrevne JEM. Herunder kan der beregnes relative risici med væsentlig statistisk styrke via usædvanlig store datamaterialer, herunder med justering for visse potentielle konfoundere. Det vil også være muligt, at vurdere dosis-respons sammenhænge, idet eksponeringskontrasten i varighed, kalendertid og mellem de enkelte job er relativ stor. Svaghed er de generelle svagheder ved brug af JEM.

Resultater

JEM erhvervsklassifikation er oversat til DISCO88, ligesom eksponeringsperioden er forlænget fra 1994 til 2015.

En række hypoteser er testet i forhold til arbejdsmiljøeksponering og risiko for ALS. Positive associationer er fundet i forhold til formaldehyd, dieseludstødning, bly, organiske opløsningsmidler og visse tungmetaller, dog uden observation af væsentlige dosis-respons sammenhænge.

Mors og fars udsættelse for organiske opløsning midler og tungmetaller er undersøgt i forhold til sønners risiko for testikelkræft. Overordnet var der ingen stærke associationer. Svage associationer blev observeret for fars udsættelse for hexavalente kromforbindelser og toluen og sønners risiko for testikelkræft.

Børnekræft er undersøgt i forhold til fars og mors udsættelse for maling, organiske opløsningsmidler, og dieseludstødning. Der blev fundet positive associationer med kræft i hjerne samt leukæmi i barnealderen.

Konklusion

Vores undersøgelser, hvor arbejdsmiljøeksponering alene er bestemt ved JEM har kunne reproducere resultater fra undersøgelser, hvor mere avancerede og tidskrævende bestemmelser af eksponering er foretaget. Dog synes størrelse af de estimerede relative risici mindre end i andre undersøgelser. På den anden side har det været muligt objektivt at bestemme arbejdsmiljøpåvirkningerne, hvilket især er vigtigt i undersøgelser af børnekræft og forældres erhvervspåvirkninger.

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Møder	Hansen J: Arbejdstilsynets Informationsmøde om kræftfremkaldende stoffer. Muligheder for brug af data i DOC*X (Danish Occupational Cohort*X - registerbaseret arbejdsmedicinsk forskningsressource) til vurdering af risiko for kræft i arbejdsmiljøet i Danmark
Præsentationer	Konferencer: • Volk J, EPICOH, Edinburgh, 2017 • Pedersen JE, EPICOH, Wellington, 2019 • Hansen J, EPICOH, Wellington, 2019

LIVSSTILS FAKTORER

Etablering af job-eksponeringsmatricer for livsstil, som kan anvendes til confounder justering: Estimeret niveau af rygning, indtag af alkohol, frugt/grønt, fysisk aktivitet i fritiden og body mass index.

Projektledelse

Delprojektet er gennemført med Jens Peter Bonde som projektleder og udarbejdet af Sesilje Bondo Petersen og Esben Meulengracht Flachs, i samarbejde med forskere fra DOC*X koordinationsgruppen samt repræsentanter fra Østerbroundersøgelsen, Kræftens Bekæmpelse, Center for Klinisk Forskning og Forebyggelse, Københavns Universitet og Statens Institut for Folkesundhed.

Formål

Dette projekt havde som formål at udvikle JEM for livsstilsfaktorer, herunder for rygning, alkoholindtage, frugt- og grøntindtag, fysisk aktivitet i fritiden samt bodymass indeks (BMI), som kan anvendes til confounder justering i registerbasserede arbejdsmedicinske kohortestudier.

Baggrund og problemstilling

JEM er fordelagtige at benytte til eksponeringsbestemmelse i arbejdsmedicinske studier, når individuelle eksponeringsdata ikke er tilgængelige, men der er også visse ulemper ved at bruge eksponeringsmål baseret på JEM (1,4). Først og fremmest giver en JEM ikke variationen på eksponeringsmålet indenfor en given jobgruppe, og der er risiko for misklassifikation, hvis jobkodningen ikke er præcist defineret. Derudover kan der opstå confounding i sundhedsstudier pga. variation i individuelle livsstilsfaktorer og sundhedsadfærd (1,5).
I registerbaserede studier er der normalt ikke adgang til individuelle data om livsstilsfaktorer, hvormed resultaterne ikke kan justeres for disse confoundere. Derfor bruger man ofte surrogatmål for livsstilsfaktorer som f.eks. socioøkonomisk status og uddannelsesniveau, da disse parametre normalt er stærkt korreleret til sundhed (6,7). Men dette er ofte ikke nok til at fjerne potentiel confounding, da livsstil og sundhed også varierer indenfor sociale klasser og uddannelsesniveauer (8).
I store register-baserede studier er der ofte ikke økonomi til at indhente individuelle data for livsstilsfaktorer og ofte vil det ikke være muligt pga. tidsforskydning mht. hvornår data er indsamlet, og hvornår de analyseres. Derfor er der brug for alternative metoder, der kan estimere livsstilsfaktorer i epidemiologiske register-baserede studier.

Metode

Det samlede datamateriale med i alt 264,054 individer bestod af selvrapporteret livsstilsdata fra fire forskellige kohortestudier:

(1) SIC-kohorten: *Social Inequality in Cancer Cohort (SIC)* består af data fra syv forskellige danske kohorter fra primært Aarhus og København. Livsstilsdata var tilgængelig fra 76,294 individer i alderen 20-93 år (9).

(2) Den Nationale Arbejdsmiljøkohorte (NAK) fra det Nationale Forskningscenter for Arbejdsmiljø med løbende dataindsamlinger fra 1990 (10-12).

(3) SUSY-undersøgelserne fra Statens Institut for Folkesundhed, der er blevet gennemført i perioden 1987-2005 (13,14).

(4) Helbredsundersøgelsen fra 2010 og 2013 som er et samarbejde mellem Statens Institut for Folkesundhed og de 5 danske regioner (15).

For mere detaljeret information om de sammenlagte data henvises til tabel 1 i publiceret artikel (se Bilag 3) Individuel information om arbejdstitel blev indhentet fra DOC*X databasen, hvor DISCO-88 koder for arbejdstitel er tilgængelig fra 1976 og frem. DISCO-88 koder blev linket til individer i den samlede studiepopulation via CPR. Tilladelse til at koble variable fra de respektive kohorter med data fra DOC*X blev indhentet fra Datatilsynet.

Oplysninger om livsstilsfaktorer blev indhentet og harmoniseret fra spørgeskema og interviewdata fra perioden 1981-2013. Vi modellerede sandsynligheden for de specifikke livsstilsfaktorer i en mixed model justeret for alder og køn for hvert niveau af DISCO-88, hvor data blev inddelt i 5-års intervaller (1=1981–1990; 2=1991–1995; 3=1996–2000; 4=2001–2005; 5=2006–2010; 6= >2010). Kun DISCO-grupper med minimum 10 observationer blev inkluderet. Hvis der var mindre end 10 observationer blev den beregnede værdi for det mindre detaljerede DISCO-niveau inkluderet i den endelige JEM. Seks forskellige JEM blev genereret ud fra den samlede datamængde. Estimatet for rygning var beregnet som sandsynligheden for at være ryger ud fra en kategorisk variabel for nuværende rygevaner (0 = ikke-ryger; 1 = ryger), hvor tidligere rygere blev defineret som ikke-rygere. Blandt rygerne blev derudover beregnet et estimat for den samlede mængde tobak pr. dag. Estimatet for alkoholindtag var defineret som et mål for antal genstande pr. uge, hvor 0 angiver ingen genstande pr. uge, 2 angiver >0-7, 3 angiver >7-14 og 4 angiver ≥14 genstande/uge. Fysisk aktivitet i fritiden er et estimat for graden af fysisk træning, hvor 1 = stillesiddende aktivitet (≈ ingen sport/træning); 2 = lav/let gang eller cykling (≈ 1-2 timer/uge); 3 = moderat træning (≈ 2-4 timer/uge); 4 = hård træning/konkurrencesport (≈ >4 timer/uge). Estimatet for BMI (kg/m2) bygger på oplysninger om højde og vægt fra spørgeskemaer/interviews eller kliniske undersøgelser. Estimatet for indtag af frugt og grønt bygger på beregning af den højeste frekvens for frugt eller grøntsager angivet i spørgsmålene fra hvert datamateriale. Frekvenserne blev opdelt i tre grupper for hyppighed af total indtagelse af frugt og grøntsager pr. uge (1 = aldrig/sjældent; 2 = 1-6 pr. uge; 3 = dagligt).

Vi beregnede kalender-specifikke *intraclass correlation coefficients (ICCs)* samt 95/5 og 75/25 percentil-ratioer til at vurdere graden af variation i og imellem grupper. For at illustrere hvordan livsstils JEM giver yderligere uafhængig information i forhold til uddannelse, som ofte bruges som surrogatmål, analyserede vi i en Poisson regression sammenhængen mellem kumulativ rygning ved 50 år og dødelighed med og uden justering for uddannelse (kort, mellem og lang).

Resultater

For de seks genererede JEM var variationen mellem jobgrupper <5% -10% af den samlede variation, men på tværs af jobgrupper var der en betydelig kontrast med ratioer mellem højest og lavest prædikterede værdi fra 1,2 til 6,8 og med 95/5 og 75/25 percentiler på hhv. 1,5-2,8 og 1,6-1,9. De estimerede værdier i JEM for hver jobgruppe kan appliceres til hvert individ i en studiepopulation via DISCO-koden i henhold til køn, alder og kalendertid. De estimerede værdier i JEM'erne er ikke beregnet som eksakte eksponeringsværdier, men bør snarere ses som relative forskelle mellem arbejdsgrupper, da de ikke er valideret mod eksterne datakilder. Analysen af dødelighed prædikteret ved JEM for rygning med og uden justering for uddannelse illustrerede, at JEM giver yderligere uafhængig information i forhold uddannelse som ofte bruges som surrogatmål. For yderligere detaljer omkring resultaterne henvises til publiceret artikel (Bilag 3). Livsstils JEM har været benyttet i hovedprojektet (se side 60), hvor resultaterne for iskæmisk hjertesygdom viser, at at eksponeringsmål fra JEM for rygning, BMI og fysisk aktivitet prædikterer risikoen for iskæmisk hjertesygdom som forventet. Validiteten af JEM vurderes derfor at være god.

Konklusion

Den store studiepopulation, der ligger til grund for genereringen af livsstils JEM giver mulighed for estimering af livsstilsfaktorer for ca. 70% af den samlede danske arbejdsstyrke. JEM kan bruges til confounder kontrol i registerbaseret arbejdsmedicinske studier med manglende information om individuelle livsstilsfaktorer.

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BIOSTATISTISK METODEUDVIKLING

Udvikling af det teoretiske grundlag for konstruktion og anvendelse af jobeksponeringsmatricer

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Projektledelse

Esben Budtz-Jørgensen, Biostatistisk Afdeling. Endvidere har forskningsassistent Frederik Sørensen (Biostatistisk Afdeling) bidraget.

Formål

(1) At bestemme konsekvensen af målefejl for bias og statistisk styrke i analyser baseret på JEM data
(2) At vurdere konsekvensen af inddragelse af flere eksponeringsvariable samtidigt
(3) Udvikling af metoder til korrektion for målefejl.

Baggrund og problemstilling

Når sammenhængen mellem en arbejdsrelateret eksponering og personens helbred estimeres i data, hvor eksponeringen er bestemt via en JEM kompliceres den statistiske analyse. Ved brug af JEM data, erstattes personens sande eksponering med en JEM-værdi svarende til personens arbejde. Da denne værdi sikkert ikke er identisk med den sande eksponering, introduceres her et problem med målefejl. Det er velkendt at sådanne målefejl have konsekvenser for bestemmelsen af eksponeringens helbredseffekter. Generelt vil man miste statistisk styrke, men effektestimater kan også blive skævvredet (biased). Denne bias afhænger af om fejlen følger en *klassisk additiv* model eller en *Berkson* model (1). Den klassiske model antager uafhængighed mellem målefejl og det sande individuelle eksponeringsniveau, mens Berkson modellen antager uafhængighed mellem målefejlen og den målte eksponeringsværdi. Berkson fejl kan opstå f.eks. hvis individuelle eksponeringer erstattes med et gruppegennemsnit og denne fejltype er derfor relevant for JEM-analyser. I lineære regressionsmodeller for sammenhængen mellem eksponering og helbred, vil klassik målefejl give bias mod nul, mens Berkson fejl ikke fører til bias men kun et tab i statistisk styrke. I ikke-lineære modeller (f.eks. logistisk regression og Cox regression) giver begge fejltyper bias, dog vil denne bias typisk være af mindre betydelig hvis målefejlen er af Berkson typen (2).

En vigtig fordel ved DOC*X er, at flere eksponeringer kan analyseres samtidigt. Dette giver bedre muligheder for konklusioner vedrørende kausale sammenhænge, men herved kompliceres den statiske analyse yderligere idet modellerne nu vil inkludere mindst to usikkert bestemte faktorer (kovariate)r. For korrelerede eksponeringer kan dette føre til såkaldt *transfer of causality,* hvor variable bestemt med større præcision ”stjæler” helbredseffekt fra mere usikkert bestemte variable. I sådanne modeller kan selv ikke-differentiel målefejl medføre overvurdering af eksponeringseffekter (3). Dette problem optræder også hvis flere variable benyttes til at beskrive samme eksponering i forskellige perioder af personernes liv.

Metode

ad (1) og (2). Eksponeringsdata fra en JEM vil være påvirket af både klassisk additive og Berkson fejl. Berkson fejlen introduceres fordi individuelle målinger erstattes med et gennemsnit, mens klassisk fejl introduceres hvis det benyttede gennemsnit ikke er præcist, f.eks. på grund af en lille stikprøve per jobgruppe i JEM data. Endvidere introduceres fejl vis personers jobgruppe misklassificeres i DOC*X databasen.

Vi vil anvende teoretiske statistiske udledninger og simulationsstudier for at belyse omfanget af målefejl og styrke reduktion ved analyse af eksponerings-udfalds sammenhænge med brug JEM data og ved inddragelse af en eller flere usikkert bestemte eksponeringsvariable. Analyserne vil tage udgangspunkt i en målefejlsmodel der tillader den samlede fejl både at bestå af en Berkson komponent og en klassisk komponent (4). I simulationsstudierne vil målefejlsvarianserne vil blive varieret i intervaller fastsat i samarbejde med DOC*X gruppens øvrige forskere. Vi vil undersøge hvilke parametre i JEM der er bestemmende for fordelingen mellem klassisk fejl og Berkson fejl i analysen af heldbredseffekter ud fra JEM data. Endvidere vil mulighederne for at estimere målefejlens størrelse ud fra typiske JEM data blive undersøgt. Disse analyser vil tage udgangspunkt i en non-differentiel målefejl dvs. at målefejlsfordelingen ikke afhænger af helbredsstatus. Differentiel målefejl kan føre til overvurdering af eksponeringseffekten, men er mest relevant i case-kontrol studier, hvor eksponeringen måles efter helbredsstatus.

ad (3) Vi vil udvikle statistiske metoder til at korrigere for målefejlen. Disse metoder vil være rettet mod typiske regressionsmodeler. Vi vil implementere metoderne i standard software således at de med tiden kan benyttes rutinemæssigt ved analyse af DOC*X data og tilsvarende databaser. Vi vil også vurdere muligheden for at benytte strukturelle ligningsmodeller (5) som inkluderer latente (u-observerbare) variable og derfor er meget velegnede til målefejlsproblemer.

Resultater

Vi har bestemt målefejlens størrelse og type (klassisk/Berkson) som funktion af grundlæggende parametre i JEM data (dvs. antal personer per jobgruppe, variation i eksponering indenfor og mellem jobgrupper). Vi har vist at ofte vil en betydelig del af målefejlen udgøres af såkaldte Berkson fejl som ikke giver bias i lineære modeller. Vi har vist at naive analyser, der ikke tager hensyn til usikkerheden i JEM data, ofte vil føre til en (mindre) bias mod nul, men de tilhørende sikkerhedsintervaller vil typisk være for smalle. Vi har udviklet statistisk teori og metoder til at opnå unbiased estimation i lineære modeller for eksponeringseffekten. Disse metoder er videreudviklet til ikke-lineære modeller (logistisk regression og Cox regression) hvor metoderne ofte vil være approksimativt unbiased. Desuden er et vigtigt bidrag, at der er udviklet formler for standard fejl på helbredseffekt-estimater, der tager højde for usikkerheden i eksponeringsdelen.

Konklusion

Der er udviklet statistiske metoder, der giver unbiased (eller næsten unbiased) estimation i JEM data. Endvidere har vi udviklet formler til beregning af tilhørende standard fejl. Metoderne kan nu rettes til så de kan benyttes rutinemæssigt i analysen af DOC*X data.

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Arbejdet har løbende været afrapporteret ved en række videnskabelige foredrag i og uden for DOC*X-gruppen. Den matematiske teoretiske del af projektet har været betydeligt større end oprindeligt planlagt. Dette har forsinket publikationsprocessen men artiklen *Consequences of measurement errors for effect estimation in studies based on job exposure matrices* er under udarbejdelse, og vil blive indsendt til publikation i tidsskriftet Epidemiology.

HOVEDPROJEKT: HJERTEKARSYGDOM

Risikoen for arbejdsbetinget hjertekarsygdom belyst ved en befolkningsbaseret fælles JEM for eksponeringer for stress, fysisk belastning, stillesiddende arbejde, støv og støj.

Projektledelse

Delprojektet er gennemført med Jens Peter Bonde som projektleder i samarbejde med projektets koordinationsgruppe: Esben Meulengracht Flachs, Ida E. H. Madsen, Sesilje Bondo Petersen, Johan Hvid Andersen, Johnni Hansen, Esben Budtz Jørgensen, Henrik Kolstad, Vivi Schlünssen og Susanne Wulff Svendsen samt Andreas Holtermann. Der er således bidrag fra samtlige deltagende institutioner i DOC*X projektet.

Formål

Dette DOC*X-delprojekt skal belyse den arbejdsrelaterede risiko for iskæmisk hjertekarsygdom som følge af høje krav og lav indflydelse, fysisk belastning i arbejdet, stillesiddende arbejde og udsættelse for støv og støj. Undersøgelsen baseres på data i DOC*X.

Det har undervejs vist sig nødvendigt at oparbejde og implementere de enkelte JEM trinvist én eksponering af gangen og det har ikke været muligt inden for tidsrammen at belyse effekten af samtlige planlagte arbejdseksponeringer. På afslutningstidspunktet er publiceret det første studie som vedrører fysisk krævende arbejde med kontrol for livsstilsfaktorer på basis af JEM udviklet i DOC*X (tobak, BMI og fysisk aktivitet i fritiden). Det er dog fortsat formålet at udnytte DOC*X mulighederne for at præsentere en samlet analyse af alle nævnte eksponeringer og dette arbejde e igangsat men ikke afsluttet.

Her rapporteres således resultater vedrørende den køns-specifikke risiko for akut myokardie infarkt (blodprop ved hjertet) ved løfte arbejde henholdsvis stående/gående arbejde for mænd og kvinder.

Baggrund og problemstilling

Hjertekarsygdomme er en af de alvorligste sygdomme i de vestlige samfund. Livsstils-forhold (tobak, motion og kost) er vigtige risikofaktorer. Undersøgelser peger på, at et dårligt psykosocialt arbejdsmiljø, fysisk belastende arbejde, stillesiddende arbejde, støvudsættelse og støj også kan være risikofaktorer.

Fysisk aktivitet: Fysisk aktivitet i fritiden medfører bedre fysisk kondition og nedsat hjertekar-dødelighed (4). Det ser ud til, at fysisk aktivitet på arbejde ikke har samme effekt på konditionen (5;6), og flere undersøgelser peger på, at fysisk aktivitet på arbejdet medfører øget risiko for hjertekarsygdomme (7-9). De negative effekter af fysisk aktivitet på arbejdet synes især at gøre sig gældende for personer med lav grad af fysisk aktivitet i fritiden og lav kondition (10). Samlet set er der dog ikke konsistente resultater. Samtidig er der, paradoksalt nok, tiltagende evidens for, at stillesiddende arbejde er en risikofaktor for hjertekarsygdom, uafhængigt af fysisk aktivitet i fritiden (11).

Psykosociale faktorer: Det er fortsat uafklaret i hvilket omfang stress på arbejdet medfører risiko for hjertekarsygdom. Nyere meget store undersøgelser peger, at arbejdsrelateret stress øger risikoen 1,2 til 2 gange (1;2). Det seneste review (3) konkluderer at sammenhængen mellem job strain og iskæmisk hjertesygdom fuldt ud kan forklares af høje krav, mens lav grad af indflydelse ikke synes at spille nogen rolle, og at sammenhængen kun ses for mænd.

Støv: Et review af 37 videnskabelige undersøgelser viste, at der er nogen evidens for, at erhvervsmæssig udsættelse for partikulær luftforurening øger risikoen for iskæmisk hjertesygdom, men størrelsesordenen er usikker (12). Også en dansk undersøgelse af metalarbejdere med udsættelse for svejserøgspartikler fandt en moderat risiko for iskæmisk hjertesygdom (13).

Støj: Nogle undersøgelser peger på at støj kan medføre vedvarende forhøjet blodtryk (14) og iskæmisk hjertesygdom (15;16), men evidensen for en årsagssammenhæng er utilstrækkelig.

Relationer mellem eksponeringerne: Fysisk aktivitet på arbejde og i fritiden ser ud til at modificere hinandens effekt på hjertekarsygdom (10). Job-strain ser ud til at hænge sammen med nedsat fysisk aktivitet i fritiden (17), og job-strain og samtidig høj støjudsættelse øger måske risikoen for hjerteinfarkt mere end svarende til effekten af hver af de to påvirkninger (16).

Metode

Studiepopulationen omfatter 1.24 million personer bosiddende i Danmark med en alder i 1995 mellem 31 og 50 år og med beskæftigelse som lønmodtager (et udsnit af den totale DOC*X kohorte). DOC*X databasens årlige oplysninger om job koder efter DISCO-88 klassifikationen (372 jobkoder) blev for hver person i perioden fra 1976-2016 koblet til henholdsvis en ekspert-baseret jobeksponeringsmatrice for tunge løft (kg/dag) og en køns- og aldersspecifik jobeksponeringsmatrice for omfang af stående/gående arbejde (skala fra 0 (minimalt) til 6 (maksimalt) baseret på lønmodtageres egne vurderinger. Data om første gangs tilfælde af akut myokardieinfarkt blev indhentet fra Landspatient Registeret (myokardieinfarkt behandles på hospital) og Dødsårsagsregisteret (dødsfald som følge af akut myokardieinfarkt i præhospitalsfasen). Risikoen for akut myokardieinfarkt i relation til løfte arbejde og stående/gående arbejde året forud (korttidseffekt) og gennem hele livet fra 20-30 årsalderen (fra 1976-2016, langtidseffekt) blev beregnet med en statistisk model for mænd og kvinder separat og med kontrol for alder, uddannelsesniveau, socialgruppe, samlivsstatus, beskæftigelse status (herunder ledighed) samt tobaksrygning, bodymassindex (BMI) og fysisk aktivitet i fritiden. Data om førstnævnte faktorer blev indhentet fra befolkningsregistre og sidstnævnte tre livsstils faktorer blev inddraget på basis af en jobeksponeringsmatrice udviklet i forbindelse med DOC*X projektet. Udover hovedanalyserne foretog vi en række supplerende analyser for at belyse forskellige fejlkilder.

Resultater

Der forekom i alt 22.037 tilfælde af akut myokardieinfarkt blandt mænd og 6942 blandt kvinder i løbet af opfølgningsperioden fra 1995-2016 under i alt 21.4 millioner person år. Jobeksponeringsmatricen for tobaksrygning og særligt bodymassindex prædikterede akut myokardieinfarkt blandt både mænd og kvinder og selv efter fuld kontrol for alle andre forhold (uddannelse, social gruppe med videre, se ovenfor). Der fandtes ingen sammenhæng mellem fysisk aktivitet på arbejde gennem det seneste 1-2 år (korttidseffekt) for hverken mænd eller kvinder. Ved sammenligning af akut myokardieinfarkt i den højeste af 5 eksponeringskategorier med den laveste fandtes blandt mænd en marginalt øget risiko ved langvarigt løftearbejde (relativ risiko 1.09, 95% sikkerhedsgrænser 1.03-1.15) og ingen risiko ved langvarigt gående/stående arbejde (relative risiko 1.01, 95% sikkerhedsgrænser 0.96-1.07). En relativ risiko på eksempelvis 1.09 svarer i det store og hele til at 9% flere end forventet bliver syge med de angivne grænser bestemt at statistisk usikkerhed. For kvinder var de tilsvarende tal RR 1.27 (95% sikkerhedsgrænser 1.15-1.49) for langvarigt tungt løftearbejde og 1.18 (95% sikkerhedsgrænser 1.07-1.30) for langvarigt gående/stående arbejde. Sidstnævnte overrisiko forsvandt ved kontrol for samtidigt løftearbejde. Disse fund blev kun delvist støttet ved en række supplerende analyser, herunder analyser i udsnit a befolkningen med ensartede sociale og uddannelsesmæssige.

Konklusion

Alt i alt fandtes ingen tungtvejende evidens for hypotesen om at fysisk aktivitet på arbejde i form af mangeårige tunge løft og langvarigt gående stående arbejde er forbundet med en øget risiko for hjertekarsygdom hos hverken kvinder eller mænd. Mulige effekter af pludselige markante fysiske belastninger belyses ikke og man kan ikke helt afvise at resultaterne kan have undervurderet en reel risiko som følge af fejlagtig klassifikation af tungt løftearbejde.

Med denne undersøgelse er der opbygget en model for undersøgelser af arbejdsrelateret sygelighed og dødelighed som i de kommende år vil finde anvendelse på de øvrige skitserede erhvervseksponeringer (psykosociale faktorer, støv og støj) – og resultaterne forventes at komme løbende.

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Publikationer mm.

Publikationer	Publiceret: • Bonde JP, Meulengracht E, Madsen IEH, Bondo Petersen S, Andersen JH, Hansen J, Jørgensen EB, Kolstad HA, Holtermann A, Schlunssen V, Svendsen SW. Acute myocardial infarction in relation to physical activities at work: a nationwide follow-up study based on job-exposure matrices. Scand J Work Environ Health. 2019 Nov 18. pii: 3863. doi: 10.5271/sjweh.3863
Populær formidling	Afventer offentliggørelse af videnskabelig artikel
Møder	Flere møder i DOC*X forsker netværket
Præsentationer	Konferencer: • DOC'X progress meeting, November 2018, NFA, Copenhagen • Arbejdsmiljøforskningsfondens seminar Januar 2019 København

DOC*X som åben forskningsressource

Status

Frem til udgangen af 2019 er ansøgning om nye projekter foregået via nedenstående vejledning. Det har vist sig, at konstruktionen med en fælles projektdatabase imellem de i projektet involverede institutioner ifølge Danmarks Statistik ikke kan opfylde de nye implementerede GDPR-regler vedrørende dataansvar. Derfor vil der i løbet af 2020 blive udarbejdet en ny konstruktion således, at alle involverede institutioner vil få adgang til DOC*X via egne særskilte projektdatabaser. Der vil stadig være en DOC*X styregruppe, som vil koordinere fremtidige DOC*X-projekter og som vil ansøge om projektmidler til løbende vedligeholdelse og udvikling af DOC*X. Løbende drift og udvikling af fagregisteret vil stadig foregå på Bispebjerg Hospital og varetages af de nuværende DOC*X database administratorer. Så snart den nye konstruktion er på plads, vil der blive udarbejdet en ny vejledning, som vil kunne findes på hjemmesiden www.doc-x.dk.

Vejledning til ansøgning om adgang til DOC*X data

Ansøgning om at benytte DOC*X databasen til et forskningsprojekt, skal stiles til DOC*X Styregruppen (www.doc-x.dk).

Ansøgningen skal indeholde en projektbeskrivelse, en beskrivelse af hvilke dele af DOC*X databasen, der ønskes benyttet, og en beskrivelse af den forskergruppe eller det forskningsmiljø, som projektet skal udføres i. Ansøgningsskema pr. 1. nov. 20019 er vedlagt i Bilag 1.

Formålsbeskrivelse

Projekter vil blive vurderet efter følgende kriterier:

1. Der skal være tale om forskningsprojekter indenfor arbejdsmiljøfeltet.
2. Der skal være tale om seriøs forskning udført af en kompetent forskningsgruppe, hvor et videnskabeligt relevant spørgsmål kan belyses med den foreslåede metodik og data.
3. Det skal sikres, at projektet ikke kolliderer med andre DOC*X-projekter.
4. Projektet skal videnskabsetisk være forsvarligt.
5. Finansieringskilder skal være transparente, og interessekonflikter selvkonfereres.
6. Der skal tilbydes medforfatterskab til en eller flere fra Koordinationsgruppen, og fra de forskningsgrupper, der har leveret JEM, hvis disse anvendes i projektet

Ansøgning

Når ansøgningen er accepteret af Styregruppen, skal der udfærdiges en projektansøgning til Danmarks Statistik, der ligeledes skal godkende projektet. Denne godkendelse sker efter Danmarks Statistiks normale procedurer for projektgodkendelser. I samarbejde med Danmarks Statistik har DOC*X's databaseadministratorer udarbejdet en standardiseret variabeludtræksliste, der bruges for DOC*X underprojekter (Bilag 2). Adgang til DOC*X databasen kan gives til forskningsprojekter indenfor arbejdsmiljøfeltet, der udføres af en institution, der er autoriseret til at benytte forskerordningen ved Danmarks Statistik.

Når projektet er godkendt af Danmarks Statistik, kan der oprettes et projekt under DOC*X databasen ved forskerservice i Danmarks Statistik, og de relevante data fra DOC*X databasen overføres hertil. Projektgruppen står selv for at indhente godkendelse og levering af eventuelle supplerende data, der er nødvendige for projektets gennemførelse.

Sammenfatning, erfaringer og konklusion

DOC*X er etableret som en åben forskningsressource under Danmarks Statistik, hvor forskere fra ind- og udland har mulighed for at søge adgang til data. Databasen indeholder ved udgangen af 2019, 16 forskellige JEM med data for eksponeringer i arbejdsmiljøet. Der er igangsat mere end 20 eksterne projekter, hvor forskere og organisationer har eller har haft adgang til data.

Information omkring ansøgning til dataadgang ligger tilgængelig på hjemmesiden www.doc-x-dk. Ansøgningsproceduren er sat i system, så der forholdsvis hurtigt kan gives adgang til data fra DOC*X's styregruppe. Derefter er det Danmarks Statistik, der skal godkende projekt og dataadgang, hvilket sker efter Danmarks Statistiks egne forskrifter. Processen er løbende blevet tilpasset og justeret, så arbejdsgangene lettes både for DOC*X's databaseadministratorer og Danmarks Statistik. Den vil yderligere blive justeret i 2020 som følge af implementeringen af de nye GDPR regler vedr. dataansvar, således at DOC*X vil blive tilgængelig via særskilte projektdatabaser i de respektive forskningsinstitutioner. Så snart den nye ansøgningsprocedure ligger klar, vil den blive tilgængelig via hjemmesiden www.doc-x.dk.

