DOC*X
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Occupational
Cohort

A quantitative general population job exposure matrix for occupational daytime light

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Aarhus University Hospital

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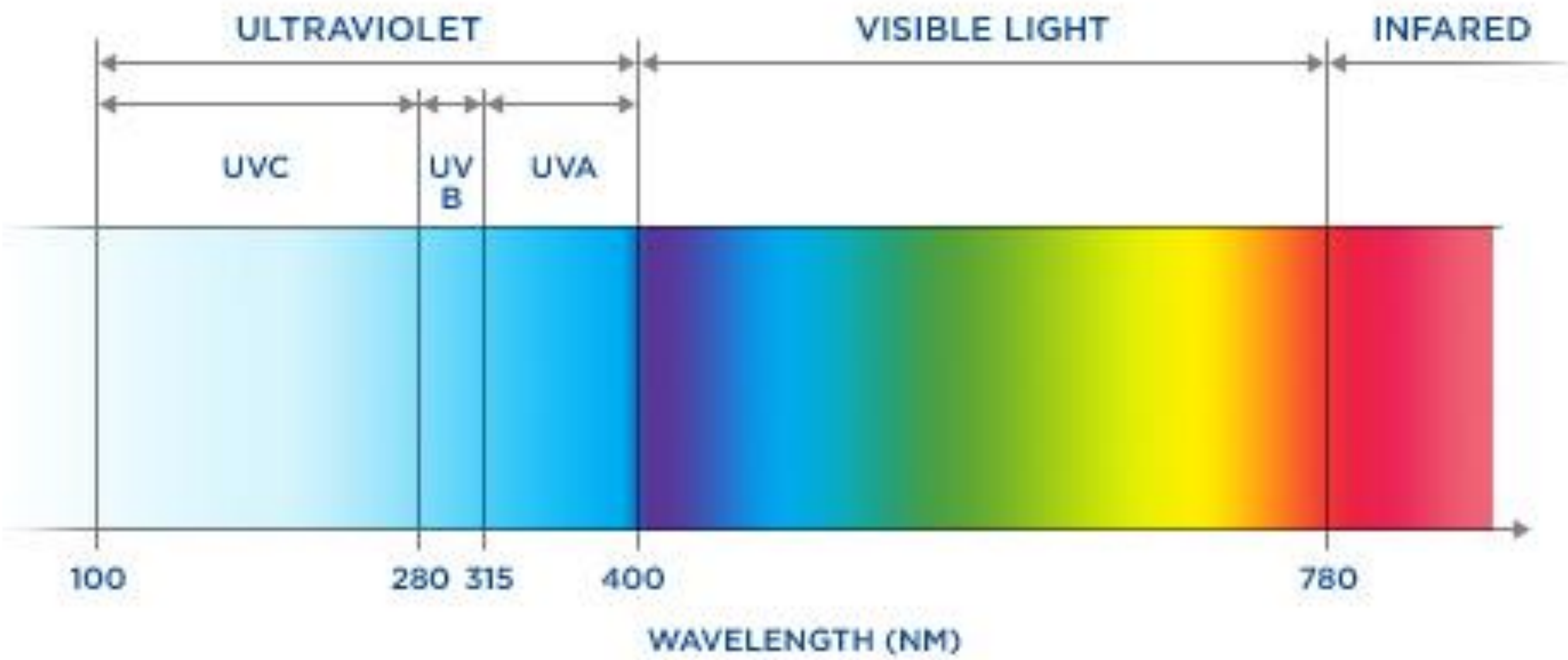
Background



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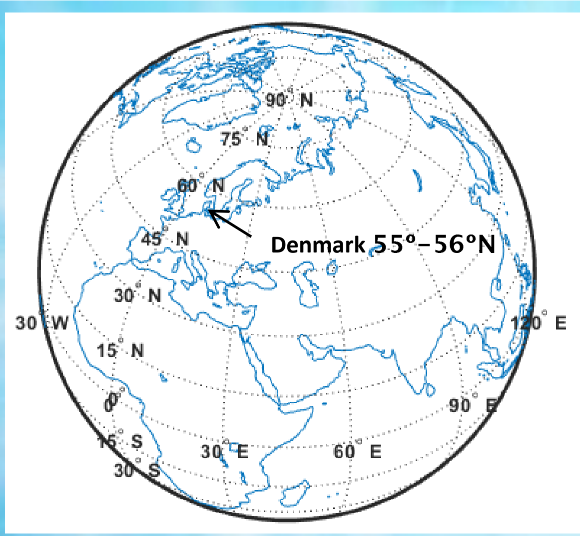