Vi har oprettet og dokumenteret fagregisteret i DOC*X med kronologiske oplysninger om fag og branche for alle personer med erhvervsarbejde i Danmark i perioden fra 1970-2017 (1971-75 undtaget). Oplysninger om fag og branche er ensartet over tid, hvilket muliggør lang opfølgningstid. Arbejdet har været besværliggjort af de forskellige klassifikationssystemer, som er anvendt af Danmarks Statistik fra 1970 og frem. Omkodninger fra et system til et andet har givet udfordringer og mange arbejdsressourcer er lagt i netop denne opgave.

De ensartede fagkoder i DOC*X er blevet valideret særskilt, hvor selvrapporteret fagtitel er blevet omskrevet til en DISCO-88 kode og sammenholdt med den registrerede DISCO-88 kode i DOC*X. Valideringen viste god overensstemmelse mellem eksponeringsniveauer ved inddeling via JEM, men varierende overensstemmelse når DISCO-88 grupperne sammenlignes direkte en til en. Vi har kun valideret DISCO-88 koder, hvor vi har haft data på minimum 10 observationer og har kun valideret på data fra før 2005, hvormed en stor del af DISCO-88 koderne ikke er valideret særskilt. Derfor er det essentielt, at validiteten tages i betragtning forud for hver enkelt studie baseret på DOC*X data, selvom vi vurderer validiteten til at være god overordnet set fra data før 2005, når vi sammenligner eksponeringsniveauer ved brug af JEM. Der er stor variation i overensstemmelsen mellem fag og over tid, og er man ikke opmærksom på dette, kan der opstå misklassifikation og dermed fejltolkning af analyseresultater. Det er intentionen at fortsætte valideringsarbejdet på data efter 2004, i så fald det bliver muligt at få adgang til data med selvrapporterede jobtitler fra et repræsentativt udsnit af den danske arbejdsstyrke fra 2005 og frem.

Fremadrettede perspektiver

Ved projektperiodens udløb er det kortsigtede formål opfyldt. DOC*X databasen med organisatoriske rammer er etableret og dokumenteret og i en række konkrete arbejdsmiljøprojekter er brugen af JEM demonstreret. DOC*X bliver brugt til både interne og eksterne projekter og flere projekter er i støbeskeen.

Arbejdsmiljøforskningsfonden har i 2019 støttet en udvidelse af DOC*X med en fødselskohorte således, at vi fremover kan undersøge om visse arbejdsmiljøeksponeringer påvirker fosterets sundhed og senere helbred.

Forudsætningen for det langsigtede mål om at kunne opnå afgørende ny erkendelse om arbejde, sygdom og erhvervsevne er således til stede og forhåbentligt vil der både nationalt og internationalt være interesse for at bruge denne nye åbne forskningsressource. I takt hermed vil videreudvikling og raffinering af jobeksponeringsmatricer være af afgørende betydning. Her er der mange muligheder – f.eks. forventes integration af de meget valide data om branche at kunne øge både præcision og kontrast ved brug af JEM. Sideløbende er der behov for at raffinere og implementere statistiske metoder og for at udbygge det internationale samarbejde omkring brug af databasen.

Formidlingsaktiviteter

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- Manuskript: Statistical modelling and development of a quantitative job exposure matrix for wood dust in the wood manufacturing industry
- Manuskript: Development of a quantitative job exposure matrix for endotoxin exposure in agriculture. Occupational and Environmental Medicine
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Konferencer

- EPICOH:
  - September 2016, Barcelona:
    - Oral præsentation: "Statistical modelling and development of a quantitative job exposure matrix for wood dust in the wood manufacturing industry" (Ioannis Basinas)
    - Oral præsentation: "Development of a quantitative job exposure matrix for endotoxin exposure in agriculture" (Ioannis Basinas)
    - Zara Ann Stokholm, Mogens Erlandsen, Vivi Schlünssen, Ioannis Basinas, Jens Peter Bonde, Susan Peters, Jens Brandt, Jesper Medom Vestergaard, Henrik Albert Kolstad. A quantitative general population job exposure matrix for occupational noise exposure.

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- 2016:
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    - Flachs et al. The Danish Occupational Cohort – a new open research database on occupational medicine. NordicEpi, Lund 2017.
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- 2018:

    - Ida E. H. Madsen, Nidhi Gupta, Esben Budtz-Jørgensen, Jens Peter Bonde, Elisabeth Framke, Esben Meulengracht Flachs, Sesilje Bondo Petersen, Annemette Coop Svane-Petersen, Andreas Holtermann, Reiner Rugulies (2018). Comparing self-reported and job exposure matrix measurements: A cohort study examining physical work demands and psychosocial working conditions as predictors of musculoskeletal pain. Abstract fra Den 15. Stressforskningskonference, København, Danmark.
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- 2019:
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    - Bonde JPE et al. Acute myocardial infarction in relation to physical activities at work: a nationwide follow-up study based on job-exposure matrices (oral præsentation). Arbejdsmiljøforskningsfondens årskonference, januar 2019.

Møder

- Der er afholdt 2-4 koordinationsgruppemøder i projektperioden
- Der er afholdt to følgegruppemøder
- Der er afholdt to seminarer i hhv. 2016 og 2018.

Bilag

1. Ansøgningsskema, DOC*X
2. Variabelliste, DOC*X
3. Publicerede artikler

Bilag 1

Application form for access to the DOC*X database	
Project title:	
Date:	
Applicant: Name, institution, address, e-mail	
Collaborators: Names and institutions of all collaborators	
Authorised research institution: Which participating institution is authorised from Statistics Denmark	
Project description: This must state purpose, population, method, and intended mode of dissemination of results (max. 300 words)	

Time Schedule	
Project start: (month / year) **Project end:** (month / year)	

Research protocol	
Research protocol enclosed: Full research protocol enclosed in addition to this application form.	____ Yes ____ No

Approvals	
Approval from the Danish Data Protection Agency**:** **Only required if the project requires additional data not already included in the DOC*X database.**	____ Yes (include copy of approval) ____ No
Approval from the Danish Biomedical Ethics Committee**:** According to Danish law, all research projects in Denmark involving human beings or any kind of human tissue, cells etc. need permission from a regional ethics committee.	____ Yes (include copy of approval) ____ No
Special note on the Prescription Database (Lægemiddeldatabasen):	The prescription database requires a separate approval. This must be applied for through Sundhedsdatastyrelsens Forskerservice or Statistics Denmark.

Finances	
Funding: Please state from where funding for the research project was obtained for all participating persons	

Description of data from the DOC*X database			
Description of Data required from the DOC*X database: Names of registers, lists of variables, selection of years and persons. Full description may be supplied as supplementary file.			
Description of Job Exposure Matrices required from the DOC*X database:	Biomechanical JEM:		
		Lower body exposures JEM	
		Vibration JEM	
		Shoulder exposures JEM	
		Physical exertion and body position JEM	
	Noise JEM		
	Light JEM (under construction)		
	Psychosocial exposures JEM		
	Particulate airborne exposures JEM:		
		Wood dust JEM	
		Endotoxin JEM	
	Lifestyle JEM:		
		Tobacco smoking JEM	
		Body Mass Index JEM	
		Alcohol consumption JEM	
		Leisure time physical activity JEM	
		Fruit and Vegetables consumption JEM	

Description of data not from the DOC*X database	
Description of external data supplied by the project: Names of data sources, lists of variables, selection of years and persons.	

Application form and supplementary files should be mailed to kontakt@doc-x.dk

Bilag 2 Fortegnelse over variable i DOC*X, relevante DST samt job eksponeringsmatricer

2a DOC*X databasen (fagregisteret)

ENDELIG-DATABASE-V2	Fagregisteret (endelig version) 1970 - 2005, forløbsregister, bemærk at alle variable ikke findes alle år			
	Variabel	Label	Startår	Slutår
	AAR	Ingen label	1970	2005
	AKM_BESK_STATUS	Ingen label	1970	2005
	ARBSTIL	Arbejdsstilling	1970	2005
	ARB_HOVED_BRA_DB07	Branchekode	1970	2005
	BESKF	Beskæftigelsesforhold	1970	2005
	BESKST	Beskæftigelsesstatus 1980 til 2001	1970	2005
	BESKST02	Beskæftigelsesstatus fra 2002	1970	2005
	BESKST13	Kode for personens væsentligste ind	1970	2005
	BESKSTAT	BESKÆFTIGELSESSTATUSKODE	1970	2005
	BESK_STATUS	Ingen label	1970	2005
	BRANCHE	BRANCHE	1970	2005
	BRANCHE_77	Branchekode	1970	2005
	BRANCHE_KODE	Branchekode for arbejdesstedet	1970	2005
	BRANCHE_SAMLET	BRANCHE i DB07	1976	2005
	BRCHL	Ingen label	1970	2005
	D08	Ingen label	1970	2005
	DB07	Hovedbranche DB07	1970	2005
	DB93_2	Ingen label	1970	2005
	DB93_3	Ingen label	1970	2005
	DB93_4	Ingen label	1970	2005
	DB93_6	Ingen label	1970	2005
	DELTID	Heltid- deltidsbeskæftiget	1970	2005
	DISCO	Fagkode for væsentligste lønmo	1970	2005

	DISCO08_ALLE_INDK	Fagklassifikation for beskæftigelse	1970	2005
	DISCO08_ALLE_INDK_13	Fagkode for væsentligste beskæftige	1970	2005
	DISCO08_NY	Ingen label	1970	2005
	DISCO88	Ingen label	1970	2005
	DISCO88_FRA_08	Ingen label	1970	2005
	DISCOALLE_INDK	Fagklassifikation for beskæftigelse	1970	2005
	DISCOSEL_INDK	FAGKODE FOR SELVST. OG MEDARB.	1970	2005
	DISCO_2008OG09	Ingen label	1970	2005
	DISCO_ALLE_INDK_13	Fagklassifikation for beskæftigelse	1970	2005
	DISCO_FOB	Ingen label	1970	2005
	DISCO_FORBEDRET	Ingen label	1970	2005
	DISCO_KODE	Disco kode for lønmodtagere	1970	2005
	DISCO_LON	Ingen label	1970	2005
	DISCO_MATCHPRIO_KODE	Kode der angiver kvaliteten af disc	1970	2005
	DISCO_NY	Ingen label	1970	2005
	DISCO_RAS_KODE	Arbejdsfunktion for lønmodtagere	1970	2005
	DODDATO	Dato for dødsfald	1970	2005
	ERHV	Erhverv	1970	2005
	FAG	Fag	1970	2005
	FAG_SAMLET	Ingen label	1970	2005
	FOB_BESK_STATUS	Ingen label	1970	2005
	FOED_DAG	Ingen label	1970	2005
	ISIC	ISIC 90-92	1970	2005
	I_BEFOLKNINGEN_KODE	I befolkningen på referencetidspunk	1970	2005
	KOEN	Ingen label	1970	2005
	NACE	Branche for væsentligste beskæftigelse	1970	2005
	NACE_13	Branche for væsentligste beskæftigelse	1970	2005
	NACE_DB07	Branche for væsentligste beskæftigelse	1970	2005
	NACE_DB07_13	Branche for væsentligste beskæftigelse	1970	2005
	NOVPRIO	Novemberprioritering	1970	2005
	NYARB	Ny arbejdsstilling	1970	2005

	NYSTGR	NY STILLINGSGRUPPERING	1970	2005
	NYSTIL	NY STILLINGSKLASSIFICERING	1970	2005
	NYSTIL_NY	Ingen label	1970	2005
	PNR	PNR T&S	1970	2005
	PRIMAER_STATUS_KODE	Kode for primær tilknytning til arb	1970	2005
	RANG	Ingen label	1970	2005
	RANG2	Ingen label	1970	2005
	RAS_BESK_STATUS	Ingen label	1970	2005
	SOCSTIL_KODE	Socioøkonomisk status	1970	2005
	SOC_STATUS_KODE	Socioøkonomisk status	1970	2005
	STIL	STILLINGSKODE	1970	2005
	STILGR1	STILLINGSGRUPPE 1	1970	2005
	STILGR2	STILLINGSGRUPPE2	1970	2005
	STILGR2_BRANCHE	Ingen label	1970	2005
	STIL_NY	Ingen label	1970	2005
	ALDER	Ingen label	1970	2005
FAGREG	Fagregisteret 2006 - seneste år, forløbsregister, bemærk at alle variable ikke findes alle år			
	Variabel	Label	Startår	Slutår
	AAR	Ingen label	2006	2016
	AKM_BESK_STATUS	Ingen label	2006	2016
	ARBSTIL	Arbejdsstilling	2006	2016
	ARB_HOVED_BRA_DB07	Branchekode	2006	2016
	BESKF	Beskæftigelsesforhold	2006	2016
	BESKST02	Beskæftigelsesstatus fra 2002	2006	2016
	BESKST13	Kode for personens væsentligste ind	2006	2016
	BESK_STATUS	Ingen label	2006	2016
	BRANCHE	BRANCHE	2006	2016
	BRANCHE_77	Branchekode	2006	2016

	BRANCHE_KODE	Branchekode for arbejdesstedet	2006	2016
	BRANCHE_SAMLET	BRANCHE i DB07	1976	2016
	D08	Ingen label	2006	2016
	DELTID	Heltid- deltidsbeskæftiget	2006	2016
	DISCO08_ALLE_INDK	Fagklassifikation for beskæftigelse	2006	2016
	DISCO08_ALLE_INDK_13	Fagkode for væsentligste beskæftige	2006	2016
	DISCO88_FRA_08	Ingen label	2006	2016
	DISCOALLE_INDK	Fagklassifikation for beskæftigelse	2006	2016
	DISCO_2008OG09	Ingen label	2006	2016
	DISCO_ALLE_INDK_13	Fagklassifikation for beskæftigelse	2006	2016
	DISCO_KODE	Disco kode for lønmodtagere	2006	2016
	DISCO_MATCHPRIO_KODE	Kode der angiver kvaliteten af disc	2006	2016
	DISCO_RAS_KODE	Arbejdsfunktion for lønmodtagere	2006	2016
	DODDATO	Dato for dødsfald	2006	2016
	ERHV	Erhverv	2006	2016
	FAG	Fag	2006	2016
	FAG_SAMLET	Ingen label	2006	2016
	FOB_BESK_STATUS	Ingen label	2006	2016
	FOED_DAG	Ingen label	2006	2016
	ISIC	ISIC 90-92	2006	2016
	I_BEFOLKNINGEN_KODE	I befolkningen på referencetidspunk	2006	2016
	KOEN	Ingen label	2006	2016
	NACE	Branche for væsentligste beskæftige	2006	2016
	NACE_13	Branche for væsentligste beskæftige	2006	2016
	NACE_DB07	Branche for væsentligste beskæftige	2006	2016
	NACE_DB07_13	Branche for væsentligste beskæftige	2006	2016
	NOVPRIO	Novemberprioritering	2006	2016
	NYARB	Ny arbejdsstilling	2006	2016
	NYSTGR	NY STILLINGSGRUPPERING	2006	2016
	NYSTIL	NY STILLINGSKLASSIFICERING	2006	2016
	PNR	PNR T&S	2006	2016

	PRIMAER_STATUS_KODE	Kode for primær tilknytning til arb	2006	2016
	RAS_BESK_STATUS	Ingen label	2006	2016
	SOCSTIL_KODE	Socioøkonomisk status	2006	2016
	SOC_STATUS_KODE	Socioøkonomisk status	2006	2016
	STIL	STILLINGSKODE	2006	2016
	STILGR1	STILLINGSGRUPPE 1	2006	2016
	STILGR2	STILLINGSGRUPPE2	2006	2016
	ALDER	Ingen label	2006	2016
PNR-POPULATION	Personnummer (afidentificeret), fødselsdag og køn på hele DOC*X, forløbsregister			
	Variabel	Label	Startår	Slutår
	PNR	PNR T&S	1970	9999
POPULATION-FOD-KON	Personnummer (afidentificeret), fødselsdag og køn på hele DOC*X, forløbsregister			
	Variabel	Label	Startår	Slutår
	DODDATO	Dato for dødsfald	1970	9999
	FOED_DAG	Ingen label	1970	9999
	KOEN	Ingen label	1970	9999
	PNR	PNR T&S	1970	9999

2b Relevante registre i Danmarks Statistik

AKM	Arbejdsmarkedsklassifikationsmodulet			
	Variabel	Label	Startår	Slutår
	AKAS	A-KASSE KODE	1980	1990
	ANT_ANSAT_ARBSTED	Antal ansatte for væsentligste arbe	2006	2013
	ANT_ANSAT_ARBSTED_13	Antal ansatte for væsentligste arbe	2010	2017
	ANT_ANSAT_SENR	Antal ansatte for væsentligste besk	1976	2005
	ARBHBR	TIDL. DSE BRANCHE FOR ARBEJDST	1980	1990
	ARBOPL	ARBEJDSSTEDSOPLYSNING	1980	1990
	ARBST	ARBEJDSSTILLING - STATUS UDEN	1976	1990
	ARBSTED	ARBEJDSSTEDSKODE	1979	1990
	ATPSUM2	Beskæftigelsesmål baseret på ATP- i	1991	2010
	BESKST	Beskæftigelsesstatus 1980 til 2001	1976	2001
	BESKST02	Beskæftigelsesstatus fra 2002	2002	2013
	BESKST13	Kode for personens væsentligste ind	1991	2017
	BRANCHE	BRANCHE	1980	1990
	BRANCHE_77	Branchekode	1991	1999
	BRCHI	Branchekode for indehaver	1991	2002
	BRCHL	Branchekode for lønmodtager	1991	1999
	DISCO08_ALLE_INDK	Fagklassifikation for beskæftigelse	2010	2013
	DISCO08_ALLE_INDK_13	Fagkode for væsentligste beskæftige	2010	2017
	DISCO08_LOEN_INDK	Fagkode for væsentligste lønmodtage	2010	2017
	DISCO08_SEL_INDK	Fagkode for arbejde i selvstændig v	2010	2017
	DISCOALLE_INDK	Fagklassifikation for beskæftigelse	1993	2009
	DISCOLOEN_INDK	Fagkode for væsentligste lønmodtage	1991	2009
	DISCOSEL_INDK	Fagkode for arbejde i selvstændig v	1991	2009
	DISCOTYP	Kilde til lønmodtager DISCO-koden	1991	2017
	DISCO_ALLE_INDK_13	Fagklassifikation for beskæftigelse	1991	2009
	FUNK_TIMEANT	Personens samlede antal arbejdstime	2008	2017
	KOMST	STILLING SOM KOMMUNEANSAT	1980	1990

	NACE	Branche for væsentligste beskæftige	1992	2007
	NACEA	Branchegruppering for arbejdssted (	1992	2007
	NACEA_DB07	Branchegruppering for arbejdssted (	2007	2017
	NACEI	Branchekode for selvstændige og med	1993	2007
	NACEI_DB07	Branchegruppering for indehaver (Se	2007	2017
	NACE_13	Branche for væsentligste beskæftige	1993	2007
	NACE_DB07	Branche for væsentligste beskæftige	2007	2013
	NACE_DB07_13	Branche for væsentligste beskæftige	2007	2017
	NYSTGR	Stillingsgruppering 1980 til 1995	1980	1999
	NYSTIL	NY STILLINGSKLASSIFICERING	1980	1990
	PNR	Personnummer	1976	2017
	SOCIO	Socioøkonomisk klassifikation fra 1	1976	2001
	SOCIO02	Socioøkonomisk klassifikation fra 2	2002	2013
	SOCIO13	Socioøkonomisk klassifikation versi	1991	2017
	STIL	STILLINGSKODE	1976	1990
	STILGR1	STILLINGSGRUPPE 1	1976	1990
	STILGR2	STILLINGSGRUPPE2	1976	1990
	TYP	Stillingstype	1991	1999
	UDDC	KODE FOR IGANGVÆRENDE UDDANNEL	1980	1990
	VERSION	Version	2014	2017
AMFO	Arbejdsmarkedsforanstaltninger			
	Variabel	Label	Startår	Slutår
	AAR	OPGØRELSESSÅR	1994	2006
	FORANST	Foranstaltning	1994	2006
	PNR	CPRnummer	1994	2006
	SLUTDTO	Slutdato for foranstaltningsforløb	1994	2006
	STARTDTO	Startdato for foranstaltningsforløb	1994	2006
	TIMERPU	Antal timer pr. uge	1994	2006
	YDTYPE1	Ydelsestype	1994	2006

BEF	Befolkningen			
	Variabel	Label	Startår	Slutår
	AEGTE_ID	Personnummer Ægtefælle	1986	2018
	ALDER	Alder pr. 1. januar.	1986	2018
	CIVST	Civilstand	1986	2018
	CIV_VFRA	Civilstandsdato	1986	2018
	EFALLE	Fælle e-familie	1986	2018
	FAMILIE_ID	Familiens identificerende nummer.	1986	2018
	FAMILIE_TYPE	Familietype	1986	2018
	FAR_ID	Faderens Person Id	1986	2018
	FM_MARK	Forældremarkering	1986	2018
	FOEDREG_KODE	Kode for personens fødselsregistrer	1986	2018
	FOED_DAG	Fødselsdato	1986	2018
	HUSTYPE	Husstandstype	1986	2018
	IE_TYPE	Indvandrere, efterkommere , persone	1986	2018
	KOEN	Køn	1986	2018
	KOM	Kommunekode	1986	2018
	MOR_ID	Personnummer mor	1986	2018
	OPR_LAND	Oprindelsesland	1986	2018
	PLADS	Familiestatus	1986	2018
	PNR	Personnummer	1986	2018
	REG	Region	1986	2018
	STATSB	Statsborgerskab	1986	2018
	VAN_VTIL	Indvandringsdato	1986	2015
CPST	CPR Status			
	Variabel	Label	Startår	Slutår
	FOED_DAG	Ingen label	1976	2007
	KOEN	Ingen label	1976	2007
	PNR	Personnummer	1976	2007

DOD	Døde i Danmark, forløbsregister			
	Variabel	Label	Startår	Slutår
	ALDER_HAEND	Alder på hændelsestidspunkt	1970	2017
	CPRTJEK	CPR-tjek	1970	2017
	CPRTYPE	CPR-type	1970	2017
	DODDATO	Dato for dødsfald	1970	2017
	PNR	Personnummer	1970	2017
DODSAARS-2001	Dødsårsagsregisteret 1970 - 2001, forløbsregister			
	Variabel	Label	Startår	Slutår
	CPRTJEK	CPR-tjek	1970	2001
	CPRTYPE	CPR-type	1970	2001
	C_DOD1	C_DOD1	1970	2001
	C_DOD2	C_DOD2	1970	2001
	C_DOD3	C_DOD3	1970	2001
	C_DOD4	C_DOD4	1970	2001
	C_DODSMAADE	Dødsart	1970	2001
	C_ULYKTYPE	C_ULYKTYPE	1970	2001
	DAAR	Dødsår	1970	2001
	D_DODSDTO	Dødsdato	1970	2001
	PNR	Personnummer	1970	2001
DODSAASG	Dødsårsagsregisteret 2002 - seneste år, forløbsregister			
	Variabel	Label	Startår	Slutår
	C_DODSMAADE	C_DODSMAADE	2002	2016
	C_DODTILGRUNDL_ACME	C_DODTILGRUNDL_ACME	2002	2016
	C_DOD_1A	C_DOD_1A	2002	2016
	C_DOD_1B	C_DOD_1B	2002	2016

	C_DOD_1C	C_DOD_1C	2002	2016
	C_DOD_1D	C_DOD_1D	2002	2016
	C_DOD_21	C_DOD_21	2002	2016
	C_DOD_22	C_DOD_22	2002	2016
	C_DOD_23	C_DOD_23	2002	2016
	C_DOD_24	C_DOD_24	2002	2016
	C_DOD_25	C_DOD_25	2002	2016
	C_DOD_26	C_DOD_26	2002	2016
	C_DOD_27	C_DOD_27	2002	2016
	C_DOD_28	C_DOD_28	2002	2016
	D_DODSDATO	D_DODSDATO	2002	2016
	D_FINDEDATO	D_FINDEDATO	2002	2016
	D_STATDATO	D_STATDATO	2002	2016
	PNR	K_CPR	2002	2016
DREAM	Den Registerbaserede Evaluering Af Marginaliseringsomfanget, 1991 uge 32 - seneste uge, forløbsregister			
	Variabel	Label	Startår	Slutår
	AKyyyy	Ingen label	2000	2018
	ARBSTED-yyyy-mm	Ingen label	$2008-01$	$2018-11$
	BRANCHE-yyyy-mm	Ingen label	$2008-01$	$2018-11$
	CIVILSTAND	Ingen label	2018	2018
	CPRTJEK	CPR-tjek	2018	2018
	CPRTYPE	CPR-type	2018	2018
	DGP	Ingen label	2018	2018
	FOEDDT	Ingen label	2018	2018
	FOR	Ingen label	2018	2018
	GRAD-yyyy-mm	Ingen label	$2008-01$	$2018-11$
	HERKOMST	Ingen label	2018	2018

	INDT	Ingen label	2018	2018
	INDT1	Ingen label	2018	2018
	INDT2	Ingen label	2018	2018
	INDT3	Ingen label	2018	2018
	INDT4	Ingen label	2018	2018
	INTPGMSLDT	Ingen label	2018	2018
	INTPGMSTDT	Ingen label	2018	2018
	KON	Ingen label	2018	2018
	KTH	Ingen label	2018	2018
	MATCH-xkvyyyy	Ingen label	$1KV2008$	$4KV2018$
	MODEDTxx	Ingen label	01	24
	NYKOMyyyy	Ingen label	2000	2018
	PNR	Ingen label	2018	2018
	STATSBORGERSKAB	Ingen label	2018	2018
	SYG	Ingen label	2018	2018
	VIRKFORM-yyyy-mm	Ingen label	$2008-01$	$2018-11$
	VISIT-xkvyyyy	Ingen label	$1KV2014$	$4KV2018$
	Y-yyww	Ingen label	$1991:32$	$2018:48$
FAIK	Familieindkomstregisteret			
	Variabel	Label	Startår	Slutår
	FAMAEKVIVADISP	Ækvivaleret disponibel indkomst for	1990	2012
	FAMAEKVIVADISP_13	Ækvivaleret disponibel indkomst for	2013	2017
	FAMBOERNETILSKUD	Børnetilskud og familieydelser til	1990	2017
	FAMBOLIGSTOETTE	Boligstøtte udbetalt til familien	1990	2017
	FAMDISPONIBEL	Diponibel indkomst for familien	1990	2012
	FAMDISPONIBEL_13	Disponibel indkomst	2013	2017
	FAMFORMUEINDK	Formueindkomst i alt for familien	1990	2012
	FAMFORMUEINDK_BRUTTO	Formueindkomst. brutto i familien	2013	2017
	FAMILIE_ID	Familie identifikation	1990	2017
	FAMINDKOMSTIALT	Familieindkomst i alt før skat	1990	2012

	FAMINDKOMSTIALT_13	Indkomst i alt, før skatter mv.	2013	2017
	FAMKONTANTHJAELP	Kontanthjælp for familien	1990	2012
	FAMKONTANTHJAELP_13	Kontant hjælp i familien	2013	2017
	FAMLOENMV	Lønindkomst i alt i familien	1990	2012
	FAMLOENMV_13	Lønindkomst i alt i familien	2013	2017
	FAMOVERFOERINDK	Familiens samlede overførselsindkom	1990	2012
	FAMSAMLETINDK	Samlet indkomst for familien	1990	2012
	FAMSOCIOGRUP	Familiens socioøkonomiske gruppe	1994	2012
	FAMSOCIOGRUP_13	Familiens socioøkonomiske gruppe De	2010	2017
	VERSION	Version	2010	2017
FAIN	Husstande og familier			
	Variabel	Label	Startår	Slutår
	AEGTEFAELLE_ID	Ægtefælle Person Id	1980	2007
	A_FAMILIE_ID	A-familie Id	1980	2007
	A_STATUS	A-familie status	1980	2007
	A_TYPE	A-familietype	1980	2007
	CIVDATO	Civilstandsdato	1980	2007
	CIVST	Civilstand	1980	2007
	C_FAELLE_ID	Partnerens Id	1980	2007
	C_FAMILIE_ID	-familie_Id	1980	2007
	C_STATUS	C-familiestatus	1980	2007
	C_TYPE	C-familie type	1980	2007
	D_ANT_FAM	Antal D-familier i husstanden	1980	2007
	D_FAMILIE_ID	D-familie Id	1980	2007
	D_TYPE	D-familietype	1980	2007
	FAR_ID	Personnummer, Far	1980	2007
	FMMARK	Forældremarkering	1980	2007
	FODREG	Kode for fødselsregistreringssted	1980	2007
	FOED_DAG	Ingen label	1980	2007
	H_TYPE	Husstandstype	1980	2007

	INDVDATO	Indvandringsdato	1980	2007
	KOEN	Køn	1980	2007
	KOM	Kommune	1980	2007
	MOR_ID	Personnummer, Mor	1980	2007
	PNR	Personnummer	1980	2007
FAM	Familieforhold			
	Variabel	Label	Startår	Slutår
	ALDAELDST	Alder på ældste barn i C-familie	1986	2018
	ALDYNGST	Alder på yngste barn i C-familie	1986	2018
	ANTB00	Antal 0 årige børn i E-familien	1986	2018
	ANTB01	Antal 1 årige børn i E-familien	1986	2018
	ANTB02	Antal 2 årige børn i E-familien	1986	2018
	ANTB03	Antal 3 årige børn i E-familien	1986	2018
	ANTB04	Antal 4 årige børn i E-familien	1986	2018
	ANTB05	Antal 5 årige børn i E-familien	1986	2018
	ANTB06	Antal 6 årige børn i E-familien	1986	2018
	ANTB07	Antal 7 årige børn i E-familien	1986	2018
	ANTB08	Antal 8 årige børn i E-familien	1986	2018
	ANTB09	Antal 9 årige børn i E-familien	1986	2018
	ANTB10	Antal 10 årige børn i E-familien	1986	2018
	ANTB11	Antal 11 årige børn i E-familien	1986	2018
	ANTB12	Antal 12 årige børn i E-familien	1986	2018
	ANTB13	Antal 13 årige børn i E-familien	1986	2018
	ANTB14	Antal 14 årige børn i E-familien	1986	2018
	ANTB15	Antal 15 årige børn i E-familien	1986	2018
	ANTB16	Antal 16 årige børn i E-familien	1986	2018
	ANTB17	Antal 17 årige børn i E-familien	1986	2018
	ANTB18	Antal 18 årige børn i E-familien	1986	2018
	ANTB19	Antal 19 årige børn i E-familien	1986	2018
	ANTB20	Antal 20 årige børn i E-familien	1986	2018

	ANTB21	Antal 21 årige børn i E-familien	1986	2018
	ANTB22	Antal 22 årige børn i E-familien	1986	2018
	ANTB23	Antal 23 årige børn i E-familien	1986	2018
	ANTB24	Antal 24 årige børn i E-familien	1986	2018
	ANTBOERNF	Antal børn i e-familien	1986	2018
	ANTPERSF	Antal personer i e-familien	1986	2018
	BOPIKOM	Bopæl i kommunen	1986	2018
	FAMILIE_ID	E-familie identifikation	1986	2018
	FAMILIE_TYPE	E-familie type	1986	2018
	HOVEDPERSON	Hovedperson i familien	1986	2018
	HUSTYPE	Husstandstype	2008	2018
	KOM	Kommune	1986	2018
	PAPNR	Hovedpersonens partner	1986	2018
FOB	Folke- og Boligt?llingen 1970			
	Variabel	Label	Startår	Slutår
	ARBST	Arbejdssted	1970	1970
	ASTIL	Civilstand	1970	1970
	BESKF	Beskæftigelsesforhold	1970	1970
	DELTID	Heltid- deltidsbeskæftiget	1970	1970
	ERHV	Erhverv	1970	1970
	FAG	Fag	1970	1970
	FSTIL	Familiestilling	1970	1970
	IGUDD	Igangværende uddannelse	1970	1970
	PNR	Personnummer	1970	1970
	SKUDD	Skoleuddannelse	1970	1970
FTDB	Fertilitetsdatabasen - Børn, forløbsregister			
	Variabel	Label	Startår	Slutår
	ANTAL	Barnets nr i fødslen	1976	2012

	FAR_KILDE	Kilde til oplysning om far	1976	2012
	FODTDATO	Fødselsdato - barnet	1976	2012
	FREGKO	Fødselsregistreringskode	1976	2012
	FTDB_LBNR	Løbenr til match med MFR	1976	2012
	INDDTO	Indvandringsdato	1976	2012
	KQN	Køn	1976	2012
	MADOPT	Markering af adoption	1976	2012
	MDOED	Markering af evt. død	1976	2012
	MOR_KILDE	Kilde til oplysning om mor	1976	2012
	PNRB	Personnummer, barn	1976	2012
	PNRF	Personnummer, far	1976	2012
	PNRM	Personnummer på mor	1976	2012
FTDK	Fertilitetsdatabasen - Kvinder, forløbsregister			
	Variabel	Label	Startår	Slutår
	ANTAL	Barnets nr i fødslen	1976	2012
	DEMPAR	Optalt demografisk paritet	1976	2012
	FODTDATO	Barnets fødselsdato	1976	2012
	FORLDRE	Forælders køn, mor eller far	1976	2012
	FREGKO	Fødselsregistreringskode	1976	2012
	FTDB_LBNR	Løbenr til match med MFR	1976	2012
	KQN	Køn	1976	2012
	MADOPT	Markering af adoption	1976	2012
	MDOED	Markering af evt. død	1976	2012
	MEDPAR	Optalt medicinsk paritet	1976	2012
	PNRBARN	Personnummer, barn	1976	2012
	PNRFLDR	Personnummer, forælder	1976	2012
	PNRINV	Personnummer, forældrens partner	1976	2012
FTDM	Fertilitetsdatabasen - Mænd, forløbsregister			

	Variabel	Label	Startår	Slutår
	ANTAL	Barnets nr i fødslen	1976	2012
	DEMPAR	Optalt demografisk paritet	1976	2012
	FORLDRE	Forælders køn, mor eller far	1976	2012
	FREGKO	Fødselsregistreringskode	1976	2012
	FTDB_LBNR	Løbenr til match med MFR	1976	2012
	KQN	Køn	1976	2012
	MADOPT	Markering af adoption	1976	2012
	MDOED	Markering af evt. død	1976	2012
	MEDPAR	Optalt medicinsk paritet	1976	2012
	PNRBARN	Personnummer, barn	1976	2012
	PNRFLDR	Personnummer, forælder	1976	2012
	PNRINV	Personnummer, forældrens partner	1976	2012
IDAN	IDA ansættelser			
	Variabel	Label	Startår	Slutår
	ANSXFREM	Ansættelsesændring frem til året ef	2014	2015
	ARBNR	Arbejdsstedsnummer	2014	2016
	CVRNR	CVR-nummer	2014	2016
	LBNR	Arbejdsstedets løbenummer	2014	2016
	PNR	Personnummer	2014	2016
IDAP	IDA - personer			
	Variabel	Label	Startår	Slutår
	ARLEDGR	Årsledighedsgrad	1980	2013
	ARLEDGR_BRUTTO	Årsledighedsgrad (bruttoledighed)	2014	2016
	ARLEDGR_NETTO	Årsledighedsgrad (nettoledighed).	2014	2016
	ATPAR	Antal år som lønmodtager	1980	2016
	CPRTJEK	CPR-tjek	2014	2016
	CPRTYPE	CPR-type	2014	2016
	EJNOV	Antal supplerende ej-november ansæt	1980	2016

	EJNOVSUM	Ej-novemberansættelser lønsum	1980	2013
	EJNOVSUM_BRED	Ej-novemberansættelser bred lønsum	2014	2016
	EJNOVSUM_SMAL	Ej-novemberansættelser smal lønsum	2014	2016
	ERHVER	Erhvervserfaring fra 1980 i 1000	1980	2016
	ERHVER79	Erhvervserfaring ultimo 1979	1980	2016
	KON	Køn	1980	2016
	LEDAR	Første ledighed (årstal)	1980	2013
	LEDAR_BRUTTO	Året for første bruttoledighed	2014	2016
	LEDAR_NETTO	Året for første nettoledighed	2014	2016
	LEDDEL	Uger delvis ledig	1980	2007
	LEDFULD	Uger fuld ledighed	1980	2007
	LEDIGHED	Uger med ledighed	2008	2013
	LEDIGHED_BRUTTO	Antal uger med bruttoledighed i åre	2014	2016
	LEDIGHED_NETTO	Antal uger med nettoledighed i året	2014	2016
	NSUP	Supplerende november-ansættelser (a	1980	2016
	PENSALD	Alder ved pensionering (offentlig)	1980	2016
	PNR	Personnummer	1980	2016
	PSOC_STATUS_KODE	Socioøkonomisk status i det primære	2014	2016
	PSTILL	Primær arbejdsstilling	1980	2013
	SSOC_STATUS_KODE	Socioøkonomisk status i det sekundæ	2014	2016
	SSTILL	Sekundær arbejdsstilling	1980	2013
	STARTAR	Første år på arbejdsmarkedet	1980	2016
	SUMGRAD	Sum af ledighedsgrader (fra 1980)	1980	2013
	SUMGRAD_BRUTTO	Summeret bruttoledighed(fra 2008)	2014	2016
	SUMGRAD_NETTO	Summeret nettoledighed (fra 1980)	2014	2016
IDAS	IDA - arbejdssteder			
	Variabel	Label	Startår	Slutår
	AARSVRK	Antal årsværk for alle ansættelsesf	2014	2016
	ANTAAR	Antal ansættelsesforhold (personer)	2014	2016
	ANTNOV	Antal ansatte pr. november	2014	2016

	ANTNOVBI	Antal bibeskæftigede pr. november	2014	2016
	ARBNR	Arbejdsstedsnummer	2014	2016
	CVRNR	CVR-nummer	2014	2016
	FILIAL	Antal arbejdssteder i firmaet (max.	2014	2016
	LBNR	Arbejdsstedets løbenummer	2014	2016
IDFI	IDA - firmaer			
	Variabel	Label	Startår	Slutår
	ANTALARB	Antal arbejdssteder i firmaet	1980	2013
	ANTARBB	Antal bevarede arbejdssteder i firm	1980	2013
	SARBGNRX	Arbejdsgivernummerskift for største	1980	2007
	SIDTILB	Identitet for største arbejdssted i	1980	2013
	SLBNR	Løbenummer for største arbejdssted	1980	2013
	STORBRA	Branchekode største arb.sted i firm	1980	1992
	STORDB03	Branchekode for størtste arbejdsste	2003	2007
	STORDB07	Branchekode for største arbejdssted	2007	2013
	STORDB93	Branchekode for størtste arbejdsste	1980	2003
	UOPLANSB	Bibeskæftigede i firma med uoplyst	1980	2013
	UOPLANSH	Hovedbeskæftigede med uoplyst arbej	1980	2013
INDH	Personindkomster			
	Variabel	Label	Startår	Slutår
	BESKST	Beskæftigelsesstatus 1980 til 2001	1980	2001
	BESKST02	Beskæftigelsesstatus fra 2002	2002	2013
	BRANCHE_77	Dansk branchekode 1977 til 1993	1980	1996
	BRUTTO	Skattepligtig bruttoindkomst før fr	1980	2013
	DISCO08_ALLE_INDK	Klassifikation: Fagklassifikation f	2010	2013
	DISCOALLE_INDK	Fagklassifikation for beskæftigelse	1991	2009
	DISCOTYP	Kilde til lønmodtager DISCO-koden	1991	2013
	LOENMV	Lønindkomst i alt	1980	2013
	NACE	Branche for væsentligste beskæftige	1992	2007

	NACE_DB07	Branche for væsentligste beskæftige	2008	2013
	PNR	Personnummer	1980	2013
	QMIDYD	Midlertidige overførselsindkomster	1980	2013
	QORLOV	Orlov børnepasning og sabbat	2002	2003
	SOCIO	Socioøkonomisk klassifikation fra 1	1994	2001
	SOCIO02	Socioøkonomisk klassifikation fra 2	2002	2013
	STIP	Stipendier fra Statens Uddannelsess	1983	2013
LPR-ADM	Landspatientregisteret, administrativ			
	Variabel	Label	Startår	Slutår
	CPRTJEK	CPR-tjek	1977	2017
	CPRTYPE	CPR-type	1977	2017
	C_ADIAG	C_ADIAG	1977	2017
	C_AFD	C_AFD	1977	2017
	C_AMT	C_AMT	2005	2017
	C_ANDENBEH	C_ANDENBEH	1977	1986
	C_BLOK	C_BLOK	1994	2017
	C_BOPAMT	C_BOPAMT	1977	2004
	C_EAKT	C_EAKT	1987	2003
	C_EMEK	C_EMEK	1987	2003
	C_EMODPART	C_EMODPART	1994	2003
	C_EPART	C_EPART	1994	2003
	C_ESTED	C_ESTED	1987	2003
	C_ETRAF	C_ETRAF	1987	2003
	C_HENM	C_HENM	1987	2017
	C_INDFORM	C_INDFORM	1977	1986
	C_INDFRA	C_INDFRA	1977	1986
	C_INDM	C_INDM	1977	2017
	C_KOM	C_KOM	1977	2017
	C_KONTAARS	C_KONTAARS	1987	2017
	C_PATTYPE	C_PATTYPE	1977	2017

	C_SENSTAT	C_SENSTAT	1977	1986
	C_SEX	C_SEX	1977	2017
	C_SGH	C_SGH	1977	2017
	C_SGHAMT	C_SGHAMT	1977	2017
	C_SPEC	C_SPEC	1977	2017
	C_UDM	C_UDM	1987	2017
	C_UDTIL	C_UDTIL	1977	1986
	C_ULYKKE	C_ULYKKE	1977	1986
	D_HENDTO	D_HENDTO	1977	2017
	D_INDDTO	D_INDDTO	1977	2017
	D_UDDTO	D_UDDTO	1977	2017
	K_AFD	K_AFD	2005	2017
	LEVERANCEDATO	DST leverancedato	1977	2017
	PNR	Personnummer	1977	2017
	RECNUM	LPR-identnummer	1977	2017
	VERSION	DST Version	1977	2017
	V_BEHDAGE	V_BEHDAGE	1977	2017
	V_INDTIME	V_INDTIME	1977	2017
	V_SENGDAGE	V_SENGDAGE	1994	2017
LPR-BES	Landspatientregisteret, ambulante besøg			
	Variabel	Label	Startår	Slutår
	D_AMBDTO	D_AMBDTO	1994	2017
	LEVERANCEDATO	DST leverancedato	1994	2017
	RECNUM	LPR-identnummer	1994	2017
	VERSION	DST Version	1994	2017
LPR-DIAG	Landspatientregisteret, diagnoser			
	Variabel	Label	Startår	Slutår
	C_DIAG	C_DIAG	1977	2017

	C_DIAGMOD	C_DIAGMOD	1977	1994
	C_DIAGTYPE	C_DIAGTYPE	1977	2017
	C_TILDIAG	C_TILDIAG	1995	2017
	LEVERANCEDATO	DST leverancedato	1977	2017
	RECNUM	LPR-identnummer	1977	2017
LPR-FOEDSLER	Landspatientregisteret, fødsler			
	Variabel	Label	Startår	Slutår
	LEVERANCEDATO	DST leverancedato	1995	2017
	RECNUM	LPR-identnummer	1995	2017
	VERSION	DST Version	1995	2017
	V_FLERNR	V_FLERNR	1995	2017
	V_PARITET	V_PARITET	1995	2017
	V_VAGT	V_VAGT	1995	2017
LPR-OPR	Landspatientregisteret, operationer			
	Variabel	Label	Startår	Slutår
	C_KOMB	C_KOMB	1977	2017
	C_OAFD	C_OAFD	1977	2017
	C_OPR	C_OPR	1977	2017
	C_OSGH	C_OSGH	1977	2017
	LEVERANCEDATO	DST leverancedato	1977	2017
	RECNUM	LPR-identnummer	1977	2017
	VERSION	DST Version	1977	2017
LPR-SKSOPR	Landspatientregisteret, operationer (SKS)			
	Variabel	Label	Startår	Slutår
	C_OAFD	C_OAFD	1996	2017
	C_OPR	C_OPR	1996	2017

	C_OPRART	C_OPRART	1996	2017
	C_OSGH	C_OSGH	1996	2017
	C_TILOPR	C_TILOPR	1996	2017
	D_ODTO	D_ODTO	1996	2017
	LEVERANCEDATO	DST leverancedato	1996	2017
	RECNUM	LPR-identnummer	1996	2017
	VERSION	DST Version	1996	2017
LPR-SKSUBE	Landspatientregisteret, behandlinger (SKS)			
	Variabel	Label	Startår	Slutår
	C_OAFD	C_OAFD	1999	2017
	C_OPR	C_OPR	1999	2017
	C_OPRART	C_OPRART	1999	2017
	C_OSGH	C_OSGH	1999	2017
	C_TILOPR	C_TILOPR	1999	2017
	D_ODTO	D_ODTO	1999	2017
	LEVERANCEDATO	DST leverancedato	1999	2017
	RECNUM	LPR-identnummer	1999	2017
	VERSION	DST Version	1999	2017
LPR-ULYK	Landspatientregisteret, ulykker			
	Variabel	Label	Startår	Slutår
	C_ART	C_ART	2000	2017
	C_TILULYK	C_TILULYK	2000	2017
	C_ULYK	C_ULYK	2000	2017
	LEVERANCEDATO	DST leverancedato	2000	2017
	RECNUM	LPR-identnummer	2000	2017
OF	Offentligt forsørgede			
	Variabel	Label	Startår	Slutår

	PNR	Personnummer	2016	2017
	PTI_TILSTAND_KODE	4-cifret foranstaltningskode	2016	2017
	PTI_TIMER_PER_UGE	Timer pr. uge	2016	2017
	PTI_VFRA	Startdato	2016	2017
	PTI_VTIL	Slutdato	2016	2017
OFFL	Offentligt forsørgede, forløbsregister			
	Variabel	Label	Startår	Slutår
	PNR	Personnummer	2018	2018
	PTI_TILSTAND_KODE	4-cifret foranstaltningskode	2018	2018
	PTI_TIMER_PER_UGE	Timer pr. uge	2018	2018
	PTI_VFRA	Startdato	2018	2018
	PTI_VTIL	Slutdato	2018	2018
RAS	Registerbaseret arbejdsstyrkestatistik			
	Variabel	Label	Startår	Slutår
	AFSTAND	Pendlingsafstand mellem bopæl og ar	2016	2016
	ALDER_AMR	Alder ultimo måneden	2016	2016
	ARB_BEL_KOM_KODE	Arbejdsstedskommune	2016	2016
	ARB_DST_ADGANGSADRESSE	Arbejdsstedsadressen ultimo novembe	2016	2016
	ARB_HOVED_BRA_DB07	Branchekode	2016	2016
	ARB_SEKTORKODE	Sektorkode for arbejdsstedet	2016	2016
	ATP_BELOEB	ATP-beløb i året	2016	2016
	ATP_BIDRAG_SATS_KODE	Sats for ATP-beløbet	2016	2016
	BOPAEL_KOM_KODE	Kommunekode for bopælen	2016	2016
	BREDT_LOENBELOEB	Bredt lønbeløb	2016	2016
	BREDT_LOENBELOEB_EBS	Bredt lønbeløb i erhvervsbeskæfigel	2016	2016
	CPRTJEK	CPR-tjek	2016	2016
	CPRTYPE	CPR-type	2016	2016

	CVRNR	CVR-nummer	2016	2016
	DISCO_KODE	Disco kode for lønmodtagere	2016	2016
	DISCO_MATCHPRIO_KODE	Kode der angiver kvaliteten af disc	2016	2016
	FIKTIV_ARB_KODE	Fiktivt arbejdssted	2016	2016
	FRAVAER_BESK_KODE	Midlertidigt fraværende fra beskæft	2016	2016
	HELTID_32_KODE	Heltid eller deltidsbeskæftiget	2016	2016
	I_BEFOLKNINGEN_KODE	I befolkningen på referencetidspunk	2016	2016
	JUR_BAGATEL_AAR	Over/under bagatelgrænsen	2016	2016
	KOEN	Køn	2016	2016
	NOV_TILSTAND_GRAD	Tilstandsgrad i november	2016	2016
	PNR	Personnummer	2016	2016
	PRIMAER_STATUS_KODE	Kode for primær tilknytning til arb	2016	2016
	SMALT_LOENBELOEB	Smalt lønbeløb	2016	2016
	SOC_STATUS_KODE	Socioøkonomisk status	2016	2016
	STOETTE_BESK_KODE	Støttet beskæftigelse	2016	2016
	TILSTAND_GRAD_AAR_AMR	Tilstandsgrad i året	2016	2016
	TILSTAND_KODE_AMR	Tilstandskode i AMR	2016	2016
	VERSION	Version	2016	2016
RAS-2015	Registerbaseret arbejdsstyrkestatistik			
	Variabel	Label	Startår	Slutår
	ADRKVAL	Adressen for arbejdsstedet kvalitet	1980	1989
	AFSTAND	Pendlingsafstand mellem bopæl og ar	2008	2015
	AKASSE_RAS	A-kasse	1985	2007
	AKOM07	Arbejdsstedskommune	2006	2006
	ALDER_AMR	Alder ultimo måneden	2008	2015
	ALDER_RAS	Alder på sidste arbejdsdag i novemb	1980	2007
	ANS2911K	Ansat ansat ultimo november	2006	2007
	ANSFRA	Ansat fra dato i det aktuelle år.	2006	2007
	ANSTIL	Ansat til dato i det aktuelle år.	2006	2007

	ARBGNR	Arbejdsgivernummer	1980	2007
	ARBRANCE	Årets branche (AKM)	1980	1989
	ARBSTIL	Arbejdsstilling	1980	1993
	ARBSTOPL	Metode til arbejdsstedsplacering	2006	2007
	ARB_BEL_KOM_KODE	Arbejdsstedskommune	1980	2015
	ARB_DST_ADGANGSADRESSE	Arbejdsstedsadressen ultimo novembe	1980	2015
	ARB_HOVED_BRA_DB07	Branchekode	2000	2015
	ARB_SEKTORKODE	Sektorkode for arbejdsstedet	2008	2015
	ARDSEJER	Åprets ejerkode (AKM)	1980	1989
	ARSOCIO	Årets socio (AKM)	1980	1989
	ATP_BELOEB	ATP-beløb i året	1990	2015
	ATP_BIDRAG_SATS_KODE	Sats for ATP-beløbet	1996	2015
	BOPAEL_KOM_KODE	Kommunekode for bopælen	1980	2015
	BRANCHE_KODE	Branchekode for arbejdesstedet	1992	2007
	BREDT_LOENBELOEB	Bredt lønbeløb	2008	2015
	BREDT_LOENBELOEB_EBS	Bredt lønbeløb i erhvervsbeskæfigel	2008	2015
	CPRTJEK	CPR-tjek	2008	2015
	CPRTYPE	CPR-type	2008	2015
	CVRNR	CVR-nummer	2008	2015
	DISCO_KODE	Disco kode for lønmodtagere	2008	2015
	DISCO_MATCHPRIO_KODE	Kode der angiver kvaliteten af disc	2008	2015
	DISCO_RAS_KODE	Arbejdsfunktion for lønmodtagere	1994	2007
	DSEJER	Primære ejerkode	1980	1989
	DSKOD	Arbejdsstedskode	1980	2007
	EJANSNOV	Ej ansat ultimo november	2006	2007
	FIKTIV_ARB_KODE	Fiktivt arbejdssted	2008	2015
	FORANST_RAS	Arbejdsmarkedspolitisk foranstaltni	1994	2007
	FORSKAT_RAS	Forsikringskategori i akassen	1980	2007
	FRAVAER_BESK_KODE	Midlertidigt fraværende fra beskæft	2008	2015
	FUNKTION_KODE	Funktionskode	1994	2007
	GRADAT1	Årsledighed	1980	2005

	GRADAT2	Årsledighed næste år	1990	2005
	HELARKOD	Helårskode	2006	2007
	HELTID_32_KODE	Heltid eller deltidsbeskæftiget	2008	2015
	HELTID_DELTID_KODE	Heltid eller deltid (arbejdsomfang/	1980	2007
	ISIC	ISIC 90-92	1980	1992
	I_BEFOLKNINGEN_KODE	I befolkningen på referencetidspunk	2008	2015
	JUR_BAGATEL_AAR	Over/under bagatelgrænsen	2008	2015
	KOEN	Køn	1980	2015
	LOENBLB	Arbejdsmarkedsbidragspligtig løn	1990	2007
	NOVPRIO	Novemberprioritering	1990	2007
	NOV_TILSTAND_GRAD	Tilstandsgrad i november	2008	2015
	NYARB	Ny arbejdsstilling	1994	1995
	NYSTIL	Ny stillingskode	1980	1989
	ORLOV_BESK_RAS	Orlov fra beskæftigelse	1994	2007
	PARBOPL	Primær arbejds oplysning	1980	1989
	PENSMARK	Pensionsmarkering	1980	1989
	PNR	Personnummer	1980	2015
	PRIMAER_STATUS_KODE	Kode for primær tilknytning til arb	2008	2015
	RASDSEJER3	DSejer3	1990	2003
	SAADRKOD	SEKUNDÆR ARBEJDSSTEDSADRESSE	1980	1989
	SADRKVAL	SEKUNDÆR ARBEJDSSTEDSADRESSE KVALIT	1980	1989
	SAKOM	SEKUNDÆR ARBEJDSSTEDSKOMMUNE	1980	1989
	SARBSTIL	SEKUNDÆR ARBEJDSTILLING	1980	1989
	SAROPL	SEKUNDÆR ARBEJDS OPLYSNINGER	1980	1989
	SBRKVAL	SEKUNDÆR BRANCHE KVALITET	1980	1989
	SDSEJER	SEKUNDÆR EJERKODE	1980	1989
	SDSKOD	SEKUNDÆR ARBEJDSSTEDSKODE	1980	1989
	SFORMAL	SEKUNDÆR FORMÅL	1980	1989
	SISIC	SEKUNDÆR BRANCHE (ISIC)	1980	1989
	SKIFT	PRIMÆRE SKIFT	1980	1989
	SKPLINDK	Skattepligtig indkomst	1980	1989

	SMALT_LOENBELOEB	Smalt lønbeløb	2008	2015
	SOCSTIL_KODE	Socioøkonomisk status	1996	2007
	SOC_STATUS_KODE	Socioøkonomisk status	2008	2015
	SOMF	SEKUNDÆR OMF	1980	1989
	STOETTE_BESK	Støttet beskæftigelse	1994	2007
	STOETTE_BESK_KODE	Støttet beskæftigelse	2008	2015
	TILSTAND_GRAD_AAR_AMR	Tilstandsgrad i året	2008	2015
	TILSTAND_KODE_AMR	Tilstandskode i AMR	2008	2015
	VERSION	Version	2008	2015
SSSY	Sygesikringsregisteret 2005 -			
	Variabel	Label	Startår	Slutår
	AFRPER	Afregningsperiode	2005	2017
	BARNMAK	Barnemarkering	2005	2017
	BRUHON	Bruttohonorar til læge mv.	2005	2017
	CPRTJEK	CPR-tjek	2005	2016
	CPRTYPE	CPR-type	2005	2016
	HONUGE	Honoraruge	2005	2017
	KONTAKT	Kontakt	2005	2017
	PNR	Personnummer	2005	2017
	SIKGRUP	Sygesikringsgruppe	2005	2017
	SPEC2	2-cifret speciale	2005	2017
	SPECIALE	6-cifret speciale	2005	2017
	YDERNR	Ydernummer	2005	2017
	YDERSAMT	Yders amt	2005	2017
	YDLANT	Antal ydelser under specialet	2005	2017
	YDLTID	Tidspunktskode for ydelsen	2005	2017
SYSI	Sygesikringsregisteret 1990 - 2005			

	Variabel	Label	Startår	Slutår
	AFRPER	Afregningsperiode	1990	2005
	BARNMAK	Barnemarkering	1990	2005
	HONUGE	Honoraruge	1990	2005
	PATTYP	Patienttype	1990	2005
	PNR	SIKREDES PERSONNUMMER	1990	2005
	SIKGRUP	Sikringsgruppe	1990	2005
	SPECIALE	6-cifret speciale	1990	2005
	YDLTID	Tidspunktskode for ydelsen	1990	2005
UDDA	Uddannelse årsstatus			
	Variabel	Label	Startår	Slutår
	AFSP1E	Forspaltekode afsluttet uddannelse	1981	2015
	ALMAUDD	Højst fuldførte almen uddannelse	1981	2017
	ALMPRIA	Nomineret uddannelsestid i måneder	1981	2014
	ALM_VFRA	Tidspunkt for opnået almenuddannels	1981	2017
	APUBL1	Forspalte tekst	1981	2015
	ATEXT	Uddannelses tekst	1981	2015
	CPRTJEK	CPR-tjek	2006	2017
	CPRTYPE	CPR-type	2006	2017
	EKPRIA	Nomineret uddannelsestid i måneder	1981	2014
	ERHAUDD	Højst fuldførte erhvervskompetenceg	1981	2017
	ERH_VFRA	Tidspunkt for opnået erhvervskompet	1981	2017
	H1	Hovedgruppe	1981	2015
	H1TEKST	Hovedgruppe tekst	1981	2015
	HFAUDD	Højste fuldførte uddannelse	1981	2017
	HFPRIA	Nomineret uddannelsestid i måneder	1981	2014
	HF_VFRA	Tidspunkt for opnået højst fuldført	1981	2017
	IG_VFRA	Påbegyndelsestidspunkt for igangvær	1981	2017
	KOMP	Kompetance for uddannelsen	1981	2015
	M1	Mellemgruppe	1981	2015

	M1TEKST	Mellemgruppe tekst	1981	2015
	PNR	Personnummer	1981	2017
	PRIA	Normeret tid for uddannelsen	1981	2015
	U1	Undergruppe	1981	2015
	U1TEKST	Undergruppe tekst	1981	2015
	UDD	Uddannelseskode	1981	2017
	VERSION	1-Forløbig version 2-Endelig versio	2006	2017
UDDF	Uddannelse, forløbsregister			
	Variabel	Label	Startår	Slutår
	CPRTJEK	CPR-tjek	1980	2018
	CPRTYPE	CPR-type	1980	2018
	HFAUDD	Højste fuldførte uddannelse	1980	2018
	HF_VFRA	Tidspunkt for opnået højst fuldført	1980	2018
	HF_VTIL	Tidspunkt for, hvornår uddannelse m	1980	2018
	PNR	Personnummer	1980	2018
	VERSION	Version	1980	2018
VNDS	Vandringer, forløbsregister			
	Variabel	Label	Startår	Slutår
	CPRTJEK	CPR-tjek	1973	2017
	CPRTYPE	CPR-type	1973	2017
	HAEND_DATO	HAEND_DATO	1973	2017
	INDUD_KODE	INDUD_KODE	1973	2017
	INDUD_LAND	INDUD_LAND	1973	2017
	PNR	Personnummer	1973	2017

2c Job eksponerings matricer I DOC*X (JEM)

BENJEM	Lower body JEM (DISCO-88)			
	Variabel	Label	Startår	Slutår
	DANISH_OCCUPATIONAL_TITLE	Ingen label	2019	2019
	D_ISCO	Ingen label	2019	2019
	INTERNATIONAL_OCCUPATIONAL_TITLE	Ingen label	2019	2019
	ISCO	Ingen label	2019	2019
	KNEELING_SQUATTING_TIME	Ingen label	2019	2019
	NUMBER_OF_TIMES_LIFTING___20_KG	Ingen label	2019	2019
	SITTING_TIME	Ingen label	2019	2019
	STANDING_WALKING_TIME	Ingen label	2019	2019
	TOTAL_KG_LIFTED	Ingen label	2019	2019
	VIBRATION_TIME	Ingen label	2019	2019

IOM-DB	DUST JEM IOM (DB07)			
	Variabel	Label	Startår	Slutår
	CHANGE_D	Dust: Yearly change of exposure lev	2019	2019
	CHANGE_E	Endotoxin: Yearly change of exposur	2019	2019
	CHANGE_MODEL_E	Endotoxin: G% of yearly change in e	2019	2019
	DB07	Industry (DB-07)	2019	2019
	GID	Industry (Primary production, text)	2019	2019
	GM_D	Dust: Level in 2001 (in mg/m3) (JEM	2019	2019