- Low daytime light levels risk factor for (SAD) and depressive symptoms

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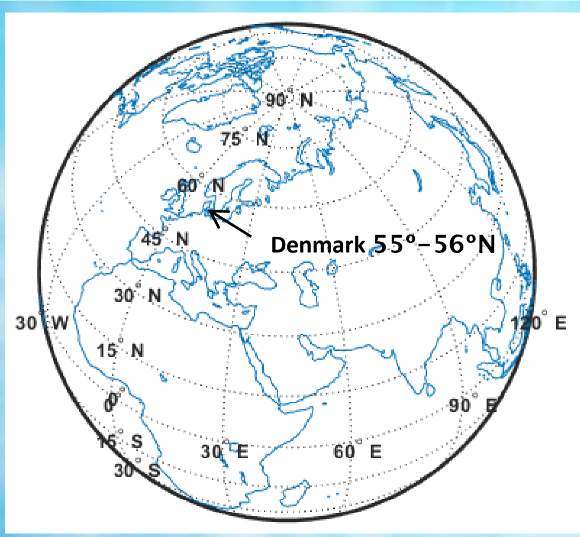

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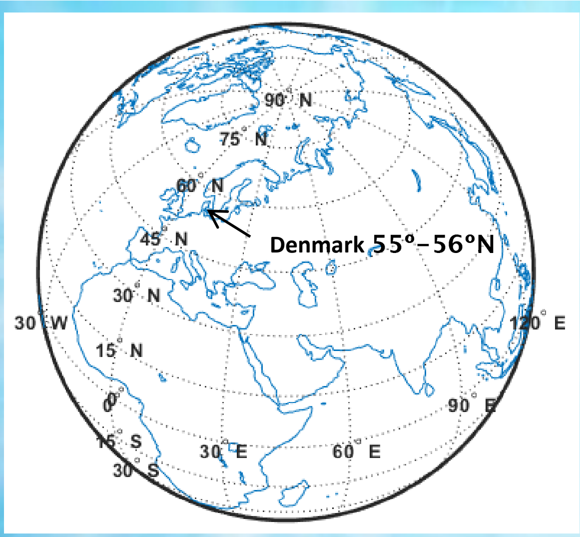

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- In Denmark (55°–56°N), outdoor workers are during daytime exposed to >2500 lux – more than 10 times higher than indoor workers

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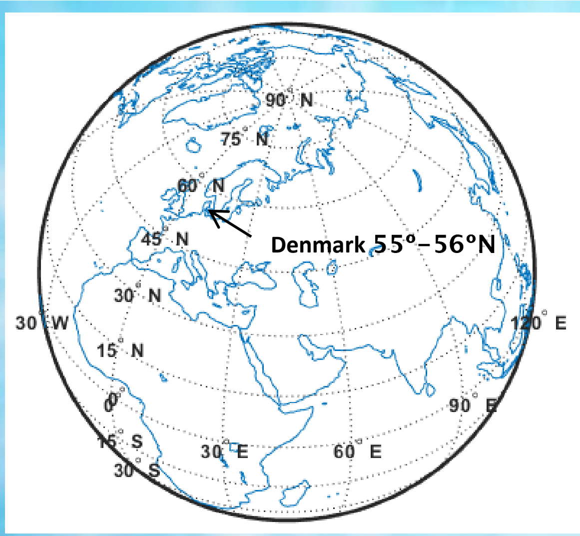

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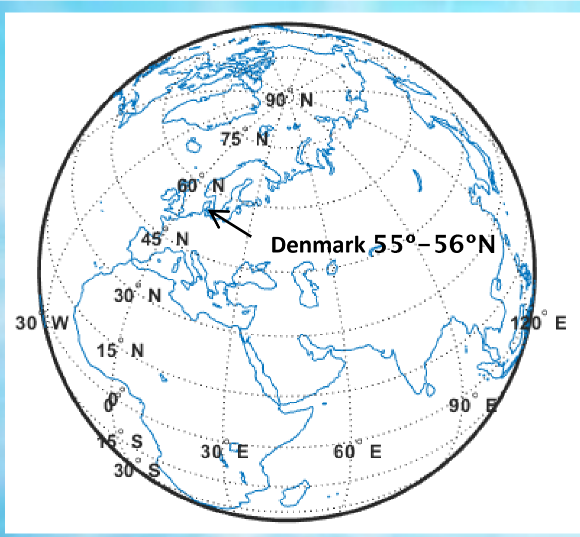

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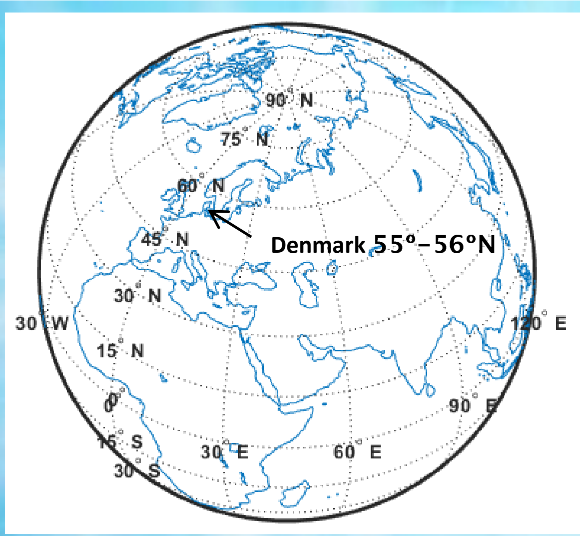

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Objectives

- I. Development of an occupational daytime light job exposure matrix (JEM) using a combination of expert ratings and daytime light exposure measurements

- II. To use the JEM to study exposure response relations between daytime light exposure, affective diseases, and other health effects

Materials and methods

– Expert scores of duration and probability of outdoor work

Three experts scored 387 DISCO-88 jobcodes

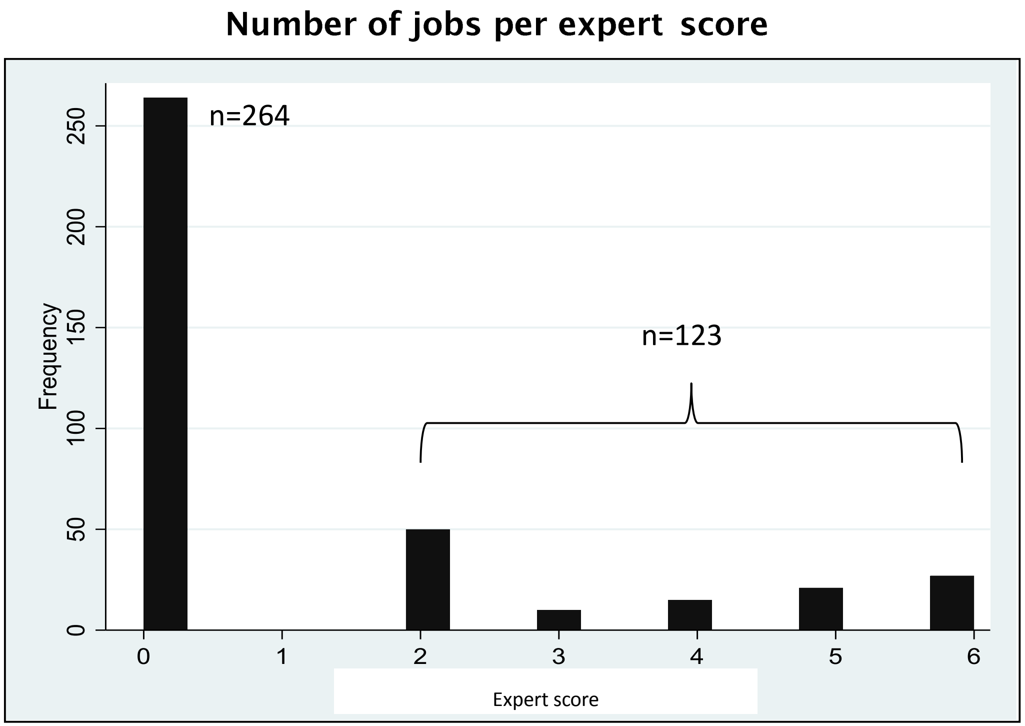
- **Probability of outdoor work:**
  - 0%
  - 1-24%
  - 25-49%
  - 50-100%