	GM_E	Endotoxin: Level in 2001 (in mg/m3)	2019	2019
	LEVEL_D	Dust: Source of level	2019	2019
	LEVEL_E	Endotoxin: Source of level	2019	2019
	MODEL_D	Dust: GM level from industry specif	2019	2019
	MODEL_E	Endotoxin: GM level from industry s	2019	2019
	TREND_D	Dust: Source of time trend	2019	2019
	TREND_E	Endotoxin: Source of time trend	2019	2019
SHOULDER	The Shoulder JEM (DISCO88)			
	Variabel	Label	Startår	Slutår
	ARMELEVATION_D	Upper arm elevation >90 degrees	2019	2019
	COMPUTER_D	Computer use, duration	2019	2019
	DISCO	DISCO-88 group (fourth level)	2019	2019
	GROUP	DISCO-88 group (first level)	2019	2019
	JOB_TITEL	Jobtitle	2019	2019
	LIFT10_D	Lifting or carrying >10kg, duration	2019	2019
	LIFT10_F	Lifting or carrying >10kg, frequenc	2019	2019
	PUSH50_D	Pushing / pulling >50kg, duration	2019	2019
	PUSH50_F	Pushing / pulling >50kg, frequency	2019	2019
	REPETITION_D	Repetitive shoulder movements, dura	2019	2019
	REPETITION_F	Repetitive shoulder movements, freq	2019	2019
	SHOULDER_EXERTION	Forceful shoulder excertion	2019	2019

	TOTAL_SCORE	Total shoulder score (0-10)	2019	2019
	VIBRATION_D	Working with hand-held vibrating to	2019	2019
	VIBRATION_G	Working with hand-held vibrating to	2019	2019
WOOD	Wood-JEM (DISCO88)			
	Variabel	Label	Startår	Slutår
	AVERAGE_EXP	Average non-country specific exposu	2019	2019
	BLUP	BLUP estimate from model	2019	2019
	COMMENTS	Comments	2019	2019
	DISCOCODE	Job title (D)ISCO-88	2019	2019
	DK_NO_EXP	DK and NO country specific estimate	2019	2019
	FI_EXP	FI country specific estimates	2019	2019
	FR_EXP	FR country specific estimates	2019	2019
	JEM_SCORE	Wood dust Asthma_JEM score	2019	2019
	JOBCODE	Job title (text)	2019	2019
	N	N of measurements available in expo	2019	2019
	NL_EXP	NL country specific estimates	2019	2019
	UK_EXP	UK country specific estimates	2019	2019
JEMBBHPHYS	PHYSICAL EXCERSTION (DISCO88) with separate domains			
	Variabel	Label	Startår	Slutår
	AGE	Ingen label	2019	2019
	CARRYJEMINT	carryjem	2019	2019

	CARRYSTDERR	carrystderr	2019	2019
	DISCOJEM	Ingen label	2019	2019
	LIFTJEMINT	liftjem	2019	2019
	LIFTSTDERR	liftstderr	2019	2019
	NCARRY	Ingen label	2019	2019
	NGROUP	Ingen label	2019	2019
	NLIFT	Ingen label	2019	2019
	NPUSH	Ingen label	2019	2019
	NREPET	Ingen label	2019	2019
	NSITT	Ingen label	2019	2019
	NSQUAT	Ingen label	2019	2019
	NTWIST	Ingen label	2019	2019
	NWALK	Ingen label	2019	2019
	PUSHJEMINT	pushjem	2019	2019
	PUSHSTDERR	pushstderr	2019	2019
	REPETJEMINT	repetjem	2019	2019
	REPETSTDERR	repetstderr	2019	2019
	SEX	Ingen label	2019	2019
	SITTJEMINT	sittjem	2019	2019
	SITTSTDERR	sittstderr	2019	2019
	SQUATJEMINT	squatjem	2019	2019
	SQUATSTDERR	squatstderr	2019	2019
	TRUNC_CARRY	Ingen label	2019	2019
	TRUNC_LIFT	Ingen label	2019	2019
	TRUNC_PUSH	Ingen label	2019	2019
	TRUNC_REP	Ingen label	2019	2019
	TRUNC_SIT	Ingen label	2019	2019
	TRUNC_SQUAT	Ingen label	2019	2019
	TRUNC_TWIST	Ingen label	2019	2019
	TRUNC_WALK	Ingen label	2019	2019
	TRUNC_WALK_HI	Ingen label	2019	2019
	TWISTJEMINT	twistjem	2019	2019

	TWISTSTDERR	twiststderr	2019	2019
	WALKJEMINT	walkjem	2019	2019
	WALKSTDERR	walkstderr	2019	2019
ACTIVE-JEM-LEVEL	Physical Activity in Leisure time (DISCO88)			
	Variabel	Label	Startår	Slutår
	AGE_GRP	Ingen label	2019	2019
	COUNT	Frequency Count	2019	2019
	FAGKODE_1	Ingen label	2019	2019
	FAGKODE_2	Ingen label	2019	2019
	FAGKODE_3	Ingen label	2019	2019
	FAGKODE_4	Ingen label	2019	2019
	GENDER	Ingen label	2019	2019
	PERIODE_1	Ingen label	2019	2019
	PERIODE_2	Ingen label	2019	2019
	PERIODE_3	Ingen label	2019	2019
	PERIODE_4	Ingen label	2019	2019
	PERIODE_5	Ingen label	2019	2019
	PERIODE_6	Ingen label	2019	2019
	PRED	Predicted	2019	2019
	STDERRPRED	Std Err Pred	2019	2019
ALCO-JEM-LEVEL	Alcohol intake (DISCO88)			
	Variabel	Label	Startår	Slutår
	AGE_GRP	Ingen label	2019	2019
	COUNT	Frequency Count	2019	2019
	FAGKODE_1	Ingen label	2019	2019
	FAGKODE_2	Ingen label	2019	2019
	FAGKODE_3	Ingen label	2019	2019
	FAGKODE_4	Ingen label	2019	2019
	GENDER	Ingen label	2019	2019
	PERIODE_1	Ingen label	2019	2019

	PERIODE_2	Ingen label	2019	2019
	PERIODE_3	Ingen label	2019	2019
	PERIODE_4	Ingen label	2019	2019
	PERIODE_5	Ingen label	2019	2019
	PERIODE_6	Ingen label	2019	2019
	PRED	Predicted	2019	2019
	STDERRPRED	Std Err Pred	2019	2019
BMI-JEM-LEVEL	Body Mass Index (DISCO88)			
	Variabel	Label	Startår	Slutår
	AGE_GRP	Ingen label	2019	2019
	COUNT	Frequency Count	2019	2019
	FAGKODE_1	Ingen label	2019	2019
	FAGKODE_2	Ingen label	2019	2019
	FAGKODE_3	Ingen label	2019	2019
	FAGKODE_4	Ingen label	2019	2019
	GENDER	Ingen label	2019	2019
	PERIODE_1	Ingen label	2019	2019
	PERIODE_2	Ingen label	2019	2019
	PERIODE_3	Ingen label	2019	2019
	PERIODE_4	Ingen label	2019	2019
	PERIODE_5	Ingen label	2019	2019
	PERIODE_6	Ingen label	2019	2019
	PRED	Predicted	2019	2019
	STDERRPRED	Std Err Pred	2019	2019
SMOKE-P-JEM-LEVEL	Smoking prevalence (DISCO88)			
	Variabel	Label	Startår	Slutår
	AGE_GRP	Ingen label	2019	2019
	COUNT	Frequency Count	2019	2019
	ESTIMAT	Ingen label	2019	2019

	FAGKODE_1	Ingen label	2019	2019
	FAGKODE_2	Ingen label	2019	2019
	FAGKODE_3	Ingen label	2019	2019
	FAGKODE_4	Ingen label	2019	2019
	GENDER	Ingen label	2019	2019
	PERIODE_1	Ingen label	2019	2019
	PERIODE_2	Ingen label	2019	2019
	PERIODE_3	Ingen label	2019	2019
	PERIODE_4	Ingen label	2019	2019
	PERIODE_5	Ingen label	2019	2019
	PERIODE_6	Ingen label	2019	2019
SMOKE-V-JEM-LEVEL	Smoking volume (DISCO88)			
	Variabel	Label	Startår	Slutår
	AGE_GRP	Ingen label	2019	2019
	COUNT	Frequency Count	2019	2019
	FAGKODE_1	Ingen label	2019	2019
	FAGKODE_2	Ingen label	2019	2019
	FAGKODE_3	Ingen label	2019	2019
	FAGKODE_4	Ingen label	2019	2019
	GENDER	Ingen label	2019	2019
	PERIODE_1	Ingen label	2019	2019
	PERIODE_2	Ingen label	2019	2019
	PERIODE_3	Ingen label	2019	2019
	PERIODE_4	Ingen label	2019	2019
	PERIODE_5	Ingen label	2019	2019
	PERIODE_6	Ingen label	2019	2019
	PRED	Predicted	2019	2019
	STDERRPRED	Std Err Pred	2019	2019
VEG-JEM-LEVEL	Intake of Fruit and vegetables (DISCO88)			
	Variabel	Label	Startår	Slutår

	AGE_GRP	Ingen label	2019	2019
	COUNT	Frequency Count	2019	2019
	FAGKODE_1	Ingen label	2019	2019
	FAGKODE_2	Ingen label	2019	2019
	FAGKODE_3	Ingen label	2019	2019
	FAGKODE_4	Ingen label	2019	2019
	GENDER	Ingen label	2019	2019
	PERIODE_2	Ingen label	2019	2019
	PERIODE_3	Ingen label	2019	2019
	PERIODE_4	Ingen label	2019	2019
	PERIODE_5	Ingen label	2019	2019
	PERIODE_6	Ingen label	2019	2019
	PRED	Predicted	2019	2019
	STDERRPRED	Std Err Pred	2019	2019
STOJJEM	Noise JEM (DISCO88)			
	Variabel	Label	Startår	Slutår
	DISCO88	DISCO88 code	2019	2019
	DISCO88_TEXT	Danish Occupational Title	2019	2019
	NOISE	Occupational noise	2019	2019
GLOVEJEMHJEM	Glove use (sex specific) (DISCO88)			
	Variabel	Label	Startår	Slutår
	ESTIMATE_MEN	Ingen label	2019	2019
	ESTIMATE_WOMEN	Ingen label	2019	2019
	FREQ_ALL	Ingen label	2019	2019
	FREQ_MEN	Ingen label	2019	2019
	FREQ_WOMEN	Ingen label	2019	2019
	MEAN_MEN	Ingen label	2019	2019
	MEAN_WOMEN	Ingen label	2019	2019
	OCC2	Ingen label	2019	2019
	SOURCE_MEN	Ingen label	2019	2019

	SOURCE_WOMEN	Ingen label	2019	2019
	STDDEV_MEN	Ingen label	2019	2019
	STDDEV_WOMEN	Ingen label	2019	2019
GLOVEJEMCOMMON	Glove use (both sexes) (DISCO88)			
	Variabel	Label	Startår	Slutår
	ESTIMATE	Ingen label	2019	2019
	FREQ	Ingen label	2019	2019
	MEAN	Ingen label	2019	2019
	OCC2	Ingen label	2019	2019
	STDDEV	Ingen label	2019	2019
WETJEMHJEM	Wet hand work (sex specific) (DISCO88)			
	Variabel	Label	Startår	Slutår
	ESTIMATE_MEN	Ingen label	2019	2019
	ESTIMATE_WOMEN	Ingen label	2019	2019
	FREQ_ALL	Ingen label	2019	2019
	FREQ_MEN	Ingen label	2019	2019
	FREQ_WOMEN	Ingen label	2019	2019
	MEAN_MEN	Ingen label	2019	2019
	MEAN_WOMEN	Ingen label	2019	2019
	OCC2	Ingen label	2019	2019
	SOURCE_MEN	Ingen label	2019	2019
	SOURCE_WOMEN	Ingen label	2019	2019
	STDDEV_MEN	Ingen label	2019	2019
	STDDEV_WOMEN	Ingen label	2019	2019
WETJEMHJEMCOMMON	Wet hand work (both sexes) (DISCO88)			
	Variabel	Label	Startår	Slutår
	ESTIMATE	Ingen label	2019	2019

	FREQ	Ingen label	2019	2019
	MEAN	Ingen label	2019	2019
	OCC2	Ingen label	2019	2019
	STDDEV	Ingen label	2019	2019
WETWORKJEMHJEM	Wet work (wet hands or gloves, sex specific) (DISCO88)			
	Variabel	Label	Startår	Slutår
	ESTIMATE_MEN	Ingen label	2019	2019
	ESTIMATE_WOMEN	Ingen label	2019	2019
	FREQ_ALL	Ingen label	2019	2019
	FREQ_MEN	Ingen label	2019	2019
	FREQ_WOMEN	Ingen label	2019	2019
	MEAN_MEN	Ingen label	2019	2019
	MEAN_WOMEN	Ingen label	2019	2019
	OCC2	Ingen label	2019	2019
	SOURCE_MEN	Ingen label	2019	2019
	SOURCE_WOMEN	Ingen label	2019	2019
	STDDEV_MEN	Ingen label	2019	2019
	STDDEV_WOMEN	Ingen label	2019	2019
WETWORKJEMHJEMCOMMON	Wet work (wet hands or gloves, both sexes) (DISCO88)			
	Variabel	Label	Startår	Slutår
	ESTIMATE	Ingen label	2019	2019
	FREQ	Ingen label	2019	2019
	MEAN	Ingen label	2019	2019
	OCC2	Ingen label	2019	2019
	STDDEV	Ingen label	2019	2019

JEMBBH-88	Ergonomic and psychosocial Demands (DISCO88) AH-data			
	Variabel	Label	Startår	Slutår
	AGE	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	EMODEMJEMINT	emodemjem	2019	2019
	EMODEMSTDERR	emodemstderr	2019	2019
	INDFLYDJEMINT	indflydjem	2019	2019
	INDFLYDSTDERR	indflydstderr	2019	2019
	JEMEMO_DICH	jememo_DICH	2019	2019
	JEMINDF_DICH	jemindf_DICH	2019	2019
	JEMJOBINS_DICH	jemjobins_dich	2019	2019
	JEMKVAN_DICH	jemkvan_DICH	2019	2019
	JEMPHYS_DICH	jemphys_DICH	2019	2019
	JEMTRAIN	JEMtrain	2019	2019
	JEMVOLD	jemvold	2019	2019
	KVANKRAVJEMINT	kvankravjem	2019	2019
	KVANKRAVSTDERR	kvankravstderr	2019	2019
	NEMO	Ingen label	2019	2019
	NGROUP	Ingen label	2019	2019
	NINDF	Ingen label	2019	2019
	NJOBINS	Ingen label	2019	2019
	NKVAN	Ingen label	2019	2019
	NPHYS	Ingen label	2019	2019
	NSTRAIN	Ingen label	2019	2019
	NVOLD	Ingen label	2019	2019
	PHYS_SCOREJEMINT	phys_scorejem	2019	2019
	PHYS_SCORESTDERR	phys_scorestderr	2019	2019
	SEX	Ingen label	2019	2019

JEMBBH-08	Ergonomic and psychosocial Demands (DISCO08) AH-data			
	Variabel	Label	Startår	Slutår
	AGE	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	EMODEMJEMINT	emodemjem	2019	2019
	EMODEMSTDERR	emodemstderr	2019	2019
	INDFLYDJEMINT	indflydjem	2019	2019
	INDFLYDSTDERR	indflydstderr	2019	2019
	JEMEMO_DICH	jememo_DICH	2019	2019
	JEMINDF_DICH	jemindf_DICH	2019	2019
	JEMJOBINS_DICH	jemjobins_dich	2019	2019
	JEMKVAN_DICH	jemkvan_DICH	2019	2019
	JEMPHYS_DICH	jemphys_DICH	2019	2019
	JEMTRAIN	JEMtrain	2019	2019
	JEMVOLD	jemvold	2019	2019
	KVANKRAVJEMINT	kvankravjem	2019	2019
	KVANKRAVSTDERR	kvankravstderr	2019	2019
	NEMO	Ingen label	2019	2019
	NGROUP	Ingen label	2019	2019
	NINDF	Ingen label	2019	2019
	NJOBINS	Ingen label	2019	2019
	NKVAN	Ingen label	2019	2019
	NPHYS	Ingen label	2019	2019
	NSTRAIN	Ingen label	2019	2019
	NVOLD	Ingen label	2019	2019
	PHYS_SCOREJEMINT	phys_scorejem	2019	2019
	PHYS_SCORESTDERR	phys_scorestderr	2019	2019
	SEX	Ingen label	2019	2019
EMO	PHYSICAL EXCERSTION (DISCO88) NAK-data			

	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	EMO1JEMINT	emo1jem	2019	2019
	EMO1STDERR	emo1stderr	2019	2019
	EMO2JEMINT	emo2jem	2019	2019
	EMO2STDERR	emo2stderr	2019	2019
	EMO3JEMINT	emo3jem	2019	2019
	EMO3STDERR	emo3stderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
EMO-SCORE-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	EMODEMJEMINT	emodemjem	2019	2019
	EMODEMSTDERR	emodemstderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
ERGO-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	PHYS_SCOREJEMINT	phys_scorejem	2019	2019
	PHYS_SCORESTDERR	phys_scorestderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019

INFLUENCE-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	INFLUENCEJEMINT	INFLUENCEjem	2019	2019
	INFLUENCESTDERR	INFLUENCEstderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
POSDEV-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	POSDEVJEMINT	PosDevjem	2019	2019
	POSDEVSTDERR	PosDevstderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
ROLECON-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	ROLECONJEMINT	Roleconjem	2019	2019
	ROLECONSTDERR	Roleconstderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
STRAIN-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår

	AGESPL1	Ingen label	2019	2019
	CONTROLJEMINT	controljem	2019	2019
	CONTROLSTDERR	controlstderr	2019	2019
	DISCOJEM	Ingen label	2019	2019
	JEMTRAIN	JEMtrain	2019	2019
	PSYDEMJEMINT	psydemjem	2019	2019
	PSYDEMSTDERR	psydemstderr	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
	STDERRSTRAIN	stderrstrain	2019	2019
	WEIGHT	Ingen label	2019	2019

VOLD-XMA	PHYSICAL EXCERSTION (DISCO88) NAK-data			
	Variabel	Label	Startår	Slutår
	AGESPL1	Ingen label	2019	2019
	DISCOJEM	Ingen label	2019	2019
	JEMVOLD	jemvold	2019	2019
	RUNDE	Ingen label	2019	2019
	SEXR	Køn	2019	2019
	STDERRVOLD	stderrvold	2019	2019
	WEIGHT	Ingen label	2019	2019

Bilag 3

Open access artikler fra DOC*X hovedprojektet

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Cohort Profile

Cohort Profile

Cohort Profile: DOC*X: a nationwide Danish occupational cohort with eXposure data – an open research resource

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Why was the cohort set up?

Occupational exposures contribute substantially to morbidity and mortality worldwide[1,2] and are of pivotal importance for sick leave, disability and preterm exit from the labour market regardless of the aetiology of disease.[3,4] Premature exit from the labour market is becoming more important as increasing life expectancy is calling for an extension of working life into older ages.[5] To comply with demands for knowledge on occupational determinants for maintaining a healthy workforce, there is a need for building large nationwide databases that integrate prospective data on occupational exposures, with data on health, work participation and labour market exits.

Health research in Denmark has unique opportunities to establish such databases due to well-established nationwide administrative and health registers (e.g. Danish registers on personal labour market affiliation[6] and The Danish National Patient Register[7]) and the possibility to link information on an individual level across registers by the personal identification number established on April 2, 1968.[8] Nevertheless, occupational epidemiology has not yet fully capitalized on these possibilities, partly because occupational exposures are not included in the administrative registers on labour market affiliation.[6] The Danish Occupational Cohort with eXposure data (DOC*X) aims to fill this gap by including a series of job exposure matrices (JEMs) that to the largest extent possible builds on uniform principles and metrics across different occupational exposures.

A JEM is a cross tabulation of jobs or job groups; in our case occupational codes according to DISCO-88 (the Danish version of the International Standard Classification of Occupations, ISCO, from 1988) and corresponding exposure estimates.[9,10] Occupational exposure assessment by means of population-based JEMs was described in the early 1980s.[11–13] Since then, JEMs have gained increasing acceptance in the scientific community[10,14,15] and have a great potential for cost-effective exposure assessment in large-scale studies.[16] The DOC*X database benefits from progress made in constructing JEMs during the past decade and includes psychosocial, mechanical, physical and chemical exposures, and lifestyle factors. Since the exposures are assessed at the same level of detail (DISCO-88 code level), the DOC*X database is designed to provide joint estimates of risks related to exposures that are most often analysed separately. In short, the objective of DOC*X is to provide a research resource that enables cost-effective studies of the impact of occupational exposures on disease and disability in a nationwide setting, by using administrative and health registers together with JEMs.

Who is in the cohort?

The cohort includes all persons gainfully employed and living in Denmark in 1970 and from 1976 to 2015, regardless of nationality. The period 1971–1975 is not covered as Statistics Denmark changed from survey-based to register-based censuses and did not carry out censuses in these years. This amounts to approximately 6.4 million persons, whose occupational history was followed for a median of 15 years (range 1–41 years). Between 2.0 and 2.9 million persons were in employment yearly, with a gradual increase from the earlier to the later years. Further details on source registers and labour market attachment are provided in the 'What has been measured?' section. Key characteristics of the cohort are provided in Table 1.

How often have they been followed up?

Employment status and occupation have been followed through the 1970 census[17] and by annual registrations from 1976 to 2015[6] for all persons aged at least 16 years. Further annual registrations will be added to the database in the future. In parallel, continuous registration of migrations, disappearances and deaths enables precise timing of such events within the entire cohort from 1970 and onwards.[8]

What has been measured?

The DOC*X database is made up of three main parts: (i) The Occupation and Industry Register, (ii) the JEMs, and (iii) register-based information on demographics, education, income, migration, retirement, death, hospitalizations and transfer payments.

(i) The Occupation and Industry Register. This register was compiled for DOC*X. It contains yearly registrations of employment status from the 1970 census,[17] which was based on mandatory self-reported information, and from the Employment Classification Module 1976 to 2015.[6,18] Both sources are from Statistics Denmark. The Employment Classification Module is based on various collections of administrative data including self-report to the civil registration authorities, union membership, public employers, private companies and tax records. Self-report and union membership were predominantly used earlier in the period, whereas tax records and information from public and private employers were used increasingly later in the period, as it became mandatory for companies with 10 or more employees to report individual-level information on occupation. Assigning occupational codes was carried out by trained coders at Statistics Denmark in the earlier part of the period but is increasingly reliant on direct employer reports through automated systems. Employment status is divided into three categories: employed, self-employed and non-employed. The two former categories are linked with information on occupation and industry. The source registers used several different classifications of occupation and industry. The 1970 census used a distinct classification developed by Statistics Denmark. The Employment Classification Module has used three classifications. (1) 1976–1992: a scheme developed by Statistics Denmark based on ISCO-68, (2) 1993–2009: DISCO-88, and (3) 2010–2015: DISCO-08 The DISCO-88 and -08 are Danish versions of the International Standard Classification of Occupations (ISCO) from 1988 and 2008, respectively.[19] The DISCO system classifies occupations into 10 major groups (1st digit level: 0, Armed forces; 1, Legislators, senior officials, and managers; 2, Professionals; 3, Technicians and associate professionals; … 8, Plant and machine operators, and assemblers; 9, Elementary occupations) and 372 groups at the 4th and most detailed level (e.g. 1210, Directors and chief executives; 2221, Medical doctors; 3231, Nursing; 7412, Bakers; and 9313, Building construction labourers). The DISCO classification is based on a combination of education/skill and job content. To enable studies of long-term exposures and studies with long-term follow-up, we have introduced a harmonized coding of occupations according to DISCO-88 as it was the primary classification for the longest period and is more detailed than DISCO-08.[19] The harmonization was performed code by code, aiming to keep the reclassification as detailed as possible. DOC*X also contains harmonized industry codes according to 'Dansk Branchekode 2007' (DB-07), the Danish extended 6-digit version of the 'Nomenclature statistique des Activités économiques dans la Communauté Européenne'

Table 1. Description of the cohort in the DOC*X database

Unique persons (N[a])	Missing DISCO code[b,c]		Recorded DISCO code		
	All	%	All	Men	Women
Total ($n = 6\ 399\ 000$)	1 002 000	16	5 398 000	2 984 000	2 414 000
Age in 1976 (years)					
P10–P90[f]	17.9–55.3		22.3–57.8	22.9–59.2	21.6–54.8
Median	30		35	37	32
Age in 2015 (years)					
P10–P90	19.5–66.2		22.7–59.4	22.8–60.1	22.6–58.7
Median	40		42	43	42
Follow-up length (years)					
Min–Max	1–40		1–39	1–40	1–40
Median	2		15	15	15
Risktime (person years[a])					
Total (T = 114 831 000)	23 550 000	21	91 281 000	49 396 000	41 885 000
Time period					
1970[d]	2 079 000	100	–	–	–
1976–1985	6 090 000	23	20 883 000	12 371 000	8 511 000
1986–1995	6 467 000	21	24 716 000	13 425 000	11 291 000
1996–2005	4 288 000	17	21 503 000	11 241 000	10 261 000
2006–2015	4 626 000	16	24 179 000	12 358 000	11 821 000
Age (years)					
16–25	8 799 000	36	15 936 000	8 358 000	7 578 000
26–35	4 304 000	16	22 819 000	11 921 000	10 898 000
36–45	3 667 000	14	22 744 000	12 012 000	10 732 000
46–55	3 297 000	15	18 791 000	10 190 000	8 600 000
56–65	2 362 000	20	9 609 000	5 819 000	3 790 000
66–75	866 000	41	1 235 000	971 000	264 000
76–85	220 000	62	136 000	116 000	20 000
86–105	35 000	79	9 000	7 000	2 000
DISCO-88 major groups[b]					
0: Armed forces	–	–	1 364 000	1 281 000	83 000
1: Legislators, senior officials, and managers	–	–	3 079 000	2 474 000	605 000
2: Professionals	–	–	12 929 000	7 626 000	5 302 000
3: Technicians and associate professionals	–	–	15 293 000	6 357 000	8 936 000
4: Clerks	–	–	12 080 000	3 131 000	8 950 000
5: Service, shop, market, and sales workers	–	–	13 982 000	3 952 000	10 029 000
6: Skilled agricultural and fishery workers	–	–	927 000	790 000	137 000
7: Craft and related trades workers	–	–	11 774 000	11 140 000	634 000
8: Plant and machine ops, and assemblers	–	–	7 203 000	5 163 000	2 040 000
9: Elementary occupations	–	–	12 651 000	7 483 000	5 168 000
Industry major groups (DB-07[e])					
Agriculture, forestry, and fishing	–	–	1 939 000	383 000	1 556 000
Manufacturing, supply	–	–	15 766 000	4 831 000	10 935 000
Construction	–	–	5 124 000	498 000	4 626 000
Trade and transport	–	–	22 280 000	8 715 000	13 565 000
Information and communication	–	–	1 849 000	641 000	1 208 000
Finance and insurance	–	–	3 224 000	1 663 000	1 562 000
Real estate and renting	–	–	1 279 000	456 000	823 000
Service	–	–	7 154 000	3 426 000	3 728 000
Public sector	–	–	33 385 000	22 837 000	10 548 000
Arts, entertainment	–	–	3 767 000	2 121 000	1 646 000
Unknown	–	–	19 063 000	7 067 000	11 996 000

[a]Rounded to nearest thousand.
[b]DISCO-88 is the Danish version of the International Classification of Occupations (ISCO).
[c]Missing DISCO-88 code even though the person was registered as in employment (employed or self-employed).
[d]The 1970 registration of occupation used a classification system that is not generally harmonizable to DISCO-88.
[e]DB-07 (Dansk Branchekode 2007) is the Danish extended 6-digit version of the ‘Nomenclature statistique des Activités économiques dans la Communauté Européenne’.
[f]1st to 9th deciles.

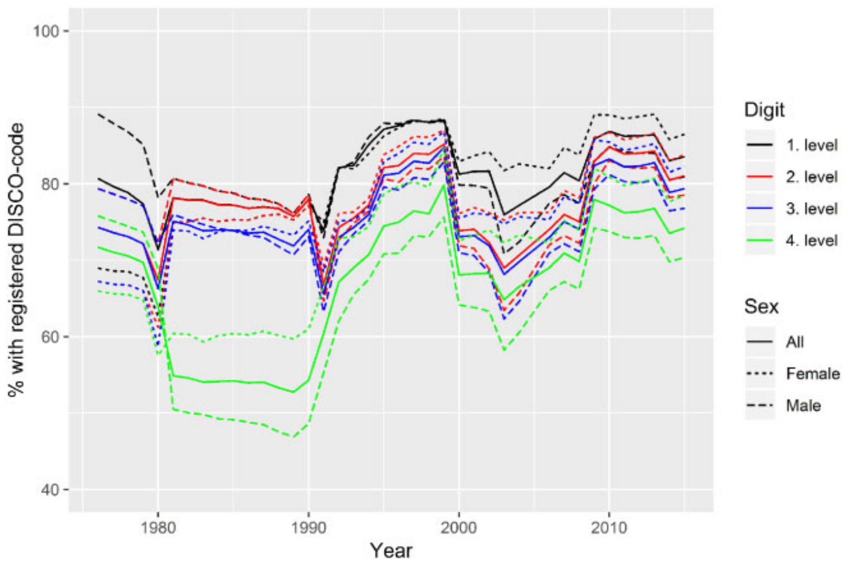

Figure 1. Percentage of persons in employment with DISCO-88 codes from 1976 to 2015 at 1st–4th digit level of classification.

(NACE).[20] Industry codes were drawn directly from the source registers, with harmonization carried out by Statistics Denmark in advance. The individual-level codes are based on industry coding of companies, with all employees in a given company given the common company code. Industry coding of companies is mandatory. Additionally, the register retains occupation and industry codes according to the original classifications.

Figure 1 gives an overview of the percentage of employed or self-employed people with harmonized DISCO-88 codes by year. On average, 79% had a DISCO-88 code at the major group level (1st digit level, i.e. the 10 major DISCO-88 categories), with somewhat higher proportions of persons with codes for the later years. The percentage with DISCO-88 codes was lower at the 2nd–4th digit levels, particularly in the 1980s, but shows the same temporal trends. The main reason for missing DISCO codes is that only companies with more than 10 employees are required to report occupational information. In general, men had a lower coverage of DISCO-88 codes (on average at the 4th digit level: men 64%, women 71%). This is primarily an effect of varying registration practices across the somewhat gender segregated Danish labour market. Men are more frequently employed as e.g. 'Craft and related trades workers' and 'Plants and machine operators and assemblers', whereas women constitute the majorities in 'Clerks' and 'Service workers and shop and market sales', where companies are typically larger and thus required to report occupational titles.

Employment status is measured from the year of the 16th birthday or from the year of first registered employment, whichever comes latest, until the last year of registered employment, or 2015, whichever comes first. With future yearly updates, the Occupation and Industry Register will continue to include up-to-date information on employment and occupation.

(ii) The job exposure matrices. The DOC*X database contains measures of a wide variety of occupational exposures provided by JEMs. Table 2 presents an overview of the occupational exposure matrices that are so far included in DOC*X. To enable linkage between the Occupation and Industry Register and the JEMs, all exposure estimates are classified according to DISCO-88 and DB-07. Additionally, the included JEMs may find use in combination with other databases with similar coding of occupation and industry.

The psychosocial JEM includes six exposures (Table 2)[21] that are based on data from a questionnaire survey of a random sample of 15 207 Danish employees in 2012: The Work Environment and Health in Denmark cohort study.[22] For continuous exposures, the DISCO group specific mean levels (and standard deviations) of scale values were generated in a random intercept multilevel model using best linear unbiased prediction (BLUP) estimators. For dichotomous exposures, the DISCO code specific probability of exposures was generated using a logit model with DISCO code and age as predictors. Continuous and dichotomous exposure estimates were generated separately for men and women, and age was modelled as a spline according to the sex-specific quartiles of the age-distribution in the population. The JEM thus contains specific exposure estimates according to occupation, sex and one-year age categories.

The mechanical JEMs (the Shoulder JEM[23] and the Lower Body JEM[24]) include 18 exposures such as time per day spent working with upper arm elevation >90°[23] and total load lifted per day[24] (Table 2). These JEMs have been

Table 2. Job exposure matrices included in the DOC*X database (examples of contents)

Data source	Time-period stratification	Exposure dimensions	Unit(s)	Average probability of exposure across occupations and range within deciles		Average intensity of exposure across occupations and range within deciles		Reference
				Upper decile	Lower decile	Upper decile	Lower decile	
Psychosocial exposures	2012	Quantitative demands	Mean summed item values (range 0–5/6)			3.5 (3.4–3.7)	2.7 (2.3–2.8)	[21]
Self-reported data in a random sample of the employed Danish population, $n = 15,207$ (best linear unbiased prediction)	Sex, age	Emotional demands				4.0 (3.8– 4.2)	2.2 (1.8–2.3)	
		Decision authority				4.4 (4.4–4.6)	3.8 (3.2–4.0)	
		Violence	Exposure yes/no	31% (11– 82)	< 0.01%			
		Job insecurity		32% (26– 55)	< 0.01%			
		Job strain		41% (33– 53)	< 0.01%			
Shoulder exposures	1990–2016	Upper arm elevation >90°	Hours/day			1.2 (0.5–2.8)	0.0 0.0	[23]
Expert ratings, postures and movements validated against measurements	None	Repetitive shoulder movements	Hours/day			4.0 (2.6–6.8)	0.0 0.0	
		Forceful shoulder exertions	Score value (0–4)			1.8 (1.4–3.0)	0.0 0.0	
Lower body exposures	1990–2016	Total load lifted	kg/day			2640 (1940–3500)	80 (0–280)	[24]
Expert ratings	None	Standing/walking	Hours/day			6.8 (6.6–7.5)	2.4 (0.9–3.8)	
		Sitting	Hours/day			5.5 (4.1–7.1)	0.7 (0.6–0.9)	
		Kneeling/squatting	Hours/day			1.6 (1.1–3.5)	0.0 0.0	
Physical exertion and body position	2012	Score based on sitting, standing/walking, kneeling, repetition, twisted back, lifted arms, lifting/carrying, pushing/ pulling	Exposure yes/no	46% (34– 79)	< 0.01			[21]
Random population sample, $n = 15\,207$, predicted probabilities based on self-report	Sex, age							
Noise Expert ratings calibrated by measurements	2001–2010 None	Noise	dB(A) intensity score: 0: <80 dB(A) 1: 80–85 dB(A) 2: >85 dB(A)			2.0	1.0	[52]
Vibration	1990–2016	Whole-body vibration	Hours/day			1.1 (0.4–4.8)	0.0 0.0	[24]
Occupational expert ratings	None							
Particulate airborne exposures	Expert rating:	Mineral dust, organic dust, fumes and vapour	Intensity score: 0, 1, 2			2.0	1.0 (0.0–1.0)	[36–39]
Expert ratings	None							
For wood and endotoxin quantitative JEMs based on measurements	Wood: 1978–2007	Wood dust	μg/m^3 ambient air			1.59 (95-percentile)	0.0 (0.0–0.0)	

(Continued)

Table 2. Continued

Data source	Time-period stratification	Exposure dimensions	Unit(s)	Average probability of exposure across occupations and range within deciles		Average intensity of exposure across occupations and range within deciles		Reference
				Upper decile	Lower decile	Upper decile	Lower decile	
(wood, $n = 12\,704$; endotoxin, $n = 3350$)	Endotoxin: 1992–2008 Country, calendar-time	Endotoxin	μg/m³ ambient air			39.2 (95-percentile)	0.0 (0.0–0.0)	
Chemical agents	1945–1994	Diesel-exhaust	mg/m³ ambient air	87% (85–90)	0.0	0.69 (0.69–0.69)		[10]
Expert ratings calibrated by measurements	15-year periods	Formaldehyde	mg/m³ ambient air	18% (5–90)	0.0	0.18 (0.00–0.50)	0.0	
		Organic solvents	mg/m³ ambient air	10% (1–70)	0.0	5.44 (0.01–0.00)	0.0	
Lifestyle	1970–2013	Tobacco smoking	% smokers	55% (46–74)	13% (6–16)			[41]
Random population sample, $n = 299\,150$ (best linear unbiased prediction)	Sex, age, calendar-time	Body mass index	kg/m²			26.9 (26.5–28.4)	22.8 (21.0–23.3)	
		Alcohol consumption	Item values (range 0–4)			2.0 (1.9–2.3)	1.0 (0.5–1.1)	
		Leisure-time physical activity	Item values (range 0–4)			2.7 (2.5–3.2)	2.0 (1.7–2.0)	
		Fruit/vegetables consumption	Item values (range 0–4)			2.9 (2.8–3.0)	2.3 (2.1–2.4)	

constructed based on expert ratings. The estimates of upper arm elevation and repetition in a range of jobs in the Shoulder JEM have been validated against inclinometer measurements[23] and the Shoulder JEM has shown good predictive validity with respect to surgery for subacromial impingement syndrome.[25–28] The Lower Body JEM was originally evaluated by two external experts, who in general agreed with the ranking of exposures,[24] and the JEM has shown good predictive validity in studies of inguinal hernia repair,[29–31] total hip replacement[32] and surgery for varicose veins.[33] Both mechanical JEMs have shown good predictive validity with respect to sickness absence and permanent work disability in relation to upper- and lower-body pain.[34]

The JEM on physical exertion and body position covers an index score based on self-report in the domains sitting, standing/walking, kneeling, lifted arms, repetitive arm movements, twisted back, lifting/carrying and pushing/pulling. Sex- and age-specific measures have been computed by BLUP estimation (Table 2).[21]

The physical JEMs cover whole-body vibration from the Lower Body JEM[24] and noise measured as A-weighted sound level in decibels (dB) (Table 2). Noise exposure estimates are based on full-shift measurements using personal samplers in a range of occupations[35] in combination with expert ratings.

The particulate airborne exposure JEMs provide data on exposure to mineral dust, organic dust, and fumes and vapours, with exposure intensity categorized as no, medium, and high average exposure (Table 2). This JEM is similar to the ALOHA JEM.[36,37] Furthermore, a wood dust JEM with quantified airborne exposure to inhalable wood dust is available based on 12 704 dust measurements collected between 1978 and 2007 from wood-related industries in Denmark, Finland, the UK, France, Norway and The Netherlands.[38] An endotoxin JEM with quantified airborne exposure to inhalable endotoxin (a major constituent in organic dust) is also available and is based on 3350 dust measurements collected between 1992 and 2008 from agricultural industries in Denmark, Germany, Canada, Norway and The Netherlands.[39]

The chemical JEMs provide calendar time specific (1945–59, 1960–74, 1975–84, 1985–94) exposure intensity and prevalence estimates for potential and confirmed carcinogenic exposures (asbestos, quartz, wood-dust, diesel-exhaust, formaldehyde and selected organic solvents) that have historically been prevalent in Danish workplaces (Table 2). The JEM is based on the template of a Finnish JEM (FINJEM[40]) but includes Danish exposure measurements where possible.[10] The original JEM used occupational codes according to NYK (Nordisk Yrkes Klassifikation), which corresponds to ISCO-1958 and has been translated into DISCO-88.

The lifestyle JEMs cover lifestyle factors associated with both job/industry and health/disability. Lifestyle factors covered are smoking, alcohol consumption, body mass index, leisure-time physical activity and intake of fruit and vegetables (Table 2).[41] The JEMs are based on a collection of representative Danish surveys with in total almost 300 000 participants covering the period from 1973 to 2013, where information on lifestyle factors was collected in consistent ways combined with information on occupation at the time of survey participation. The lifestyle JEMs are computed in a random intercept multilevel model using BLUP estimators by DISCO-88 code. These JEMs are included to facilitate adjustment for potentially confounding lifestyle factors, which are rarely available in nationwide registers. Whereas inclusion of socio-economic status may be used as a proxy for lifestyle factors, socio-economic status (in a Danish register setting) is dependent on occupation, and thus not a good choice when studying occupational health.

(iii) Supplementary data. The third part of the DOC*X database consists of register-based sociodemographic, health and transfer payment data that can be linked with the Occupation and Industry Register on an individual level. These data include sex, date of birth, education, income, migration, death, hospitalizations, transfer payments and labour market exit (Figure 2). A large part of the supplementary data are yearly status data, e.g. age, place of living, family structure (single, cohabitating, married, number of children), income and education, which are found in registers at Statistics Denmark (BEF, FAM, FAIK, UDD).[42] Some data are registered continuously with dates, e.g. migration, retirement and death, which are also found in registers at Statistics Denmark (VNDR, AKM, DODE).[42]

Health outcomes are included in the DOC*X database by individual-level linkage to the National Patient Register[7,43] and the Causes of Death Register.[44] Data on birth outcomes from the Medical Birth Register[45] are also available in the DOC*X database together with linkage between parents and children. Data from the Prescription Register[46] and specialized registers on specific diseases (e.g. cancer[47] and heart disease[48]) may be included on a study-by-study basis.

Data on transfer payments (e.g. sickness absence, disability pension, age pensioning and early retirement) are included from the Danish National Register on Public Transfer Payments (The DREAM database) starting in 1991.[49–51] These supplementary data enable categorization of periods of unemployment due to various reasons and studies of return to work.

What has been found? Key findings and publications

Using the DOC*X database, we have analysed the rate of permanent retirement from the labour market (disability pension, age pensioning and early retirement using data from the Danish National Register on Public Transfer Payments) according to major DISCO-88 groups in the Occupation and Industry Register (Figure 3), and according to occupational exposure to total load lifted per day by use of the Lower Body JEM[24] (Table 3; Figure 4). We calculated sex- and time-period- (in 5-year groups) specific age-standardized retirement rate ratios, using the average sex-specific retirement rates in the entire period as reference. Major group '0, Armed forces' was excluded, as the pensioning scheme of the armed forces differs from the rest of the labour market, and 'Skilled agricultural and fishery workers' was excluded among women due to few persons. Substantial differences in retirement rates across DISCO-88 major groups were seen throughout the 25-year period, with higher rates in DISCO-88 major groups 5–9 (manual occupations), but a strong attenuation of differences from the mid-1990s. We observed a similar pattern of attenuation of differences after 2000 in manual occupations stratified according to quartiles of total load lifted per day (Figure 4).

Other examples of research that has applied DOC*X JEMs to nationwide data, are studies addressing risk of cardiovascular disease in relation to noise at the workplace[52,53] and studies of amyotrophic lateral sclerosis in relation to exposure to formaldehyde and diesel exhaust.[54] See also examples mentioned in the description of the mechanical JEMs.[25–34]

What are the main strengths and weaknesses?

The main strengths are the nationwide inclusion of the major part of the Danish workforce, the more than 40 years coverage of the Occupation and Industry Register, and the comprehensive inventory of JEMs. In addition, the availability of supplementary data with almost complete follow-up covering the entire cohort enables detailed analyses of associations between occupational exposures and disease and disability outcomes with adjustment for other potentially influential factors including lifestyle.

The main weaknesses are the incomplete registration of DISCO codes in the Occupation and Industry Register, with up to 23% missing data in some time periods, particularly for companies with <10 employees, where report of occupational title is not mandatory, and lack of specificity for some DISCO codes, as even the most detailed 4th digit level may include several different occupations, which may convey different exposures. These issues may be resolved by selection of DISCO-88 codes with high completeness and specificity of registration—possibly in

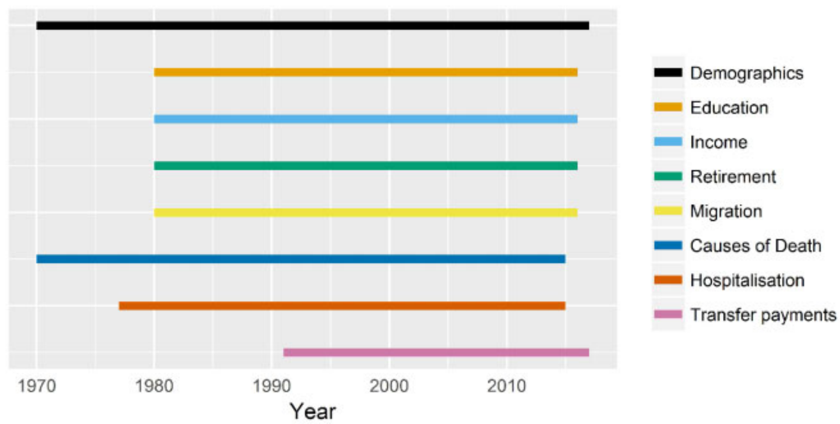

Figure 2. Supplementary data in the DOC*X database with years of availability.

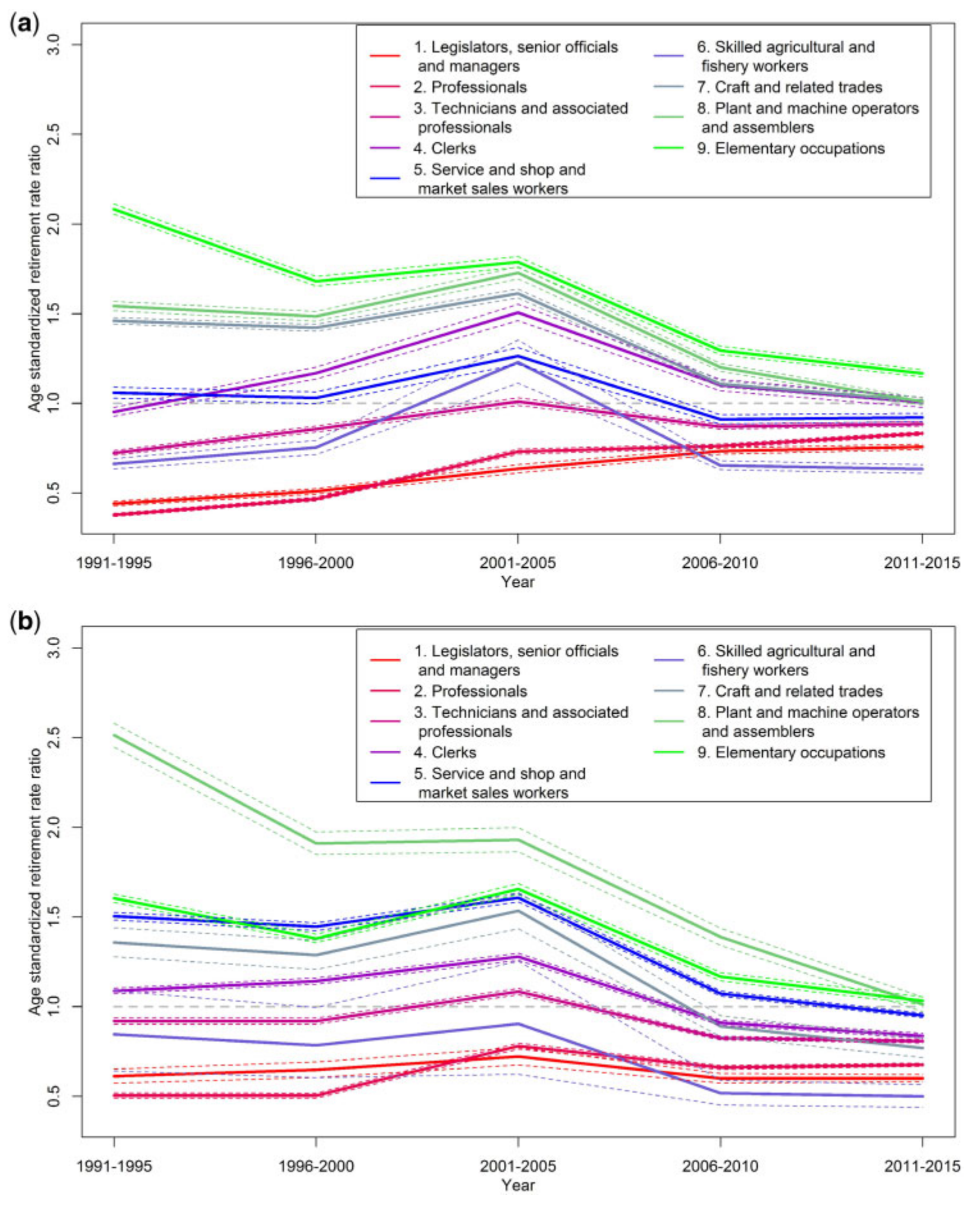

Figure 3. Age-standardized retirement rate ratio (and 95% confidence limits) in Denmark according to DISCO-88 major groups 1991 to 2015 for men (a) and women (b). DISCO-88 is the Danish version of the International Classification of Occupations version 1988.

Table 3. Percentage distribution of total load lifted per day according to The Lower Body JEM (job exposure matrix)[24] by calendar year periods

	Total load lifted per day		
Year[a]	Unknown[b]	Negligible	>Negligible–3500 kg
1981–1985	40	25	35
1986–1990	41	26	33
1991–1995	30	29	41
1996–2000	22	35	43
2001–2005	31	32	38
2006–2010	23	35	41
2011–2015	19	42	40

[a]The Lower Body JEM, which covers the period from 1990 onwards, is also applied before 1990 to illustrate the percentages of person-years with unknown exposure status throughout the period covered by the DOC*X database. The percentages do not always add up to 100% due to rounding.

[b]Due to unknown DISCO code.

combination with industry codes, which are also part of the DOC*X database. To remedy these shortcomings, we currently work to include information from the Register of the Danish Labour Market Supplementary Pension Scheme (Arbejdsmarkedets TillægsPension — a mandatory employer paid pension scheme), containing employment period and industry information, but lacking occupational titles, on all Danish employees from 1964 onwards. The validity of the DOC*X occupational titles following the DISCO-88 classification using time-specific self-reported information on occupation as gold standard is outlined in a separate forthcoming paper (SE Bondo-Petersen *et al.*, submitted for publication). A tabulation of the agreement between DISCO-88 codes and self-reported occupation will be available for specific DISCO-88 codes at the DOC*X website (www.doc-x.dk) to assist researchers in selecting relevant occupations with the most complete and valid DISCO-88 codes.

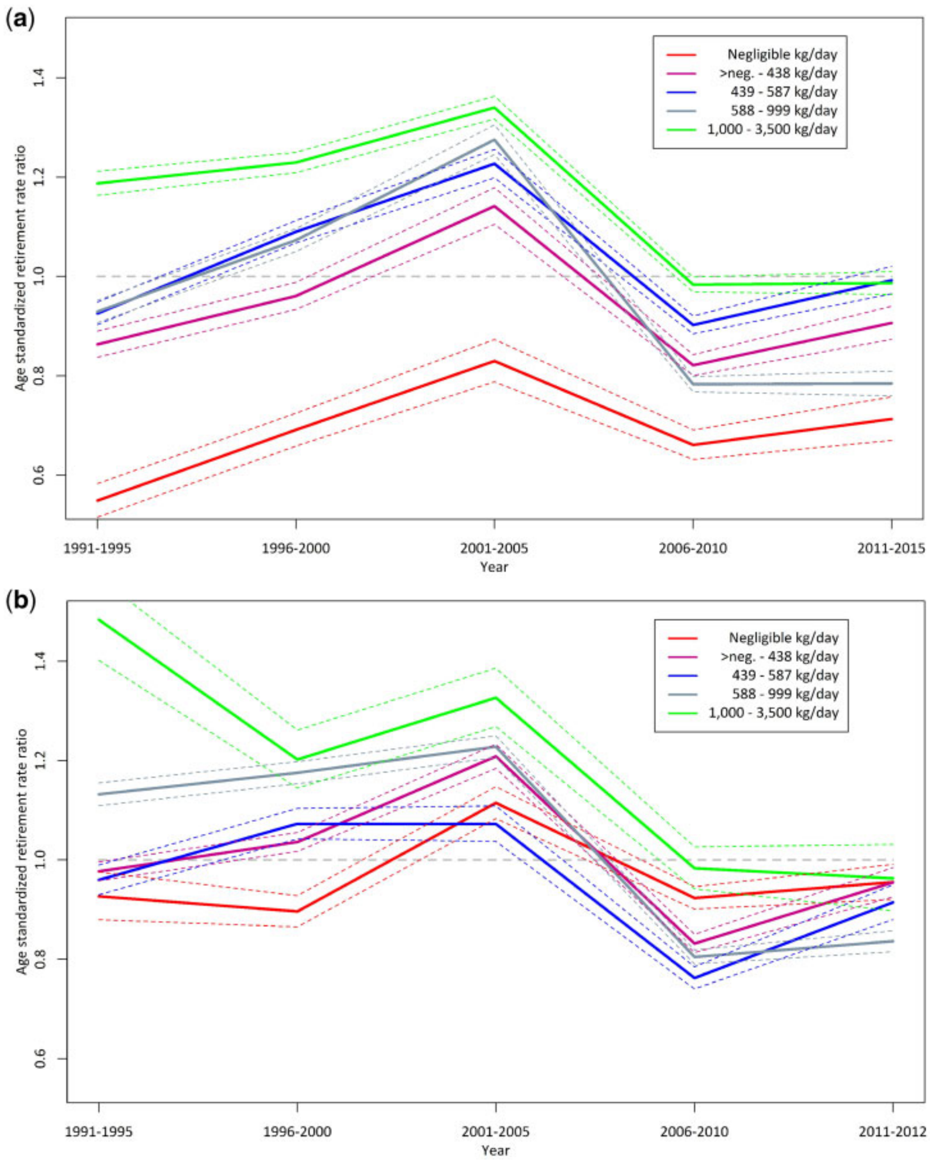

Figure 4. Age-standardized retirement rate ratio (and 95% confidence limits) in Denmark in DISCO-88 groups 5–9 according to total load lifted per day quantified by The Lower Body Job Exposure Matrix[24] 1991 to 2015 for men (a) and women (b). DISCO-88 is the Danish version of the International Classification of Occupations version 1988.

Further, the registers carry little information on lifestyle factors, which may be important confounders of the association between occupational exposures and health outcomes. Thus JEMs on lifestyle factors were constructed as an integrated tool in the database to explore and quantify such potential biases.[41]

Finally, JEM-based exposure assessment may be inherently affected by non-differential misclassification since JEMs do not capture variation of exposure within job groups, which may be large, compared with the variation between job groups. This problem may be addressed in a large cohort like DOC*X by carefully selecting occupations with large contrast of the exposure of interest (i.e. large variation between job groups relative to the variation within job groups). Moreover, misclassification by occupational titles is to some degree cancelled out by the JEM, as misclassification into related DISCO-88 codes results in similar exposure levels. Furthermore, the group-based exposure assessment that is inherent in JEMs reduces some bias issues regarding measurement errors and misclassification, as the main part of the error will be Berkson type rather than classical error.[55] Therefore the expected attenuation of truly elevated risk estimates due to non-differential misclassification of exposure is small or non-existent in some cases.[55] However, the JEM estimates remain measures of average exposure at the DISCO group level. This means that power will be lost compared with a situation where individual exposure levels are present, but this may not be critical given the large sample size of the DOC*X cohort.

Can I get hold of the data? Where can I find out more?

Permission to use data is obtained through the DOC*X executive committee at Bispebjerg-Frederiksberg Hospital. Further information on contents of the DOC*X database, and on how to gain access, is available at the DOC*X website: www.doc-x.dk/en. Individual-level data in the DOC*X database are available through online access at Statistics Denmark under standard conditions.

Profile in a nutshell

- The cohort was setup to broaden possibilities for register-based research in occupational health, with a nationwide occupational classification of the major part of the Danish workforce in 1970 and from 1976 to 2015.
- The cohort covers the major part of the Danish working population from age 16 in the period from 1970 to 2015 comprising approximately 6.4 million persons.
- The register-based nature of the cohort ensures yearly follow-up on occupations and continuous follow-up on most outcomes from 1970 or 1980 to 2015 and onwards.
- The cohort contains yearly information on employment status, occupation and industry in a harmonized coding across time. Translation into occupational exposures is done by means of job exposure matrices.
- Suggestions for collaboration should be sent to Esben.meulengracht.flachs@regionh.dk or Sesilje.elise.bondo.petersen@regionh.dk at The Department of Occupational and Environmental Medicine, Bispebjerg University Hospital, Copenhagen, Denmark. The DOC*X website: www.doc-x.dk/en contains further information on access to individual-level data, which is available through online access at Statistics Denmark under standard conditions.

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Original article

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Influence of errors in job codes on job exposure matrix-based exposure assessment in the register-based occupational cohort DOC*X

by Petersen SB, Flachs EM, Svendsen SW, Marott JL, Budtz-Jørgensen E, Hansen J, Stokholm ZA, Schlünssen V, Andersen JH, Bonde JP

We found substantial agreement between job-exposure-matrix-derived exposure estimates according to DISCO-88 codes based on self-reported job-titles and registered in the Danish Occupational Cohort with eXposure data (DOC*X), with respect to airborne, mechanical, and physical exposures. Substantial agreement was also found between the two sets of DISCO-88 codes. The results are promising with respect to future studies based on the DOC*X.

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Key terms: arm elevation; DOC*X; epidemiology; exposure; ISCO-88; JEM; job code; job code error; job exposure matrix; lifting; metal dust; noise; occupation; occupational cohort ; shoulder; standing; validity; walking; wood dust

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Additional material

Please note that there is additional material available belonging to this article on the *Scandinavian Journal of Work, Environment & Health* -website.

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Influence of errors in job codes on job exposure matrix-based exposure assessment in the register-based occupational cohort DOC*X

by Sesilje B Petersen, PhD,[1] Esben M Flachs, PhD,[1] Susanne W Svendsen, PhD,[2] Jacob L Marott, MSc,[3] Esben Budtz-Jørgensen, PhD,[4] Johnni Hansen, PhD,[5] Zara Ann Stokholm, PhD,[6] Vivi Schlünssen, PhD,[6, 7] Johan Hviid Andersen, PhD,[2] Jens Peter Bonde, MD [1]

Petersen SB, Flachs EM, Svendsen SW, Marott JL, Budtz-Jørgensen E, Hansen J, Stokholm ZA, Schlünssen V, Andersen JH, Bonde JP. Influence of errors in job codes on job exposure matrix-based exposure assessment in the register-based occupational cohort DOC*X. *Scand J Work Environ Health* – online first. doi:10.5271/sjweh.3857

Objective Job-exposure matrices (JEM) may be efficient for exposure assessment in occupational epidemiological studies, but they rely on valid job information. We evaluated the agreement between JEM-based exposure estimates according to self-reported job titles converted to DISCO-88 codes and according to register-based DISCO-88 codes in the Danish Occupational Cohort with eXposure data (DOC*X). Furthermore, we evaluated the agreement between these two sets of DISCO-88 codes.

Methods We used JEM regarding wood dust, lifting, standing/walking, arm elevation >90°, and noise from DOC*X. Participants from previous questionnaire studies were assigned JEM-based exposure estimates using (i) self-reported job titles converted to DISCO-88 codes and (ii) DISCO-88 codes registered in DOC*X, in four time periods (1976–78: N=7707; 1981–83: N=2193; 1991–94: N=2664; 2004: N=11 782). Agreement between the exposure estimates and between the DISCO-88 codes (four-digit levels, 1–4) was evaluated by kappa (κ) statistics. Sensitivities were calculated using the self-reported observation as the gold standard.

Results We found substantial agreement (κ>0.60) between exposure estimates for all types of job-exposures and all time periods except for one κ. Low sensitivity (30–65%) was found for the period 1981–83, but for the other time periods the sensitivities varied between 60–91%. For individual 4-digit DISCO-88 codes, the sensitivities varied substantially and overall the sensitivities increased by lower digit level of DISCO-88.

Conclusion The validity of the DISCO-88 codes in DOC*X was generally high. Substantial agreement was found for the JEM-based exposure estimates and the DISCO-88 codes per se, although the DISCO-88 code-specific agreement varied across digit levels and time periods.

Key terms arm elevation; epidemiology; ISCO-88; JEM; job code error; lifting; metal dust; noise; occupation; shoulder; standing; validity; walking; wood dust.

Since the late 1970s, job-exposure matrices (JEM) have been increasingly used to obtain exposure estimates in occupational epidemiological studies. A JEM is a cross-tabulation of job titles or occupational codes and occupational exposures, preferably for a specific time window (1–4). JEM can be used in large epidemiological studies where methods based on individual interview data, observation, or technical measurements would be very costly. Other important advantages are that JEM can be used to estimate both current and past exposures and minimize the risk of information bias compared to individual-based self-report methods (2, 5, 6).

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The validity of occupational exposure estimates assigned to individuals by means of JEM depends on the quality of information about exposures in specific jobs in different time periods, as well as on correct job titles or occupational codes (7). The latter aspect of JEM validity is particularly important when occupational codes are retrieved from national registers, without occupational research as the primary objective. While the validity of exposures assigned by JEM has been examined in a number of publications (8–13), the validity of the job titles and occupational codes per se has seldom been examined (7, 14). Incorrect occupational codes in registers may be the result of erroneous reporting from the primary sources (eg, tax agents, companies) and – if classification systems have changed over time – errors in translation from one classification system to another. Therefore, the validity of registered occupational codes may vary between industries and occupations and across time periods.

The Danish Occupational Cohort with eXposure data (DOC*X) is a nationwide cohort for occupational research containing occupational histories in terms of year-by-year codes according to the Danish version of the International Standard Classification of Occupations (DISCO) on an individual level from 1970 through 2015 with ongoing updates. DOC*X is an open research resource that provides opportunities to perform register-based epidemiological studies of occupational exposures by use of JEM (15). The validity of the DISCO codes in the nationwide registers, which form the foundation of DOC*X, has not been investigated.

The overall aim of this study was to evaluate the validity of DISCO codes in DOC*X. Specific aims were to evaluate (i) the agreement between JEM-based exposure estimates according to self-reported job titles converted to DISCO codes and according to register-based DISCO codes in DOC*X; and (ii) the agreement between these two sets of DISCO codes per se.

Methods

Danish Occupational Cohort with eXposure data (DOC*X)

DOC*X is a nationwide database including 6.4 million residents in Denmark from the age of 16, who have been gainfully employed at a private or public workplace in Denmark from 1970 through 2015 (15–17). The database has been compiled and is updated at a secured platform at Statistics Denmark. The backbone of the database is the information on occupation and industry, which includes calendar specific DISCO-88 codes for each individual based on the 1970 Census (16) and the Employment Classification Module (1976–2015) (17). The Employment Classification Module has used three classifications: (i) a scheme developed by Statistics Denmark based on ISCO-68 (1976–1990), (ii) DISCO-88 (1991–2009), and (ii) DISCO-08 (2010 onwards) (15). In DOC*X, the different coding versions have been harmonized to DISCO-88 codes in a code-by-code manner as described previously (15). The codes vary in detail from 1- to 4-digit levels, of which the last-mentioned is the most detailed. The annual DISCO-88 code for each individual is defined by the job with the highest income during each calendar year. We extracted annual DISCO-88 codes by use of the personal identifier (18).

Population used for validation

From 1976–1994, we used occupational data from the Copenhagen City Heart Study (CCHS). In total, 19 698 men and women from the center of Copenhagen were randomly drawn from the Copenhagen Population Register. The sample was age-stratified within 5-year age groups from 35–70 years of age. All participants completed a self-administrated questionnaire in 1976–1978, including a freeform question about current job title (N=14 223). Follow-up studies with information on job title were completed in 1981–83 (≥500 20–25-year-olds) and in 1991–94 (≥3000 20–49 year-olds) (19, 20). The proportions that responded were 73.6% at baseline and 70.2% and 61.2% at follow-up. In the beginning of 2016, the job title text strings from the stored questionnaires were digitalized and assigned DISCO-88 codes by three librarians, who worked independently. The codes were cross-checked and a supervising occupational health specialist resolved discrepancies.

For 2004, we used data from the ASUSI cohort of 14 266 men and women, who completed a questionnaire in a population-based study of working environment and sickness absence (ASUSI is a Danish acronym for working environment, sickness absence, premature exit from the labor market, social inheritance, and intervention) (21). Two trained sociologists digitalized the job title text strings from the questionnaires assigned DISCO-88 codes. Only persons who had been in employment for ≥80% of the time during the previous year or had been employed for 6 out of the 12 weeks preceding 1 July 2004 were included.

Assessment of occupational exposure intensities

We assessed five types of exposure using four JEM:

Wood dust estimates were assessed using a wood dust JEM based on expert ratings and 12 704 measurements collected in 1978–2007 in wood related industries in six European countries (22, 23). We dichotomized the exposures as non-exposed and exposed because wood dust exposure was rare in the study population.

Lifting and standing/walking estimates were assessed using the Lower Body JEM (24) . Five Danish occupational health physicians with a minimum of 10 years of experience rated the exposures. We categorized the lifting exposures as described previously (25–28) (0=non-exposed, 1=medium exposed (>0–<1000 kg/day), and 2=highly exposed (≥1000 kg/day)) and divided the exposure estimates for standing/walking into three groups [(0=non-exposed (0 hours/day), 1=medium exposed (>0–5.9 hours/day), and 2=highly exposed (≥6.0 hours/day)] according to previously used categories (27, 28).

Work with the arms elevated >90° estimates were assessed using the Shoulder JEM, which is based on expert ratings by five Danish occupational health physicians with a minimum of 10 years of experience (29–32). The expert rated estimates of time spent working with the arms elevated >90° (hours/day) have been validated against technical measurements (13). We divided the exposure estimates according to previously used cut-off value for high exposure (0=non-exposed, 1=medium exposed (>0-0.4 hours/day), and 2=highly exposed (≥0.5 hours/day) (32, 33).

Noise was assessed using the Noise JEM (35, 36), which is based on personal dosimeter measures of occupational noise exposure in the periods 2001–03 and 2009–10 among 1140 workers (1343 measurements) within the ten industries with the highest reporting of noise induced hearing loss according to the Danish Working Environment Authority. The measurements represented 100 occupational titles according to the DISCO-88 system. Four experts rated the noise intensity levels for the remaining jobs using 35 benchmark groups. Their ratings were used to construct an expert score dependent on sex, age, and calendar time (34, 35). We used the categorical variable for noise exposure (0=<80 dB, 1=80-84 dB, 2=≥85dB), based on ISO-1999 thresholds (35, 36).

We assigned exposure estimates to individuals in the CCHS/ASUSI cohorts with DISCO-88 codes for which a JEM exposure estimate was available. The estimates were assigned by connecting the JEM with their calendar-year specific DISCO-88 codes based on self-report and their DISCO-88 codes in DOC*X for the specific calendar year.

Statistical methods

From both cohorts (CCHS and ASUSI) and each time period, we excluded persons, who stated that they were unemployed or had retired. For each exposure and time period, the final population included only individuals with both sets of DISCO-88 codes and only DISCO-88 codes with ≥10 self-reported observations (37). Furthermore, we only included observations where JEM-based exposure estimates were available for both sets of codes.

We computed kappa coefficients (κ) with 95% confidence intervals (CI) for exposures with two exposure categories (wood dust) and weighted κ with 95% CI for exposures with three exposure categories (all other exposures). Additionally, we in 3×3 tables computed sensitivity (the percentage of true exposure categorizations for the highest exposed individuals) and specificity (the percentage of true exposure categorizations for the non-exposed individuals) based on self-report as the gold standard. This means that the medium exposed groups not were included in the interpretation of sensitivity and specificity. We also assessed the sensitivity and agreement (weighted κ) between the DISCO-88 codes per se (specificity was not assessed because it would always be very high due to the low frequency of persons in any DISCO-88 group compared to the total number of persons in the study). Sensitivity was calculated as the percentage of true registrations within each DISCO-88 code digit level (1–4) taking the DISCO-88 codes based on self-report as the gold standard. In addition to the agreement at 1-, 2-, 3-, and 4-digit levels, we computed weighted κ coefficients by time period (1976–78; 1981–1983; 1991–1994; 2004) at DISCO-88 1-digit level (DISCO-88 major groups). We interpreted the κ coefficients as: <0=poor, 0.00–0.20=slight, 0.21–0.40=fair, 0.41–0.60=moderate, 0.61–0.80=substantial, and 0.81–1.00=almost perfect agreement (38). SAS software, version 9.4, (SAS Institute Inc, Cary, NC, USA) was used.

Results

Table 1 presents the number of DISCO-88 codes according to time period, including all digit levels of DISCO-88 (based on self-reported job titles), that met the inclusion criteria of minimum ten observations in our final study dataset. These codes represented 29–56% of the total number of codes, including all digit levels of the DISCO-88 system, with the lowest percentage in 1991–94 and the highest in 2004. The number of individuals in each time period is also shown; their distribution across DISCO-88 groups is presented in supplementary table S1, www.sjweh.fi/show_abstract.php?abstract_id=3857.

As seen in table 2, our data showed substantial agreement between JEM-based exposure estimates according to the two sets of DISCO-88 codes based on self-reported job titles and registrations in DOC*X, except for noise in 1981–83. Across time, both the sensitivities and κ estimates were lowest for the time period 1981–83. Overall, the specificities were high showing substantial agreement for the non-exposed individuals.

Table 1. Number of individuals with two sets of DISCO-88 (Danish version of the International Standard Classification of Occupations from 1988) codes including all (1–4) digit levels of DISCO that met the inclusion criteria of ≥10 self-reported observations.

Time period	N (≥10) [a] DISCO-88 codes	% (≥10) [b] DISCO-88 codes	Final population number of individuals
1976–78	215	44	7707
1981–83	180	37	7193
1991–94	142	29	2664
2004	271	56	11 782

[a] Number of DISCO-88 groups available for validation in the final population out of 486 groups in the DISCO-88 classification system including all (1–4) digit levels.

[b] Percent of DISCO-88 groups, including all (1–4) digit levels of DISCO, available for validation in the final study sample.

Table 3 shows that the agreements between the two sets of DISCO-88 codes were substantial across 1-, 2-, 3-, and 4-digit levels. The highest κ estimates were seen for the 4-digit DISCO-88 group level with estimates between 0.73–0.81. The sensitivities varied between 51.5–73.2% and were highest for the 1-digit DISCO-88 level. As seen in table 4, the DISCO-88 code specific agreement at 1-digit level varied from fair to almost perfect across time periods (κ=0.34–0.91). Group 0 (armed forces) had almost perfect agreement, whereas group 1 with legislators, senior officials, and managers showed the lowest agreement; no time trends were evident. The sensitivities generally showed the same pattern as the κ-values.

Sensitivities for individual DISCO-88 codes, according to time period, are presented in supplementary table S1. The highest sensitivities across all time periods were found for dentists (2222; 96.2%); nursing associate professionals (3231; 95.0%); police officers (5162; 92.2%); medical doctors (2221; 91.5%); jewelry and precious-metal workers (7313; 91.3%); bakers, pastry-cooks and confectionery-makers (7412; 89.3%); and primary education teaching professionals (2331; 89.8%). Prison guards (5163) and travel attendants (5111) and travel stewards had 100% sensitivity in 2004, but not enough observations for the other time periods. In general, low sensitivities were found across all time periods for business services agents and trade brokers not elsewhere classified (3429; 1.7%); production clerks (4132; 6.2%); other teaching associate professionals (3340; 6.5%); advertising and public relations managers (1234; 7.4%); finance and sales associate professionals not elsewhere classified (3419; 10.1%); safety, health and quality inspectors (11.7%; 3152); receptionists and information clerks (4222; 12.3%); and buyers (3416; 13.5%).

Discussion

Job titles and occupational codes constitute a crucial basis for the use of JEM, but errors in job titles and assignment of occupational codes have received minimal scientific attention. The present study benefitted from exposure data from JEM concerning five airborne, mechanical, and physical exposures. Self-reported job titles for the CCHS/ASUSI cohorts were translated into DISCO-88 codes, which were connected with the JEM to provide exposure estimates, which were then compared to JEM-based exposure estimates according to DISCO-88 codes registered in DOC*X. High sensitivities and substantial agreement was found for the JEM-based exposure estimates and for the DISCO-88 codes per se, although the DISCO-88 code-specific agreement varied across digit levels and across time periods.

The number of individuals in the study population from 1991–94 was low since only about one third of the individuals with a self-reported job title had a DISCO-88 code in DOC*X. An explanation may be the higher mean age in the population by calendar time as the main part of the population was included in 1976 with an age of up to 70 years at that time. For example, if they retired from the workforce before 1991, they have no DISCO code registered in DOC*X database for the time-period 1991–94. The classification system used by Statistics Denmark changed in 1981 and 1993, which may be an explanation for lower agreement observed in the period 1981–83, and again in 1991–94. In 1981–83, the classification system was less detailed than the DISCO-88 system. This means that it was very difficult to translate specific job groups from that time-period to DISCO-88 codes. Therefore, discrepancies between DISCO-88 codes may be because of translation difficulties rather than exact differences between jobs. Because of the less detailed job groups in 1981–83, the solution was to translate job titles to less detailed DISCO-88 group levels. The system for code assignment also changed in 1991, when the DISCO-88 classification system was introduced by Statistics Denmark. The DISCO-88 was based on the ISCO-88. Before 1991, the occupational codes were assigned by trained coders at Statistics Denmark based on self-reported information and union membership, but from 1991 the system was automatized and based on tax records and other personal register information. This shift in code assignment led to a temporary reduction of data reporting, which probably also contributed to the low number of individuals in the final study population for 1991–94.

The variation across DISCO-88 codes probably reflected variations in the accuracy by which DISCO codes are reported to the central authorities. Reporting to Statistics Denmark from large public and private com-

Table 2. Sensitivity, specificity, and agreement between occupational exposures assigned by job-exposure matrices (JEM) according to self-reported job titles converted to DISCO-88 codes and according to DISCO-88 codes registered in the Danish Occupational Cohort with eXposure data (DOC*X). For each exposure and time period, the final population included only individuals with both sets of codes, only DISCO-88 codes with ≥10 self-reported observations were included, and only DISCO-88 codes for which there is a JEM-exposure estimate. [CI=confidence interval; DISCO-88=Danish version of the International Standard Classification of Occupations from 1988; κ=kappa coefficient]

Exposure time period	Self-reported N non/medium/high	Registered N non/medium/high	Sensitivity [a]	Specificity [b]	Agreement weighted κ, (95% CI)
Wood dust [c]					
1976–1978 [d]	6448/ – /119	6446/ – /121	90.9	99.9	0.91 (0.88–0.95) [f]
1981–1983 [d]	4295/ – /37	4294/ – /38	63.2	99.7	0.64 (0.51–0.76) [f]
1991–1994 [d]	1712/ – /14	1710/ – /16	85.7	99.8	0.80 (0.64–0.96) [f]
2004 [e]	9465/ – /230	9479/ – /216	76.1	99.7	0.78 (0.74–0.82) [f]
Lifting					
1976–1978 [d]	2854/2755/944	2655/2695/1203	60.3	89.6	0.71 (0.70–0.72)
1981–1983 [d]	2196/1638/465	2108/1785/406	47.3	88.9	0.64 (0.63–0.66)
1991–1994 [d]	904/585/198	817/665/205	76.6	94.6	0.78 (0.75–0.81)
2004 [e]	4358/2777/1783	4383/2826/1371	80.2	84.8	0.72 (0.70–0.73)
Standing/walking					
1976–1978 [d]	2776/2032/1745	2619/2698/1236	78.8	89.5	0.68 (0.67–0.70)
1981–1983 [d]	2160/1242/897	2070/1140/1089	61.5	89.4	0.68 (0.66–0.70)
1991–1994 [d]	882/507/298	811/575/301	76.4	94.6	0.78 (0.75–0.80)
2004 [e]	4347/3224/1347	4379/3122/1417	68.2	84.8	0.69 (0.67–0.70)
Arm elevation >90°					
1976–1978 [d]	2790/2646/1083	2645/2988/886	86.0	91.4	0.78 (0.77–0.80)
1981–1983 [d]	2235/1503/594	2090/1344/898	57.9	89.8	0.70 (0.68–0.72)
1991–1994 [d]	941/624/179	891/632/179	71.9	92.1	0.78 (0.75–0.80)
2004 [e]	4875/3379/1384	5146/3016/1476	73.8	82.2	0.69 (0.68–0.70)
Noise					
1976–1978 [d]	4713/1516/387	4568/1663/385	75.1	94.0	0.75 (0.73–0.76)
1981–1983 [d]	3482/777/73	3251/954/127	29.9	93.8	0.56 (0.53–0.58)
1991–1994 [d]	1345/386/15	1319/400/27	73.3	94.3	0.78 (0.75–0.81)
2004 [e]	6504/2634/587	6703/2473/549	60.8	93.2	0.72 (0.70–0.73)

[a] The percentage of true registrations for the highest exposed individuals.
[b] The percentage of true registrations for the non-exposed individuals.
[c] Dichotomized (non-exposed/exposed)
[d] Observations from the Copenhagen City Heart Study.
[e] Observations from the ASUSI study. (ASUSI is a Danish acronym for working environment, sickness absence, premature exit from the labor market, social inheritance, and intervention)
[f] For wood dust the κ and 95% CI are not weighted.

panies is undertaken by trained staff according to written guidelines, while small private companies with fewer resources may provide less accurate DISCO codes. It is only mandatory for Danish companies with ≥10 employees to report information on occupation, and therefore significant differences in accuracy may be expected.

The misclassification of JEM-based individual exposures assigned by using DISCO-88 codes in DOC*X seems less than might be expected based on comparison of the sensitivities for the DISCO-88 codes per se; overall, the sensitivities were higher when comparing JEM-based exposure estimates than when comparing the two sets of DISCO-88 codes (especially at the 3- and 4-digit levels). This is because DISCO-88 codes belonging to similar job groups in the JEM are assigned similar job-exposures (7, 14). For example, the noise JEM will assign the same low level of noise exposure to all types of office workers regardless of the specific DISCO-88 code. Lack of agreement between two sets of DISCO-88 codes will therefore not necessarily affect the agreement between JEM-based exposure estimates.

The variation in agreement between the two sets of individual DISCO-88 codes seems to depend on characteristics of the jobs covered by the code. In general, the codes with lowest sensitivities are broadly defined and not specified, eg, business services agents and trade brokers not elsewhere classified, other teaching associate professionals, and finance and sales associate professionals not elsewhere classified. The two last-mentioned groups will probably be classified as other kinds of office workers, which will reduce the effect of the misclassification on the assigned JEM-based exposure estimates (see above). Another possibility is to exclude DISCO codes with low sensitivities in epidemiological studies (at least in sensitivity analyses) as they may increase the risk of misclassification of exposures. Thus, the actual validity of the DISCO-codes per se may be significantly higher in cleaned data prepared for analysis.

Strengths and limitations

One strength of our study is that we have data from four different time periods during a 24-year long period where Statistics Denmark used different classification systems of occupations in their registers. Furthermore, we have access to self-reported job titles. It may

Table 3. Sensitivity and agreement between self-reported job titles converted to DISCO-88 codes and DISCO-88 codes registered in the Danish Occupational Cohort with eXposure data (DOC*X) at 1-4-digit levels. [CI=confidence interval; DISCO-88=Danish version of the International Standard Classification of Occupations from 1988; κ= kappa coefficient]

	Self-reported [a]	Registered [b]	Final population [c]	Sensitivity [d]	Agreement
	N	% (N)	% (N)		κ, (95% CI)
1976–1978 [e]					
4-digit	10 443	73.8 (7708)	55.8 (5824)	66.3	0.77 (0.76–0.79)
3-digit	10 933	74.3 (8124)	65.7 (7182)	61.4	0.71 (0.70–0.72)
2-digit	11 335	71.7 (8128)	66.1 (7491)	67.1	0.71 (0.70–0.73)
1-digit	11 688	72.1 (8430)	65.9 (7707)	70.6	0.73 (0.72–0.74)
1981–1983 [e]					
4-digit	9319	55.8 (5204)	42.6 (3973)	59.4	0.74 (0.72–0.75)
3-digit	9744	69.8 (6804)	65.2 (6352)	54.4	0.69 (0.68–0.71)
2-digit	10 041	69.8 (7012)	68.3 (6856)	60.8	0.69 (0.67–0.70)
1-digit	10 311	69.8 (7199)	69.8 (7193)	65.5	0.69 (0.67–0.70)
1991–1994 [e]					
4-digit	8186	28.4 (2322)	17.6 (1443)	71.4	0.81 (0.79–0.83)
3-digit	8552	28.6 (2447)	23.9 (2042)	65.5	0.72 (0.70–0.75)
2-digit	8753	28.8 (2522)	28.0 (2451)	69.4	0.72 (0.70–0.74)
1-digit	8992	29.7 (2668)	29.6 (2664)	73.2	0.73 (0.71–0.75)
2004 [f]					
4-digit	13 858	77.9 (10 794)	65.4 (9064)	51.5	0.73 (0.72–0.74)
3-digit	13 892	78.4 (10 891)	72.9 (10 134)	56.6	0.72 (0.71–0.73)
2-digit	13 892	82.6 (11 469)	75.9 (10 540)	64.1	0.72 (0.71–0.73)
1-digit	14 266	84.5 (12 048)	82.6 (11 782)	65.8	0.71 (0.70–0.72)

[a] Number of individuals with a DISCO-88 code based on self-reported job-titles within each DISCO-88 code digit level.
[b] Number of individuals also registered in DOC*X within each DISCO-88 code digit level.
[c] For each exposure and time period, the final study sample includes observations with both sets of codes, and only DISCO-codes with at least 10 self-reported observations overall in the sample.
[d] The percentage of true registrations within each DISCO-88 code digit level based on self-reported job-title as the gold standard.
[e] Agreement between registered DISCO-88 codes in DOC*X and self-reported job titles converted to DISCO-88 codes based on the Copenhagen City Heart Study.
[f] Agreement between registered DISCO-88 codes in DOC*X and self-reported job titles converted to DISCO-88 codes based on the ASUSI cohort.

Table 4. Sensitivity and agreement between DISCO-88 codes (major group level) registered in the Danish Occupational Cohort with eXposure data (DOC*X) and DISCO-88 codes assigned from self-reported job titles according to time period. [CI=confidence interval; DISCO-88=Danish version of the International Standard Classification of Occupations from 1988; κ= kappa coefficient]

DISCO Group [a]	1976–1978			1981–1983			1991–1994			2004		
	N [b]	Sensitivity [c] (%)	Agreement [d] κ, (95% CI)	N [b]	Sensitivity [c] (%)	Agreement [d] κ, (95% CI)	N [b]	Sensitivity [c] (%)	Agreement [d] κ, (95% CI)	N [b]	Sensitivity [c] (%)	Agreement [d] κ, (95% CI)
0	55	96.4	0.91 (0.86–0.97)	48	97.9	0.87 (0.80–0.94)	10	90.0	0.86 (0.70–1.00)	83	90.4	0.71 (0.64–0.78)
1	303	57.4	0.43 (0.39–0.48)	340	40.0	0.38 (0.33–0.43)	155	56.8	0.46 (0.40–0.53)	994	33.3	0.41 (0.37–0.44)
2	933	82.1	0.82 (0.80–0.84)	995	78.7	0.73 (0.71–0.75)	665	78.0	0.78 (0.75–0.80)	2258	71.4	0.69 (0.68–0.71)
3	1038	67.8	0.56 (0.53–0.59)	1054	54.8	0.53 (0.50–0.56)	557	68.4	0.62 (0.58–0.66)	2487	67.0	0.52 (0.50–0.53)
4	1549	81.7	0.70 (0.68–0.72)	1481	75.3	0.72 (0.70–0.74)	411	77.1	0.72 (0.69–0.76)	1130	68.0	0.52 (0.50–0.55)
5	1125	50.7	0.53 (0.50–0.56)	985	56.4	0.56 (0.53–0.59)	274	72.3	0.71 (0.67–0.76)	1630	80.7	0.76 (0.74–0.77)
6	20	75.0	0.77 (0.62–0.92)	20	55.0	0.40 (0.23–0.56)	11	54.5	0.54 (0.29–0.79)	61	57.4	0.52 (0.42–0.63)
7	1243	82.8	0.83 (0.81–0.84)	903	75.6	0.79 (0.77–0.81)	255	79.6	0.77 (0.73–0.81)	1150	77.0	0.70 (0.68–0.72)
8	489	68.7	0.60 (0.57–0.64)	504	39.3	0.34 (0.30–0.38)	98	64.3	0.57 (0.49–0.65)	974	54.1	0.56 (0.54–0.59)
9	952	55.8	0.57 (0.54–0.60)	863	69.9	0.48 (0.45–0.50)	228	72.4	0.63 (0.57–0.68)	1015	52.3	0.52 (0.49–0.55)

[a] 0=Armed forces; 1=Legislators, senior officials and managers; 2=Professionals; 3=Technicians and associate professionals; 4=Clerks; 5=Service workers and shop and market sales workers; 6=Skilled agricultural and fishery workers; 7=Craft and related trades workers; 8=Plant and machine operators and assemblers; 9=Elementary occupations.
[b] Number of observations with two sets of DISCO-88 codes at major (1-digit) group level.
[c] The proportion of true registrations within each major DISCO-88 group based on self-reported job-title as the gold standard.
[d] Agreement between registered DISCO-88 codes in DOC*X and self-reported job titles converted to DISCO-88 codes based on the Copenhagen City Heart Study.
[e] Agreement between registered DISCO-88 codes in DOC*X and self-reported job titles converted to DISCO-88 codes based on the ASUSI Cohort.

be questioned if self-reported job titles converted to DISCO-88 codes can be taken as a gold standard, but self-reported information on the current job is generally considered to have high validity (14, 39).

One limitation of our study is that we have no self-reported job titles from the years after 2004, and therefore no validation has been performed on DOC*X registrations from 2005 onwards. This limitation particularly pertains to DISCO-88 codes after the time point when Statistics Denmark introduced the DISCO-08 system in 2010 (15). Another limitation is that the DISCO-88 codes, which were available for validation, only represented around half of the codes in the DISCO-88 system so that only frequent occupational titles were validated at the 4-digit level. If the agreements are lower for rare DISCO-88 codes, we may have overestimated the general validity of the DISCO-88 codes in DOC*X. On the other hand, the sensitivities did not seem to depend on the number of observations (all ≥10) per DISCO-code.

In our analyses of agreement between exposure levels, we used categorical variables with two or three categories. The JEM exposures for wood dust and noise only exist as categorical variables while the other JEM contain continuous measures, which we categorized to ensure comparability. It may be a limitation that we only validated the DISCO-88 codes based on categorical variables instead of using continuous scales. We chose to focus on the lowest and highest exposure categories to examine whether they were correctly categorized. To the extent that DISCO-88 codes in DOC*X are misclassified so that highly exposed are categorized as medium or non-exposed, the data would not be of a quality that allows future exposure–response analyses.

Validity of DISCO-88 codes in future DOC*X studies

This study concerned selected airborne, mechanical, and physical exposures, and it remains open whether the validity of DISCO-88 codes in DOC*X is similar for other exposures, eg, chemicals. The validity varied across 4-digit DISCO-88 codes and time periods, which should be considered when planning studies in DOC*X. DOC*X also covers industry codes from 1976 and onwards (15) and it can be relevant to use those industry codes together with the DISCO-88 codes to reduce the risk of misclassification of occupations.

Concluding remarks

The validity of the DISCO-88 codes in DOC*X was generally high. Substantial agreement was found for the JEM-based exposure estimates and group-based DISCO-88 codes per se, although the DISCO-88 code-specific agreement varied across digit levels and time periods.

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Conflicts of interest

The authors declare no conflicts of interest.

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ORIGINAL ARTICLE

Job-exposure matrices addressing lifestyle to be applied in register-based occupational health studies

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ABSTRACT

Objectives Information about lifestyle factors in register-based occupational health studies is often not available. The objective of this study was therefore to develop gender, age and calendar-time specific job-exposure matrices (JEMs) addressing five selected lifestyle characteristics across job groups as a tool for lifestyle adjustment in register-based studies.

Methods We combined and harmonised questionnaire and interview data on lifestyle from several Danish surveys in the time period 1981–2013 for 264 054 employees registered with a DISCO-88 code (the Danish version of International Standard Classification of Occupations (ISCO)-88) in a nationwide register-based Danish Occupational Cohort. We modelled the probability of specified lifestyles in mixed models for each level of the four-digit DISCO code with age and sex as fixed effects and assessed variation in terms of intraclass correlation coefficients (ICCs) and exposure-level percentile ratios across jobs for six different time periods from 1981 through 2013.

Results The ICCs were overall low (0.26%–7.05%) as the within-job group variation was large relative to the between job group variation, but across jobs the calendar period-specific ratios between highest and lowest predicted levels were ranging from 1.2 to 6.9, and for the 95%/1% and the 75%/5% percentile ratios ranges were 1.1–2.8 and 1.1–1.6, respectively, thus indicating substantial contrast for some lifestyle exposures and some occupations.

Conclusions The lifestyle JEMs may prove a useful tool for control of lifestyle-related confounding in register-based occupational health studies where lacking information on individual lifestyle factors may compromise internal validity.

Key messages

What is already known about this subject?

► Information about lifestyle factors in register-based occupational health studies is often not available, which may raise concern about inappropriate control of confounding.

What are the new findings?

► This study describes six different job-exposure matrices (JEMs) with predicted estimates of exposure averages for lifestyle factors for specific job groups.

How might this impact on policy or clinical practice in the foreseeable future?

► The JEMs provide us with new possibilities to conduct large nationwide register-based studies controlling for lifestyle habits.

Linked

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INTRODUCTION

Job-exposure matrices (JEMs) have for decades been applied in studies addressing occupational risk of disease when individual exposure data are not available or too costly to collect.[1 2] A JEM is a cross-tabulation of occupations with exposure data for a certain well-defined occupational exposure in a given time window and geographical area. Information on exposure can be based on measurements, observations, expert assessments, self-reported information or combinations of those.[2 3]

There are limitations when using JEMs in epidemiological studies. First of all, JEMs do not capture variation in occupational exposure within a given job group, and errors in job coding may also lead to misclassification.[1 4] Another limitation is the potential risk of confounding by individual characteristics and health behaviour, such as smoking, alcohol consumption and physical activity level that rarely are included in community-based studies using data retrieved from public registries and JEMs.[1 5] It is known that both socioeconomic status and educational levels are strong predictors for health and healthy lifestyle[6 7]; however, lifestyle factors also vary across and within socioeconomic status and education, and therefore it is a key issue to include information about lifestyle in studies dealing with occupational exposures and health outcomes.[8] Especially regarding smoking, the social context seems to be an underplayed factor.[9] Although level of education—readily available in many public registries—captures some of the variation in lifestyle factors, a lifestyle JEM is providing a higher level of detail corresponding to the level of detail in occupational JEMs.

In large register-based studies, it is often not economically feasible to acquire data on lifestyle information for the main part of the study subjects, and for some study subjects it is not possible because of time lag or deceased individuals. Gathering information on just a small part is also costly and time-consuming, which emphasises the advantage of alternative methods accounting for lifestyle in epidemiological studies based on register data.

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Traditionally, indirect methods have been used to evaluate the magnitude and direction of the potentially confounding in observational studies, when lifestyle information is missing.[10 11] An alternative approach is development of survey-based lifestyle JEMs with predicted gender, age, calendar time and job-specific estimates of lifestyle characteristics, even when jobs are not direct causes of certain lifestyles (as, for instance, higher body mass index (BMI) in sedentary work and higher alcohol consumption in brewery workers). The need in JEM-based occupational studies addressing health effects of specific and explicit workplace exposures is to obtain systematic information on the distribution of potentially confounding lifestyle factors across job titles at the same level of detail as used for the construction of occupational exposures. The present study is the first, as we know, that aims to develop and document lifestyle JEMs on a very large study population by combining questionnaire and interview data from several Danish research studies.

The objective of the present study was to develop JEMs addressing smoking, alcohol consumption, leisure-time physical activity, intake of fruits and vegetables, and BMI across job groups as a tool for lifestyle adjustment in register-based JEM studies where individual lifestyle information is not available and where adjustment for one or more lifestyle factors is essential considering study populations and outcomes. Thus the aim is not to examine the occurrence of health behaviours in certain jobs per se, but rather to enable adjustment for lifestyle in studies addressing workplace exposures where individual lifestyle information is unavailable.

Table 1 Observations and individuals in the aggregated study population by time and data source

Year	SIC	DNHI	DWEC	DNHS	Cumulative number of observations	Cumulative number of individuals
1981	3089				3089	3089
1982	3985				7074	7074
1983	4098				11 172	11 172
1984	24				11 196	11 196
1986	899				12 095	12 095
1987	288	3063			15 446	15 350
1990			7019		22 465	22 186
1991	1288	3076			26 829	26 451
1992	128				26 957	26 579
1993	80				27 037	26 659
1994	3326	2943			33 306	32 844
1995	13 636		6774		53 716	48 011
1996	17 294				71 010	63 305
1997	7418				78 428	72 723
1999	3133				81 561	75 856
2000	2194	9997	6003		99 755	87 200
2001	139				99 894	87 339
2005		7701	8013		115 608	97 522
2010			10 312	92 126	218 046	191 319
2013				81 104	299 150	264 054

DNHI, Danish National Health Interviews; DNHS, Danish National Health Survey; DWEC, Danish Work Environment Cohort; SIC, Social Inequality in Cancer Cohort.

METHODS

Study population

We retrieved individual self-reported data on lifestyle from four large Danish population-based studies (figure 1). Combined questionnaire and interview data on lifestyle were available from the years 1981 to 2013 (table 1). In total, we had 16 different data files from the respective surveys. They were merged into one data file by use of the Danish personal identification number (CPR).[12]

Social Inequality in Cancer Cohort (SIC) comprises pooled data from seven Danish cohorts including 83 006 individuals aged 20–93 years of age at entry, primarily living in the Danish

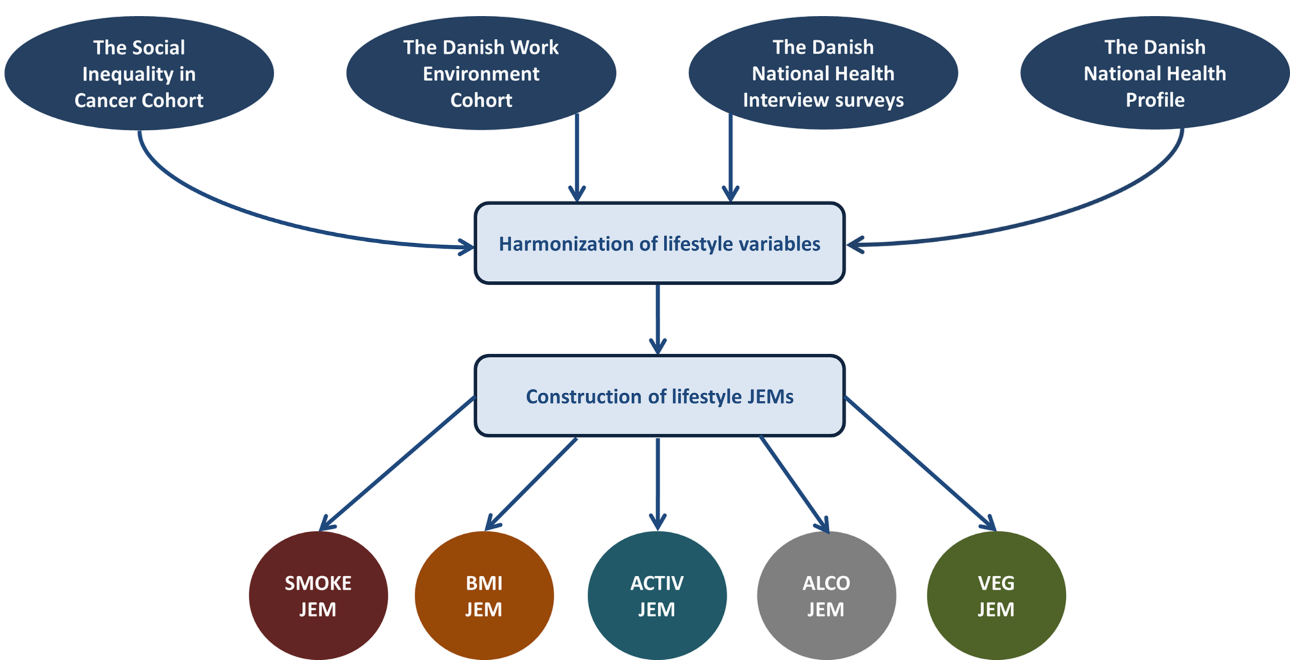

Figure 1 Overview of the data flow linking the respective cohort studies in one data file, where in the lifestyle job-exposure matrices(JEMs) are generated. BMI, body mass index.

cities of Aarhus or Copenhagen. Lifestyle data were harmonised across the seven cohorts (n=76 294) as described elsewhere.[13]

The Danish Work Environment Cohort (DWEC) studies from the National Research Centre for Working Environment were initiated in 1990 and include nationwide random samples of employees aged 18–59.[14–16]

The Danish National Health Interviews (DNHI) surveys from the Danish National Institute of Public Health were carried out from 1987 through 2005. All samples were randomly drawn using the Danish Civil Registration System. Study design and characteristics of the DNHI surveys have been described elsewhere.[17 18]

The Danish National Health Survey (DNHS) was carried out in 2010 and 2013 at the Danish National Institute of Public Health, together with the five Danish regions. National representative surveys were conducted to provide an overview of the health, morbidity and well-being of the Danish adult population.[17 19]

Assessment of occupation

Individual information of occupation for all individuals in the study was available from the DOC*X database at Statistics Denmark,[20] and linked to the survey data by the use of the CPR.[21] In DOC*X, all employed Danish citizens are included from the age of 15, with annual information on occupational code, industry code and income. All occupational codes in DOC*X have been harmonised to the DISCO-88 classification system based on the four-digit International Standard Classification of Occupations (ISCO)-88 classification system,[22] including 372 job groups. For descriptive purposes, we grouped DISCO-88 codes according to procedures from Statistic Denmark.[23 24]

Permission to link variables from the included cohorts and surveys with the DOC*X database was obtained from the Danish Data Protection Agency.

Assessment of lifestyle factors

Information about lifestyle factors was extracted and harmonised from questionnaire and interview data from the four data sources. We assembled a categorical variable for current smoking (0=non-smoker; 1=smoker), where ex-smokers were defined as non-smokers. Among smokers we calculated the total amount of tobacco smoked per day (gram of tobacco for each unit: cigarette=1, cheroot=3, cigar=4; pipe=3). Alcohol consumption was calculated as units of alcohol per week (12 g of alcohol in a unit). We further made a categorical variable for alcohol (0=0 units/week; 2= >0–7 units/week; 3= >7–14 units/week; 4= >14 units/week). Leisure-time physical activity was combined in one categorical variable (1=sedentary activity (≈ no sport/training); 2=low/easy waking or biking (≈ 1–2 hours/week); 3=moderate training (≈ 2–4 hours/week); 4=hard training/competitive sport (≈ >4 hours/week)). Information on height and weight was available either from questionnaires/interviews or clinical examination data for the calculating of the BMI (kg/m^2). Vegetable consumption was calculated as the highest frequency of fruit or vegetables indicated in the question(s) of each data material. The frequencies were divided into three groups for frequency of total intake of fruits and vegetables per week (1=never/rarely; 2=1–6 per week; 3=daily).

Statistical methods

We restricted our study sample to men and women with an occupational code registered in the DOC*X cohort for the same year as for completion of either the questionnaire or interview.

The exposure level in a job group was calculated as best linear unbiased predictions (BLUPs) by fitting mixed models in SAS (V.9.4, SAS Institute). We used linear models (Proc Mixed procedure) except for probability of smoking, where we used mixed logistic regression (Proc Glimmix, link=logit, dist=binary). Age group (1= <30; 2=30–39; 3=40–49; 4= ≥50 years of age), gender (men/women) and source of data[1–16] were included as fixed effects and DISCO-88 codes as random effect. Data were divided into 5-year intervals, except for the first 10-year interval with less participants (1=1981–1990; 2=1991–1995; 3=1996–2000; 4=2001–2005; 5=2006–2010; 6= >2010). Only job -groups with at least 10 observations were included. If <10 observations were available for a DISCO-code, the predicted value for the less detailed DISCO-code was imputed to the final JEM (eg, the predicted value for the DISCO-code 931 was imputed for the missing value of 9311). The final JEMs included predicted values for each combination of DISCO-code, gender, age group and time period. Furthermore, the number of study subjects used for the predictions and the SD for the predicted measures was included. In this article, only the results for the most detailed level of DISCO are presented.

For evaluation of each JEM on the most detailed four-digit DISCO-level, we calculated the intraclass correlation coefficient (ICC) and the highest/lowest, 95/5 and 75/5 percentile ratios for each time period. The ICC is equal to the variance between the job groups divided by the sum of the variance within and between job groups plus the residual value, and it ranges from 0 to 1 (all variation is between job groups).

We calculated Spearman correlations between JEMs to investigate any agreement between the different lifestyles.

To illustrate that the lifestyle JEMs carries independent information in addition to education, we made analyses using sex, age and the cumulated smoking at age 50 (by the smoking proportion JEM, categorised according to quartiles) as predictors, both with and without including education in Poisson regression of all-cause mortality. Education was defined as highest attained education at age 50, categorised as short (primary or secondary school or vocational), medium or long.

The population included was persons from the Danish population (employed between 1976 and 2015) with at least 20 years of (JEM-)recorded smoking exposure before the age of 50, followed -up from first employment between age 50–60 and until 2015 or death whichever came first. In total, 976 264 persons were followed for 9 458 032 years (43 326 deaths).

RESULTS

In our study sample, 57.4% of the subjects had a job title registered in the DOC*X database for the current year, which overall resulted in a final sample of 264 054 study subjects for construction of the JEMs (table 1). Characteristics of the surveys are provided in table 2.

The calendar period-specific 95/5 and 75/25 percentile ratios were 1.5–2.8 and 1.6–1.9, respectively (table 3).

Smoking

We saw a linear decline in the proportion of smokers from 56% in the period 1981–1990 to 19% after 2010 (table 3), whereas the amount of tobacco consumed by smokers only changed slightly across the years (table 3).

The predicted proportion of smokers ranged from 6% to 40% between job groups for the latest period (>2010) with a ratio between highest and lowest predicted level of 6.8, while

Table 2 Distribution of gender, age and lifestyle by time period and data source

Time period	Age (years)	Gender (% men)	Smoking (% smokers)	Smoking (g/day among smokers)	Alcohol (units/week)	BMI (kg/m²)	Physical activity†	Fruits and vegetables†
1981– 1990								
SIC81-87	47.7*	53.1***	58.6*	9.8*	9.8*	25.0*	2.1	–
DNHI87	38.2	53.8	49.2	7.5	7.9	23.5	–	–
DWEC90	37.6	52.1	46.9	7.4	–	23.5	–	–
1991–1995								
SIC91-95	54.4*	52.1***	39.9*	7.2*	12.5*	25.9*	2.4*	2.6
DNHI91	38.6	51.5	58.4	5.3	–	–	2.2	–
DNHI94	39.0	52.2	43.6	6.7	8.7	24.0	2.2	–
DWEC95	38.9	51.8	40.8	6.3	–	24.0	–	–
1996–2000								
SIC96-00	53.4*	52.5*	32.3*	5.5***	11.8*	26.0*	2.6*	2.6*
DNHI00	39.4	50.7	57.0 ‡	8.8‡	8.7	24.6	2.2	2.5
DWEC00	39.2	49.8	36.7	5.8	5.9‡	24.4	2.6	2.7
2001–2005								
SIC01-05	36.7*	38.8*	36.7***	5.5***	6.4**	25.6***	1.9*	–
DNHI05	41.2	49.5	28.1	4.4	9.5	24.9	2.3	2.6*
DWEC05	41.5	46.1	27.6	4.2	9.7	24.9	2.1	2.7
2006–2010								
DWEC10	43.5*	45.1***	22.7***	2.8***	10.2*	25.4**	2.5*	2.8*
DNHS10	42.6	45.3	23.0	2.7	7.9	25.3	2.3	2.7
>2010								
>2010 DNHS13	44.3	45.5	19.1	2.1	7.0	25.4	2.3	2.7

*$p < 0.001$ in an ANOVA (continuous variable) or χ^2 test (class variable) for each time period.
**$p < 0.01$ in an ANOVA (continuous variable) or χ^2 test (class variable) for each time period.
***$p > 0.05$ in an ANOVA (continuous variable) or χ^2 test (class variable) for each time period.
† Data censored from the final study population due to unrealistic estimates (not included in ANOVA or χ^2 tests).
‡ Frequency on a scale of 1–4 physical activity (sedentary activity (≈ no sport/training)/ low/easy waking or biking (≈ 1–2 hours/week)/moderate training (≈ 2–4 hours/week)/ hard training/competitive sport (≈ >4 hours/week)) and 1–3 for the frequency of eating fruits and vegetable (never/rarely/1–6 per times per week/daily).
ANOVA, analysis of variance; DNHI, Danish National Health Interviews; DNHS, Danish National Health Survey ; DWEC, Danish Work Environment Cohort; SIC, Social Inequality in Cancer Cohort.

the amount of smoking ranged from 8.0 to 19.5 g/day, corresponding to a ratio on 2.4 (figure 2).

The calculated ICCs for the SMOKE-JEM for proportion increased linearly from 2.7% in the first time period to 5.7% in the last, which indicates increased variability between the job groups with calendar year. Similarly the ICCs increased by time period in the SMOKE-JEM for amount of smoking (table 3).

Alcohol

Information on alcohol was available from 1981 until 2013, and no major changes in the overall intake of alcohol were observed (table 3).

Average consumption of alcoholic beverages varied between the job groups with predicted values ranging from 2.4 to 10.0 units/week (ratio=3.7) (figure 2). The calculated ICCs were small with decreased ICCs by time period from 3.80% to 1.07% (table 3).

Body mass index

In the first time period, only 23% (n=84) of the DISCO codes had BMI information at the most detailed four-digit DISCO level, whereas in the latest time period BMI information was available for 71% (n=264). The mean BMI increased almost linearly from 24.2 kg/m² in the first time period to 25.2 kg/m² in the latest time period (table 3). In general, men had a higher BMI than women and the BMI increased by age in all time periods. The ICCs were small with no time trend (table 3), and the predicted values ranged from 21.3 to 28.0 kg/m² with a ratio of 1.3. Analysis of the relationship between matrix estimates for BMI and socioeconomic status indicated a positive linear relationship (R^2=0.46 in >2010).

Leisure-time physical activity

Information on leisure-time physical activity was available from 1981 until 2013 but only small differences in the mean levels were found across the time periods (table 3). The level of physical activity was highest among the oldest and youngest age groups before the year 2000, but thereafter the level was lowest among the oldest age group. In general, men had a higher level of physical activity than women. The ICCs varied from 0.26% to 2.21% with no clear time trend (table 3). The predicted levels in the job groups ranged from 1.7 to 3.2 (>2010) with a ratio on 1.8.

Fruits and vegetables

Information on intake of fruits and vegetables was available from 1991 until 2013. We saw a small increase in the predicted intake during the time periods from 2.5 to 2.7 on a scale ranging from 1 to 3 (table 3). In general, women had a higher intake than men, and the intake of fruits and vegetables increased by age. The ICCs were small without any time trend (table 3). The average intake of fruits and vegetables ranged from 2.4 to 2.9 with a ratio of 1.2 in the latest time period.

Table 3 Crude and best linear unbiased prediction (BLUP) statistics by lifestyle factor across calendar time

	Crude data (surveys)		BLUP statistics applied to the entire population			Ratio of percentiles (high/low, %)		
JEM	Mean	SD	Mean	SD	ICC (%)	100/0	95/5	75/25
SMOKE-JEM, proportion								
1981–1990	0.53	0.50	0.56	0.06	2.66	191.7	146.2	117.7
1991–1995	0.41	0.49	0.39	0.07	3.23	306.0	177.9	125,5
1996–2000	0.33	0.47	0.34	0.07	3.52	372.7	191.5	132.4
2001–2005	0.28	0.45	0.27	0.06	6.53	447.6	238.0	128.0
2006–2010	0.23	0.42	0.22	0.06	6.00	504.5	273.9	155.0
>2010	0.19	0.39	0.19	0.06	5.73	689.1	280.6	148.7
SMOKE-JEM, amount (g/day)								
1981–1990	16.1	8.8	15.9	2.3	2.28	225.1	159.8	124.7
1991–1995	16.9	9.7	16.5	2.9	2.85	265.5	175.6	132.5
1996–2000	16.2	9.6	15.6	2.8	2.80	300.4	191.9	134.8
2001–2005	15.5	8.1	15.2	2.2	4.83	253.2	161.0	123.7
2006–2010	14.1	7.4	14.0	2.1	7.05	257.3	164.1	122.0
>2010	13.6	8.1	13.2	1.8	5.04	244.0	158.4	122.8
ALKO-JEM, drinks/day								
1981–1990	1.4	1.0	1.5	0.4	3.80	434.2	210.2	158.8
1991–1995	1.7	0.9	1.6	0.3	2.79	274.7	188.1	141.5
1996–2000	1.7	0.9	1.6	0.3	2.12	276.5	181.4	135.2
2001–2005	1.5	1.0	1.6	0.3	1.95	291.9	184.1	137.1
2006–2010	1.4	0.9	1.4	0.3	1.34	304.5	199.4	134.3
>2010	1.3	0.8	1.3	0.2	1.07	266.6	188.1	131.7
BMI-JEM, kg/m^2								
1981–1990	24.2	3.8	24.2	1.3	3.14	130.3	120.2	108.5
1991–1995	25.3	3.9	24.7	1.2	3.53	132.3	116.8	107.3
1996–2000	25.5	4.0	24.3	1.1	2.81	127.3	115.1	106.1
2001–2005	24.9	4.0	24.8	1.0	2.18	123.5	113.8	105.5
2006–2010	25.3	4.4	25.1	1.2	2.96	131.8	117.9	107.1
>2010	25.4	4.5	25.2	1.2	2.71	131.7	118.2	107.3
ACTIVE-JEM, scale 1–4								
1981–1990	2.1	0.7	2.2	0.2	2.01	166.8	137.2	116.0
1991–1995	2.4	0.8	2.4	0.2	0.95	137.0	123.6	110.3
1996–2000	2.4	0.8	2.3	0.1	0.26	125.0	118.5	108.1
2001–2005	2.2	0.7	2.1	0.2	2.02	152.8	128.9	112.2
2006–2010	2.3	0.7	2.3	0.2	1.87	174.5	130.1	112.0
>2010	2.3	0.7	2.3	0.2	2.21	186.5	133.9	113.4
VEG-JEM, scale 1–3								
1991–1995	2.6	0.5	2.5	0.1	2.23	131.1	119.3	110.8
1996–2000	2.6	0.5	2.5	0.1	1.82	134.5	122.1	110.5
2001–2005	2.7	0.5	2.7	0.1	2.73	126.8	115.0	108.7
2006–2010	2.7	0.5	2.7	0.1	2.88	125.2	114.6	107.0
>2010	2.7	0.5	2.7	0.1	2.28	122.5	113.0	106.6

JEM, job-exposure matrix.

Performance of the lifestyle JEMs (an example)

Most lifestyle factors are moderately correlated, though smoking and activity and BMI, and alcohol and BMI are only very weekly correlated (online supplemental table S1). The JEM-based cumulative smoking exposure is a strong predictor of death from all causes, even when simultaneously controlling for education (online supplemental table S2).

DISCUSSION

We created health behaviour JEMs based on 264 054 study subjects from different studies with interview and questionnaire data on smoking, alcohol consumption, leisure-time physical activity, BMI, and intake of fruits and vegetables. The between-job group variation was <5%–10% of the total variation, but across job groups a substantial contrast was evident with ratios between highest and lowest predicted levels ranging from 1.2 to 6.8 and with 95/5 and 75/25 percentiles ranges of 1.5–2.8 and 1.6–1.9, respectively. The analysis of all-cause mortality predicted by the smoking JEM with and without adjustment for length of education illustrates that the JEM carries substantial independent information in addition to usual lifestyle proxies as education.

Strengths and limitations

Our study is by far the biggest Danish study on lifestyle exposures measured by pooling interview and questionnaire data

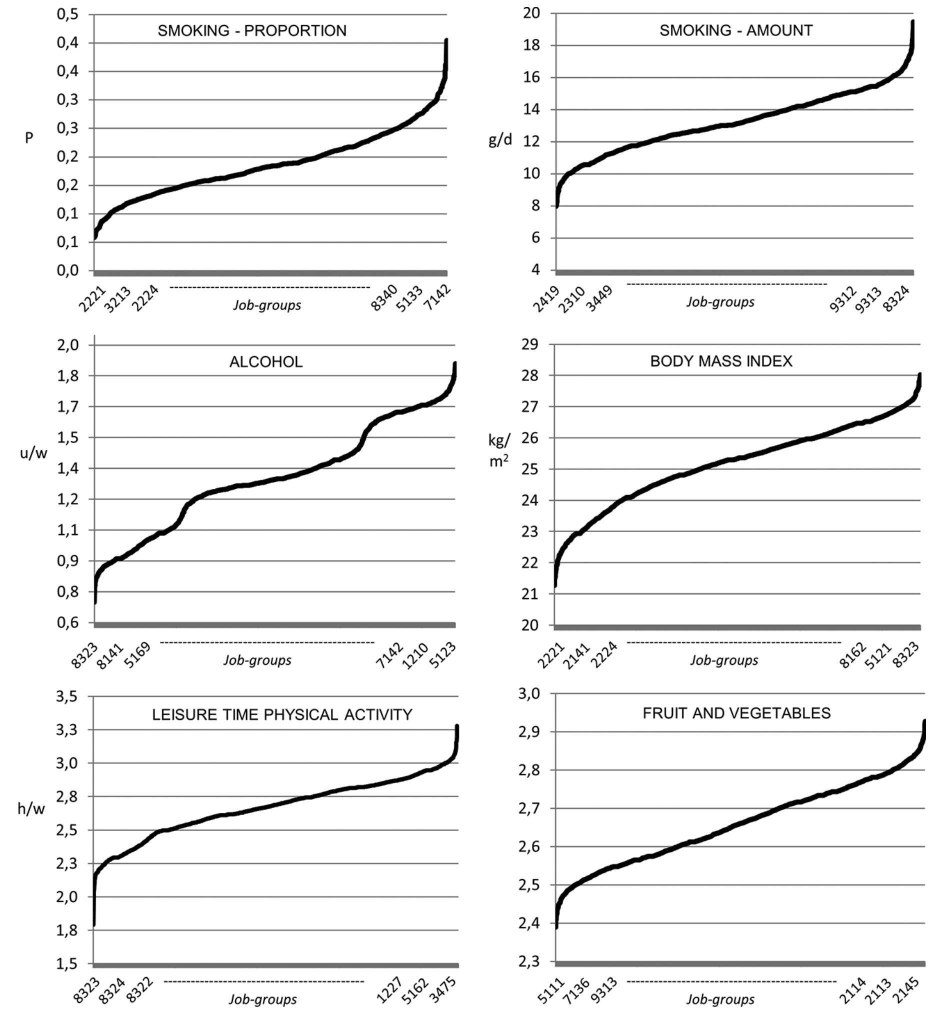

Figure 2 The population distribution of the predicted values of the lifestyle job-exposure matrices across all job groups with specification of the three jobs with lowest and highest predicted values for each lifestyle JEM. 1210=directors and chief executives; 1227=production and operations department managers; 2113=chemists; 2114=geologists and geophysicists; 2141=architects, town and traffic planners; 2145=mechanical engineers; 2221=medial doctors; 224=pharmacists; 2310=college, university and higher education teaching professionals; 2419=business professionals; 3213=farming and forestry advisers; 3449=customs, tax and related government associate professionals; 3475=athletes and sportspersons; 5111=travel and attendants; 5121=housekeepers and related workers; 5123=waiters and bartenders; 5133=home based personal care workers; 5162=police officers; 5169=protective service workers; 7136=plumbers and pipe fitters; 7142=varnishes and related painters; 8141=wood processing-plant operators; 8162=steam engine and boiler operators; 8322=car, taxi and van drivers; 8323=bus and tram drivers; 83244=heavy truck and lorry drivers; 8340=ships', deck crews and related workers; 9312=construction and maintenance labourers; 9313=building construction labourers.

from several Danish surveys. The large study sample allows for estimation of lifestyle factors for about 70% of the entire workforce on a detailed DISCO level. The large time span provides time-specific estimates, which is a key issue, as lifestyle habits have changed significant in the Danish population since 1981.[25 26] The lifestyle JEMs were refined by including gender, age and calendar period in the BLUP models which contributed significantly and thus served to decrease misclassification inherent in the JEM approach.

The construction of lifestyle JEMS relies in linkage of different cohort studies. Repeated cross-sectional surveys with fixed questions over time would be a useful alternative source but unfortunately no cross-sectional surveys with repeated information on both lifestyle and occupational titles are readily available.

The survey data included have used different recruitment strategies. The SIC consists of data from several cohort studies where the participants have been invited according to age group and living in defined areas of Copenhagen and Aarhus[12] —the two largest cities in Denmark. The SIC data are therefore not representative for the whole country. The study populations of the DNHI, DWEC and DNHS have used other recruitment strategies, but overall with the purpose to create nationally representative samples. Overall, the number of study subjects and the representativeness increased by time period in our data, which may influence the estimated exposure values in the JEMs. The low number of jobs traditionally placed at the country side may leave us with less precise estimates for those jobs. For a given job group, however, we do not believe that the various sampling strategies introduce noteworthy bias. Participation bias may also be introduced in our estimates as a consequence of the healthy participant effect. We know from other studies that people participating in research studies in general are healthier than people who choose not to participate.[27] If the healthy participant effect is introduced in our data, the predicted values for lifestyle factors may not reflect the general workforce, but only the healthiest part of it.

Another limitation in our study is that the questions used for estimation of lifestyle exposures differ between surveys. BMI is calculated in the same way for all surveys, but in the SIC cohort a large part of the measurements for weight and height is from clinical examinations. In the questionnaire surveys, weight and height are self-reported. We saw a tendency to lower BMI in self-reported data compared with data from clinical examinations, indicating that people may underestimate their weight and overestimate their height in self-administrated questionnaires. The systematic bias in BMI is supported by findings in other studies.[28 29]

Between-group and within-group variation

The between-group variation in health behaviours was small compared with the within-group variation as reflected in ICC values <5%–10%. This is expected because the studied unhealthy behaviours are rather prevalent regardless of type of occupation which is in contrast to rare occupational exposures.[30 31] Small differences in the occurrence of unhealthy behaviours in the most prevalent occupations also contribute to small ICCs when calculations are based on the entire population. ICCs for subsets of the population defined to increase the occupational exposure contrast of interest may have substantially higher ICCs as evidenced by the ratio of unhealthy behaviour between jobs with highest and the lowest occurrence, which for some lifestyle factors proved substantial.

For smoking the ICC increased by time period, which indicated larger between-group variation by calendar year. During the 2000s, we saw major changes in the Danish Society with respect to smoking habits as educational institutions, the public transport systems, private companies, etc, began to introduce smoking policies. Furthermore, the Danish government introduced a nationwide smoking policy in 2007 with the purpose of limiting smoking at public places.[32] However, this is not directly reflected in our smoking data since we saw an almost constant decline in both smoking proportion and amount of smoking from the time period 1991–1995.

For alcohol consumption, we saw the opposite pattern with decreased ICC by time period, indicating that alcohol consumption in the last decade is happening equally in all socioeconomic status groups and in all job groups, as we did not see a social gradient for alcohol consumption. For BMI, leisure-time physical activity and intake of fruits and vegetables, the ICCs were in general small and did not show a clear time-dependent pattern. This indicates that there have been no major changes in the variability between job groups for the lifestyle parameters during the time periods. However, the low ICCs could also indicate that the harmonisation of the interview and questionnaire data for leisure-time physical activity and intake of fruits and vegetables has been inappropriate to measure the variability between job groups.

How to use the JEMs

The lifestyle JEM can be used simply as a systematic and transparent external information on average health behaviours in specific jobs or—depending on the research questions—it can be applied to the entire national population or subsets of the population defined by job title to obtain the optimal trade-off between contrast of exposure and statistical power. Thus the gender, age and calendar time-specific lifestyle JEMs are intended as tools to address potential confounding in occupational register-based studies where workplace exposure assessment is assigned by JEMs. The objective was not to provide a tool for registry-based studies of lifestyle per se, but rather to enable adjustment for lifestyle in studies addressing workplace exposures where individual lifestyle information is unavailable. In addition to community-based studies, this also includes occupational cohorts with industry-specific JEMs, but without information on lifestyle. The application of lifestyle JEMs will introduce non-differential misclassification and less efficient control of confounding than use of individual data, but since the behaviour JEMs are developed for use in register-based occupational JEM studies, the misclassification of lifestyle factors is balanced to the misclassification of the exposure of interest. Hereby the lifestyle JEMs represent a systematic alternative to other methods for control for lifestyle-related confounding in occupational studies such as ad hoc adjustment of excess risk based on hypothetical assumptions about health behaviours in exposed and controls[10] or use of antecedent ad hoc data on health behaviours that often are based on small samples. However, since health behaviours and lifestyle patterns are highly time-specific and country-specific the JEMs are not a priori useful in other countries.[33]

The estimated values for each job group can be applied to individual study subjects according to job title, gender, age and calendar time. The estimated values in the JEMs are not intended as exact exposure measures but should rather be seen as relative measures between job groups since they are not validated against external data sources. DOC*X is an open research resource, which means that researchers from all over the world can get access to the data after approval from the DOC*X steering committee, the Statistics Denmark and the Danish Data Protection Agency. More information can be found at www.doc-x.dk.

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Original article

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Acute myocardial infarction in relation to physical activities at work: a nationwide follow-up study based on job-exposure matrices

by Bonde JPE, Flachs EM, Madsen IEH, Petersen SB, Andersen JH, Hansen J, Jørgensen EB, Kolstad H, Holtermann A, Schlünssen V, Svendsen SW

We know that leisure-time physical activity is related to reduced cardiovascular morbidity, but some recent papers provide evidence that physical activities at work are related to increased risk. We used job exposure matrices for assessment of physical activities at work, we found indications of slightly elevated long-term risks of acute myocardial infarction associated with lifting, but not with standing/walking.

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Key terms: acute myocardial infarction; cohort study; epidemiology; heart disease; heavy lifting; JEM; job-exposure matrix; occupation; physical activity; standing; strenuous work; walking

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Additional material

Please note that there is additional material available belonging to this article on the *Scandinavian Journal of Work, Environment & Health* -website.

Original article

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Acute myocardial infarction in relation to physical activities at work: a nationwide follow-up study based on job-exposure matrices

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Objective This study aimed to evaluate sex-specific risks of acute myocardial infarction (AMI) according to lifting and standing/walking at work.

Methods The study population included 1.15 million Danish wage earners. Annual job codes from 1976 onwards were linked to specific exposures using job-exposure matrices (JEM). Cases of AMI during follow-up 1996–2016 were retrieved from national registers. Incidence rate ratios (IRR) were computed by Poisson regression adjusting for demographic and JEM-assessed lifestyle factors. Models addressed physical activities at work the previous 0–2 years (short-term risk) and cumulative physical activities (long-term risk).

Results During 21.4 million person-years of follow-up, 22 037 AMI occurred in men and 6942 in women. Exposure–response relationships between recent physical activities at work and AMI were not evident. In men, the fully adjusted long-term IRR for the highest of five exposure categories compared to the lowest were 1.09 [95% confidence interval (CI) 1.03–1.15] for lifting and 1.01 (95% CI 0.96–1.07) for standing/walking. In women, the corresponding figures were 1.27 (95% CI 1.15–1.40) and 1.18 (95% CI 1.07–1.30). The latter risk estimate was strongly attenuated, and the trend became insignificant when adjusted for lifting. Findings were only partially supported by sensitivity analyses.

Conclusion The study provides limited support to the hypothesis that long-term lifting and standing/walking at work is related to increased risk of AMI. Possible effects of acute physical exertion are not addressed and bias towards the null because of crude exposure assignment cannot be ruled out.

Key terms cohort study; epidemiology; heart disease; heavy lifting; JEM; occupation; standing; strenuous work; walking.

There is strong epidemiological evidence that leisure-time physical activity is related to reduced cardiovascular morbidity and mortality (1–3). The lower threshold for beneficial effects seems to be less than moderate-intensity physical activity, such as brisk walking (4). The US Department of Health and Human Services recommends ≥150 minutes a week of moderate-intensity aerobic physical activity or 75 minutes a week of vigorous-intensity physical activity (5). The seminal epidemiological studies of bus drivers and longshoremen from the 1950s and 60s indicate that physical activities at work are also beneficial for cardiovascular health (6–8). On the other hand, more recent studies have reported increased risk of ischaemic heart disease (IHD, atherosclerosis of the coronary arteries, the most prevalent type of cardiovascular morbidity) with increasing physical activities at work (9–14). Together with observations of increased all-cause mortality in studies addressing physically demanding work (15), the discrepancy between the beneficial effects of leisure-

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time physical activity (LTPA) and the seemingly unfavourable effects of physical activities at work has been labelled a paradox (16, 17). However, studies often combine different physical activities at work such as walking, lifting, carrying, climbing stairs, and digging (18–21), even though relations with IHD may differ across activities (16). Thus, the evidence on effects of physical activities at work is far from clear.

In most studies of physical activities at work, exposure assessment is based on self-report, which may result in inflated risk estimates due to recall bias or deflated risk estimates because of inaccurate and crude assessment of exposure. Vaguely defined physical activities and potential confounding by social and lifestyle factors have been emphasized as major limitations (17). Other issues are small study populations, low participation, short follow-up time, limited exposure contrast and selective reporting.

Some of the methodological limitations of most earlier studies may be addressed by use of job-exposure matrices (JEM) in nationwide register-based studies, even though this approach may introduce other limitations such as exposure misclassification and challenges in obtaining information on potential confounders – information which is available in some recent large prospective studies (15, 22). JEM provide individual exposure measures in a transparent and independent way and can be applied in large populations with time specific information on occupation (23). Recently, lifestyle JEM have also been introduced (24, 25). Besides being time- and cost-effective, JEM may in some situations provide less attenuated risk estimates than individual-based exposure assessment (26). Men and women share established risk factors for IHD (27) and therefore major sex-specific effects of physical activities at work are not expected. Nevertheless, analyses stratified by sex are justified to evaluate the consistency of findings. Acute myocardial infarction (AMI) is a prevalent manifestation of IHD with well-defined diagnostic criteria and was selected for this study to ensure high specificity of the outcome.

The aim of this study was to evaluate the hypothesis that the sex-specific incidence rate of AMI is increased by short-term and long-term (cumulative) exposure to higher levels of physical activities at work in terms of lifting and standing/walking. These activities were chosen to include generic occupational activities of physically demanding and less-demanding nature.

Methods

Design and population

We conducted a follow-up study of all Danish residents, who in 1995 at an age of 31–50 years were gainful wage earners with a valid job code according to the Danish version of the International Standard Classification of Occupations from 1988 (DISCO-88) (28). We requested a DISCO-88 code at baseline in 1995 at the digit 2 level or higher. Military employees were excluded. The study population was retrieved as a subset of the Danish Occupational Cohort with eXposure data (DOC*X) after permission from the Danish Data Protection Agency (P-2019-04) and from Statistics Denmark (P-707006). DOC*X is profiled in a separate paper (29).

Assessment of physical activities at work 1976–2015

Annual job codes. The DISCO-88 codes in the DOC*X are based on the Employment Classification Module (30, 31). These data mainly stem from public and private companies but are also retrieved from tax authorities and unemployment insurance funds. Various classification systems of occupational titles have been used within the past decades. In the DOC*X, occupational codes according to other classification systems than DISCO-88 have been converted to DISCO-88 codes (29), which have been validated against self-reported information on job titles (32).

Expert-rated JEM on lifting. To obtain estimates of occupational lifting, we used The Lower Body JEM (33), which provides estimates of total load lifted (kg/day) at work. This JEM has documented predictive validity for several outcomes (34–37). The JEM was constructed by grouping 2227 occupational titles into 122 job groups that were considered homogeneous with respect to physical activities at work (121 exposed groups and 1 minimally exposed group). Five experts in occupational medicine independently assessed the average total load lifted per day. If the most detailed DISCO-88 code included occupational titles from different job groups, the average exposure was used with few exceptions (38). In Denmark, specialists in occupational medicine have vast experience in quantifying total load lifted during a working day in all types of occupations because compensation for low back disorders and hip osteoarthritis is based upon detailed documentation of lifting work. The mean weighted kappa statistic for interrater agreement on ranking of the 121 job groups was 0.49 (moderate agreement (32). With few exceptions, two external experts confirmed the face validity of the rankings of the mean values (32). Furthermore, the average score on time spent lifting obtained for 125 DISCO-88 codes among men and women in a population survey (39) was strongly predicted by ranking of job codes according the expert-rated JEM (supplementary material, www.sjweh.fi/show_abstract.php?abstract_id=3862, figure S1). The range across lowest and highest deciles of DISCO-88 codes was 80–2640 kg/day. The JEM is not sex- or age-specific.

Self-report JEM on standing/walking. To obtain sex- and age-specific exposure estimates for standing/walking, we used the Occupational Activity JEM (39), which provides a sum score for the time spent standing/walking during a working day. Data was derived from a questionnaire survey encompassing a population sample of employees in Denmark in 2012 (the Work Environment and Health in Denmark study, N=26 165, response proportion 51.5%). The question was: "Do you stand or walk at work?" With the following six response categories: (i) never, (ii) rarely, (iii) about ¼ of the time, (iv) about ½ of the time, (v) about ¾ of the time, and (vi) almost all the time. Each answer was assigned a score from 1 (lowest) to 6 (highest). Using best linear unbiased prediction modeling, sex- and age-specific scores were computed for 168 of the 372 DISCO-88 codes, where the survey provided enough information. For the purpose of this study, we computed average scores at the 2- and 3-digit level for codes without 4-digit level information. The intraclass correlation coefficient (ICC) across all 168 DISCO-88 codes was 0.42 for men and 0.44 for women. The range across lowest and highest deciles of DISCO-88 codes was 2.7–5.2 score points.

Exposure assignment by job-exposure matrices. Calendar-year specific exposures were assigned to each cohort member by linking DISCO-88 codes for the longest held job in a year with the JEM. For lifting, we assigned cumulative exposures corresponding to the pack-year concept of smoking. One ton-year was defined as lifting one ton per day for one year (38). For standing/walking, we assigned cumulative exposures by summing up the scores for each year. The cumulative exposures were calculated across calendar years from 1976 or age 20, whichever came first. If the DISCO-88 code was missing or indicated military employment in years with active employment status according to the Employment Classification Module (8.2%), we assigned the average individual exposure during the latest up to five years. If still missing, we assigned exposure estimates of zero. Years without employment were also assigned a zero value. The quantitative estimates of exposure intensities (kg/day and standing/walking score points) and cumulative exposures (ton-years and standing/walking sum scores) were categorized by the sex-specific 25th, 50th, 75th and 90th percentiles.

Outcome ascertainment

We excluded cohort members with any type of IHD before start of follow-up using data on hospital discharge diagnoses (ICD-8 codes 410 from 1977–1993; ICD-10 codes I21–I23 as principal diagnosis from 1994–2016) obtained from the Danish National Patient Register (31). The outcome in the follow-up period (1996–2016) only included the specific diagnosis of AMI (ICD-10 principal diagnosis I21) due to a high completeness of data and validity of hospital information on this disease. The positive predictive value of a first-time AMI diagnosis according to the Danish National Patient Register was 97% in a validation study using medical records as the gold standard (40). Data on prehospital deaths from AMI during follow-up was retrieved from the Danish Register of Causes of Death (40) and constituted 6.9% of all incident cases.

Covariates

From public registers hosted by Statistics Denmark, we obtained information on the following baseline variables (1995): sex (men/women) and highest education (primary, secondary, short tertiary, medium tertiary, long tertiary and missing) as well as the following annually measured time-varying variables: vital status (alive/dead), emigration (yes/no), disappearance (yes/no), age (integers), cohabitation (yes/no/missing), employment status [employee, employer, no gainful employment (including unemployment, long-term sick leave, disability pension and voluntary early retirement)] and social position defined by DISCO-88 major codes (first digit: 1–2 managers and professionals, 3 technicians, 4–5 clerks, service and sales workers, 6–7 skilled workers, 8–9 unskilled workers) (28).

Time-varying individual proxies of lifestyle factors in terms of sex-, age- and period-specific probability of current smoking and estimates of body mass index (BMI) (kg/m^2) and LTPA [score points low (1) to high (6)] were assigned by lifestyle JEM based on questionnaire information from several large random samples of the Danish population (24). Lifestyle exposures in years without employment and in years with missing DISCO-88 codes were assigned the individual average exposure during all previous years (10.9% and 8.2%, respectively).

Statistical analysis

We used Poisson regression to compute sex-specific incidence rate ratios (IRR) with 95% confidence intervals (CI) for the association between incident AMI and physical activities at work from start of follow-up 1 January 1996 until first-occurring incident AMI (including prehospital death from AMI), death of another cause, emigration, disappearance or end of follow-up 31.12. December 2016. P-values for monotonic trends across exposure categories were computed by assigning integer values 0–4 to exposure categories (excluding the missing category) and reported if P<0.001 or <0.05 (subset analyses). Data on education was missing in 19% of records. Missings were kept as a separate category in the analyses.

Short-term risk. We analyzed the incidence of AMI according to physical activities at work the previous calendar year. Since employment status could not be resolved in more detail than one year, the one-year time lag spanned one day and two years.

Long-term risk. We analyzed the incidence of AMI according to cumulative physical activities at work from 1976 until and including the previous year.

Adjustments. All models were adjusted by a fixed set of constant and time-varying covariates. The constant covariates included sex (by stratification) and highest education at baseline (6 levels including a category of missing). The time varying variables were age (integers), cohabitation (yes/no/missing), social position (DISCO-88 major groups, 6 levels including a category of missing), employment status (employee, employer, no gainful employment), smoking (25th, 50th, 75th and 90th percentiles), BMI (25th, 50th, 75th and 90th percentiles) and LTPA (25, 50, 75 and 90 percentiles). The grouping of the three lifestyle variables were based upon cumulative years with a probability above the upper quartile. All time-varying variables were analyzed with a one-year time lag.

Sensitivity analyses. First, to counteract potential attenuation of risk estimates by the correlation between number of exposed years and staying in employment because of good health (healthy worker survivor selection), we repeated the analysis of long-term risk but redefined cumulative exposure as exposure from 1976 until but not including 1996 (start of follow-up) and ignored exposure during subsequent years. Second, we performed analyses according to cumulative exposures during the ten most recent years based on the assumption that physical activities at work more than ten years ago have little impact, if any. Third, we calculated IRR within selected DISCO-88 major groups with large ranges of physical activities as an alternative way to account for potential confounding by social factors. Fourth, we repeated the analyses of short-term effects using models with adjustment for cumulative exposure accrued before the previous calendar year. Finally, we adjusted analyses of long-term standing/walking for effect of lifting.

Supplementary analyses. To examine potential interactions between lifting and the strong risk factors for AMI, smoking and BMI, we performed sex-stratified crude and fully adjusted analyses using models that in addition to main effects as continuous variables also included the product of cumulative lifting and (i) cumulative smoking and (ii) years with BMI in the upper tertile. All analyses were carried out in SAS 9.4 (SAS Institute, Cary, NC, USA) on a platform at Statistics Denmark.

Results

The study population included 1.15 million individuals with 41.5 million person-years equally divided in years before and after start of follow-up. The number of prehospital deaths due to AMI during follow-up and incident hospitalizations for AMI was 22 037 among men and 6 942 among women. A skewed distribution according to lifting was evident for highest education and social position, and for smoking, BMI and LTPA (table 1). All covariates – except LTPA – exhibited robust prospective and mutually independent associations with AMI in the expected direction (supplementary table S1). LTPA was, as expected, associated with reduced risk of AMI in analyses only adjusting for age, but not in fully adjusted analyses (table S1).

Lifting at work

Among men, the short-term risk of AMI was not associated with lifting (table 2). The fully adjusted long-term risk increased with increasing cumulative lifting (ton-years) up to the previous year reaching a maximum IRR of 1.09 (table 2). The associations were attenuated or disappeared in models using cumulative exposure before start of follow-up, in models based on the most recent ten years (supplementary table S2), and in three of four social strata with large ranges of cumulative lifting up to the previous year (see supplementary tables S3 for exposure ranges and S4 for results).

Among women, the fully adjusted short-term risk of AMI tended to increase with increasing lifting exposure reaching a maximum IRR of 1.16 (table 2), even when adjusted for cumulative lifting accrued before the previous calendar year (results not shown). The fully adjusted long-term risk increased with increasing cumulative lifting (ton-years) up to the previous year. Associations were also seen in sensitivity analyses only including cumulative exposure before start of follow-up (table S2), but not in models based on the previous ten years (table S2). Moreover, indications of higher risk with higher levels of exposure (intensity times duration) were seen in two of four social strata with large ranges of cumulative lifting up to the previous year (see table S3 for exposure ranges and table S4 for results), but tests for trend were not significant at the 5% level in any of these analyses (table S4).

There were no indications of an increased risk of AMI due to interaction between cumulative lifting and cumulative smoking in either sex in fully adjusted models (OR 1.00, 95% CI 0.99–1.01 in men; OR 1.01, 95% CI 0.99–1.02 in women). Corresponding figures for interaction between cumulative lifting and cumulative BMI were OR 0.99, 95% CI 0.99–1.00, for men and OR 0.98, 95% CI 0.97–1.00, for women.

Table 1. Characteristics of the study population at baseline (1995) and distribution of person-years according to total load lifted per day before and after start of follow-up on 1 January 1996. Lifting assigned by an expert-based job-exposure matrix (JEM). [LTPA=leisure-time physical activity.]

	Persons (N=1 115 413)		Person years (N=41 505 028)			
			Lifting in years before start follow-up (1976–1995, person years=20 138 845)		Lifting in at-risk years during follow-up (1996–2016, person years=21 366 283)	
	N	%	≤1000/500 kg/day [a] (N=16 679 084) %	>1000/500 kg/day [a] (N=3 459 761) %	≤1000/500 kg/day [a] (N=16 679 084) %	>1000/500 kg/day [a] (N=3 459 761) %
Sex						
Male	546 085	49.0	48.2	52.0	51.3	50.0
Female	569 328	51.0	51.8	48.0	48.7	50.0
Age (years)						
20–30	0	0.0	39.1	40.2	0	0
31–40	554 376	49.7	42.8	42.5	11.7	12.0
41–50	561 037	50.3	15.7	14.7	36.7	37.7
51–60	0	0.0	2.4	2.6	40.8	40.3
61–65	0	0.0	0.0	0.0	10.8	10.0
Cohabitation						
Yes	234 825	78.4	41.8	42.7	74.5	74.3
No	874 743	21.1	12.8	12.3	21.6	22.2
Missing	5 845	0.5	45.4	45.0	3.9	3.5
Highest education						
Long tertiary	65 318	5.8	4.7	0.2	8.2	0.1
Medium tertiary	180 237	16.2	15.4	1.9	21.9	1.7
Short tertiary	40 885	3.7	3.5	0.7	5.0	1.0
Secondary	424 584	38.1	35.1	32.0	39.4	54.0
Missing	191 608	17.1	24.3	31.6	8.6	11.2
Employment status [b]						
Employee	1 115 413	100.0	92.3	94.5	80.9	83.1
Employer	0	0.0	2.1	2.3	2.7	2.4
No gainful employment	0	0.0	5.6	3.2	16.4	14.6
Social position [b]						
Managers and professionals	217 972	19.5	18.2	0.8	25.4	1.5
Technicians	237 945	21.3	18.3	2.6	25.5	3.1
Clerks, service and sales workers	328 452	29.5	29.1	33.3	20.9	36.3
Skilled workers	141 618	12.7	13.1	19.4	8.7	14.9
Unskilled workers	189 426	17.0	13.3	37.3	10.7	33.5
Missing	0	0	8.0	6.7	8.7	10.5
Probability of smoking >Q3 [c] (men 0.57; women 0.52)						
Yes	241 395	21.6	42.4	60.0	4.4	16.7
No	874 018	78.4	53.2	36.4	95.6	83.3
Missing [d]	0	0	4.4	3.6	0	0
Probability of body mass index >Q3 [c] (men 25.4 kg/m^2; women 23.7 kg/m^2)						
Yes	247 844	22.2	11.4	26.3	26.5	40.3
No	867 659	77.8	84.2	70.1	73.0	59.7
Missing [d]	0	0	4.4	3.6	0	0
Probability of LTPA score >Q3 [c] (range 1–6; men 2.4; women 2.3)						
Yes	313 457	28.1	37.0	40.8	20.6	28.3
No	801 956	71.9	58.6	55.6	79.4	71.7
Missing [d]	0	0	4.4	3.6	0	0

[a] Median lifting 1976–2015 ≤ or >1000 kg/day for men and ≤ or >500 kg for women.
[b] No missing values before start of follow-up because of the inclusion criterion of a valid DISCO-88 code at baseline.
[c] Q3: 75th-percentile for the distribution of sex-, age- and period-specific JEM-based probability in 1995. Missing values in a year replaced by the individual average across all previous years.
[d] The sex-, age- and period-specific lifestyle JEM was incomplete for the period 1976–1994.

Standing/walking at work

Among men, the fully adjusted models did not consistently indicate associations between standing/walking at work and short- or long-term risk of AMI (table 3 and table S2).

Among women, there were no indications of increased short-term risks (table 3). The fully adjusted long-term risk increased with increasing cumulative standing/walking up to the previous year (reaching a maximum IRR of 1.18), but the association was attenuated when adjusting for long-term lifting (maximum IRR 1.11, 95% CI 1.00–1.23) and the trend became insignificant (P=0.08). Moreover, this relationship was neither found in models only including cumulative exposure before start of follow-up nor in models based on the previous ten years (table S2).

Table 2. Short- and long-term risk of acute myocardial infarction (AMI) according to lifting at work assessed by an expert-rated job-exposure matrix (JEM) [a]. **Bold indicates P-value for trend <0.001** (fully adjusted analyses only). [IRR=incidence rate ratios; CI=confidence intervals.]

Lifting at work	Men				Women				
	Cases	IRR [b]	IRR_{adj} [c]	95% CI	Lifting at work	Cases	IRR [b]	IRR_{adj} [c]	95% CI
Total load lifted per day the previous year, kg/day									
0	9859	1.00	1.00		0	4 488	1.00	**1.00**	
>0–100	417	0.96	**1.13**	1.02–1.25	>0–390	36	1.34	**1.12**	0.80–1.57
>100–620	5316	1.10	1.03	0.98–1.07	>390–1050	1 753	1.21	**1.14**	1.06–1.22
>620–1680	3529	1.16	1.04	0.99–1.09	>1050–3500	180	1.33	**1.16**	0.97–1.32
>1680–3500	2068	1.19	1.00	0.94–1.05	Missing	176	0.96	**1.07**	0.92–1.25
Missing	848	1.04	1.01	0.94–1.09					
Ton-years (1976 to previous year)									
0–≤3.1	4309	1.00	**1.00**		0–0.5	1 392	1.00	**1.00**	
>3.1–11.7	4770	1.25	**1.06**	1.01–1.11	>0.5–1.5	1 374	1.13	**1.06**	0.98–1.15
>11.7–25.6	5986	1.43	**1.08**	1.03–1.14	>5.1–12.4	1 707	1.38	**1.13**	1.05–1.23
>25.6–45.2	3353	1.50	**1.09**	1.03–1.15	>12.4–22.0	1 357	1.66	**1.22**	1.12–1.34
>45.2–126.6	3619	1.54	**1.09**	1.03–1.15	>22.0–118.0	1 112	1.71	**1.27**	1.15–1.40

[a] Lifting intensity (total load lifted per day) the previous calendar year and cumulative lifting (ton-years) assigned by an expert-rated JEM. Values grouped by the sex-specific 25th, 50th, 75th and 90th percentiles across all person-years.
[b] Adjusted for age (integers).
[c] Additionally adjusted for age (integers), cohabitation, highest education, employment status, social position, smoking, body mass index and leisure-time physical activity.

Table 3. Short- and long-term risk of acute myocardial infarction (AMI) according to standing/walking at work assessed by a self-report job–exposure matrix (JEM) [a]. **Bold indicates P-value for trend <0.001** (fully adjusted analyses only). [IRR=incidence rate ratios; CI=confidence intervals.]

Standing/walking at work	Men				Women				
	Cases	IRR [b]	IRR_{adj} [c]	95% CI	Standing/walking at work	Cases	IRR [b]	IRR_{adj} [c]	95% CI
Standing/walking per day the previous year, score									
1–≤2.8	5612	1.00	1.00		1–2.7	2273	1.00	1.00	
>2.8–3.5	3826	1.02	1.01	0.95–1.08	>2.7–3.6	1262	0.96	0.98	0.84–1.14
>3.5–4.7	4198	1.18	1.06	1.00–1.14	>3.6–4.8	1086	0.97	0.96	0.82–1.12
>4.7–5.1	3449	1.29	0.97	0.90–1.04	>4.8–5.1	991	1.17	1.04	0.89–1.22
>5.1–6.0	2058	1.14	0.90	0.83–0.97	>5.1–5.8	825	1.50	1.08	0.92–1.27
Missing	2894	1.10	0.94	0.87–1.00	Missing	505	1.04	0.91	0.77–1.08
Standing/walking sum score (1976 to previous year)									
1–≤ 60	3999	1.00	1.00		1–≤64.6	1277	1.00	**1.00**	
>60–85	4803	1.05	1.04	1.00–1.08	>64.6–86.9	1536	0.98	**1.03**	0.95–1.11
>85–111	5865	1.08	1.03	0.99–1.08	>86.9–113.2	1801	0.97	**1.05**	0.98–1.14
>111–136	4348	1.12	**1.06**	1.01–1.11	>113.2–138.4	1312	0.99	**1.10**	1.01–1.20
>136–229	3022	1.00	1.01	0.96–1.07	>138.4–228.6	1016	0.95	**1.18**	1.07–1.30

[a] Standing/walking at work according to a self-report JEM (Do you stand or walk? Never (1), rarely (2), about ¼ of the time (3), about ½ of the time (4), about ¾ of the time (5), almost all the time (6)). Values grouped by the sex-specific 25th, 50th, 75th and 90th percentiles.
[b] Adjusted for age (integers).
[c] Additionally adjusted for age (integers), cohabitation, highest education, employment status, social position, smoking, body mass index and leisure-time physical activity.

Discussion

In this register-based nationwide follow-up study using JEM for assessment of physical activities, we found indications of slightly elevated long-term risks of AMI associated with lifting at work, while no consistent associations were observed for standing/walking.

Strengths of the study are the large study population covering the entire spectrum of occupations, a follow-up period of 20 years, almost complete data, assessment of occupational and cardiovascular risk factors from young age, assignment of independent information on specific physical activities at work, reliable outcome ascertainment, comprehensive adjustment for social factors, adjustment for smoking, BMI and LTPA and statistical power to perform sex-specific analyses and analyses stratified by social position.

Limitations are primarily related to exposure misclassification, lack of detailed information on LTPA, residual confounding and the potential for a healthy worker survivor effect. Exposure assignment based on JEM inherently causes misclassification – let alone because a JEM does not reflect variation in exposure among individuals in the same occupations. As the within-occupation variation relative to the between-occupation variation increases, still larger study populations will be needed to separate true effects from statistical noise (41). The implication of exposure misclassification is inability to detect effects of the entire range of individual exposures, but risk estimates of the occurring average exposure across occupations are not expected to be attenuated. Since the ranges of job specific average exposures to lifting and standing/walking were rather wide, the study provides valuable information. However, risks related to the very high end of exposures – for instance lifting ≥10 tons/day – cannot be evaluated in this study since the highest JEM-based average lifting for an occupation was 3.5 tons/day. Further evidence regarding the validity of the JEM is the rather strong crude exposure–outcome associations in the expected direction observed in this study and the ability to predict several other outcomes in earlier studies (34–37).

The standing/walking JEM does not distinguish between standing and walking. We cannot exclude the possibility that prolonged standing is associated with an increased risk and walking without prolonged standing with a decreased risk resulting in no-risk when combined as in our study. However, to the best of our knowledge, there are no data to indicate that standing at work is a risk factor for AMI. Of note, a recent study included standing (shop assistants, security guards) in physical activities in parallel with lifting and leisure time physical activities and reported no increase in cardiovascular mortality (42). The design does not allow for examination of immediate (triggering) effects since the most detailed exposure resolution is one calendar year. For instance, it might be hypothesized that an acute severe exertion of heavy lifting at work might trigger AMI. This might be explored in future case-cross over studies. On the other hand, earlier epidemiological evidence is based upon the hypothesis that (unspecified) physical activities at work result in gradual cumulative damage to the cardiovascular system (16).

Residual confounding. The study benefits from sufficient statistical power to enable comprehensive adjustment for a range of well-established risk factors which all except LTPA independently predicted the risk of AMI. In many analyses, risks related to physical activities were strongly attenuated towards null in fully adjusted models. Socio-economic position is a strong risk factor of AMI and was accounted for by highest education, employment status and social position (DISCO-88 first digit groups) – and by analyses restricted to selected social strata with wide ranges of exposure. We did not have data on individual cardiovascular risk factors except that we were able to exclude persons who had been hospitalized due to IHD before start of follow-up. However, the use of lifestyle JEM for smoking and BMI performed well. Both factors were robustly and independently associated with AMI risk in both men and women, even after adjustment for highest education, social position and employment status. This adds to the evidence that these sex-, age-, and period-specific lifestyle JEM are valuable tools to adjust for risks related to lifestyle in register-studies without access to individual information (24).

However, the LTPA JEM did not consistently predict a reduced risk of AMI. This is perhaps not surprising since LTPA is prevalent regardless of type of occupation and low and high levels of LTPA occur in all job groups. . Nevertheless, this JEM serves the purpose of controlling confounding since exposure is also defined by JEM.

Other potentially confounding factors, such as heredity, hypertension, hyperlipidemia, diabetes, major depression (27), job strain (22), environmental (43) and occupational noise (44), shift work (45) and airborne particulate exposure (46), were not explicitly controlled for. Therefore, we are not able to exclude the possibility of residual confounding.

Healthy worker survivor effect. Individuals with emerging cardiovascular disease may leave physically demanding jobs long before death or hospitalisation for AMI leading to a healthy worker survivor effect (bias towards the null). This was probably counteracted by analyses only based upon exposure before start of follow-up, where cohort members were 30-50 years old and by including employment status as a covariate during follow-up.

Earlier findings

Although an increasing number of studies have addressed cardiovascular morbidity in relation to physical activities at work, direct comparisons of results are impeded by vaguely defined exposures. With few exceptions (21, 47), earlier studies relied on individual self-report of physical activities at one point in time and often combined various activities into one measure (9, 12–14, 19, 48). For example, one study defined physical activity as "standing and walking most of the time with quite a bit of carrying or lifting heavy burdens or work that requires vigorous or strenuous physical activity" (12) and another study defined physical activity as "most of the time you walk, and you often have to walk upstairs and lift various items (eg, mail delivery and construction work). Or you have heavy physical work. You carry heavy burdens and carry out physically strenuous work (eg, digging and shoveling)" (9). A Finnish study used a more transparent approach by converting self-report data on time spent in various activities into energy requirements (kcal/kg/hour) of these activities (sitting, standing, walking, climbing stairs – but without a category for heavier work) (13). Thus, the inability to distinguish more physically demanding work is a limitation of most previous studies. Moreover, confounding by individual and social risk factors is likely in many studies (17).

Sex differences. While most earlier studies reported effects in men (9, 12, 13, 19, 48), this study found most consistent associations in women. Biologically, it does not seem plausible that women are more susceptible to physical activities at work than men. The existence of sex-specific differences in the pathophysiology and pathogenesis of AMI is widely acknowledged (49) and some risk factors are more potent in women. However, men and women share all established risk/protective factors such as smoking, high BMI, exercise, diabetes, hypertension, and depression (27). It is therefore hard to figure out why physical activities at work would be deleterious in one sex but not in the other. In this study, we performed sex-stratified analysis to demonstrate consistency. It also seems unlikely that occupational exposure patterns and levels would confer a higher risk among women. However, the level of physical activity relative to the individual maximal capacity rather than the absolute level may be of importance (13). If women with physically demanding work have a higher work load relative to their maximal physical capacity than men, this might in fact explain sex differences, but this potential explanation of our findings seems less likely given the fact that we used lower category boundaries for lifting for women than for men. Of note, a large study of nurses with long follow-up found increased rate of incident IHD with increasing level of self-reported physical activities at work across all strata of self-reported LTPA (14). In this study physical activities were categorized as mainly sedentary (low), standing/walking (medium) and lifting/carrying/ heavy/fast/physically exerting work (high) (14).

Leisure time physical activity versus physical activities at work. It has been argued that the intensity of physical activity at work is too low to improve cardiorespiratory fitness and cardiovascular health (16). But this seems not to fit with evidence that even moderate physical activity such as brisk walking for 2.5 hours/week is related to substantially decreased cardiovascular mortality and that vigorous frequent physical training only accomplishes moderate additional risk reduction (4, 5). However, physical activity at work is distinguished by other characteristics. It has been argued that physical activity at work is associated with an elevation of the 24-hour heart rate and blood pressure (which is related to increased cardiovascular disease risk), insufficient recovery and work control and increased level of low-grade inflammation (16). Studies based on objective recordings of LTPA and specific physical activities at work are needed to corroborate or refute the relevance of these factors.

Concluding remarks

This study provides limited support to the hypothesis that long-term lifting and standing/walking at work are related to an increased risk of AMI.

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