- **Duration of outdoor work:**
  - 0 hours
  - 1-2 hours
  - 3-4 hours
  - >4 hours

→ Expert score (duration + probability)

Materials and methods

– Expert scores of duration and probability of outdoor work



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Materials and methods

– Data collection

n=695 participants with work daylight measurements

2011-2012

Data collection I
n=511 participants

2015-2016

Data collection II
n=184 participants (n=24 in both summer and winter, n=30 one day work shifts (NFA))

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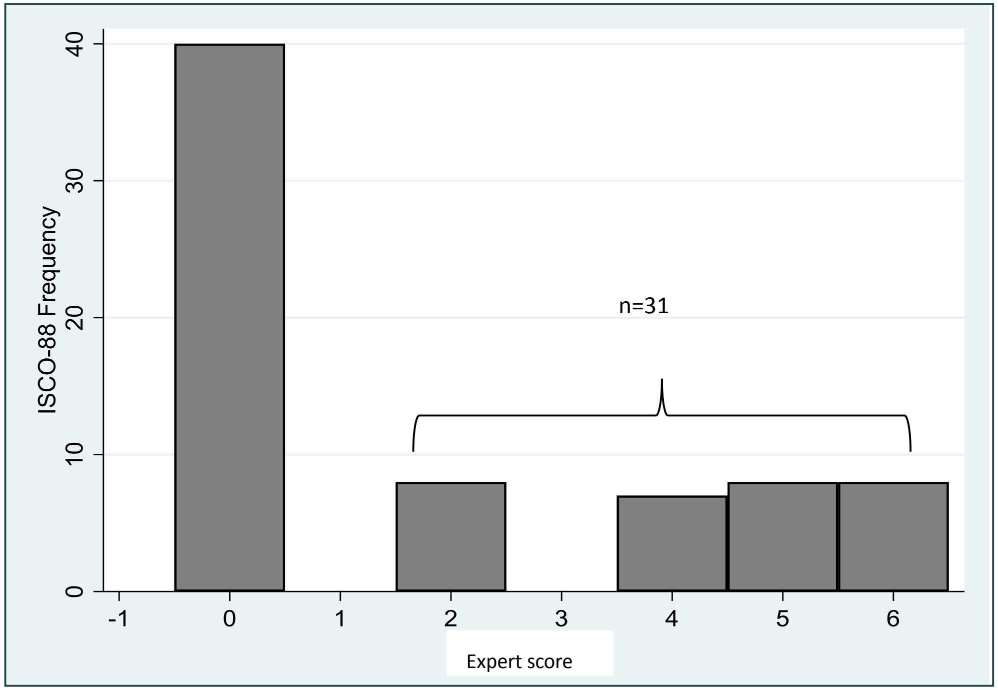
Materials and methods

– Data collection

Number of jobs with measurements per expert score



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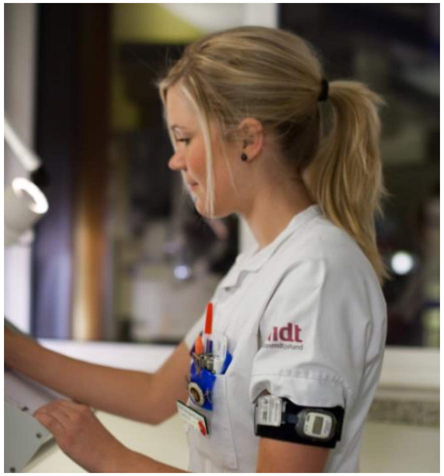
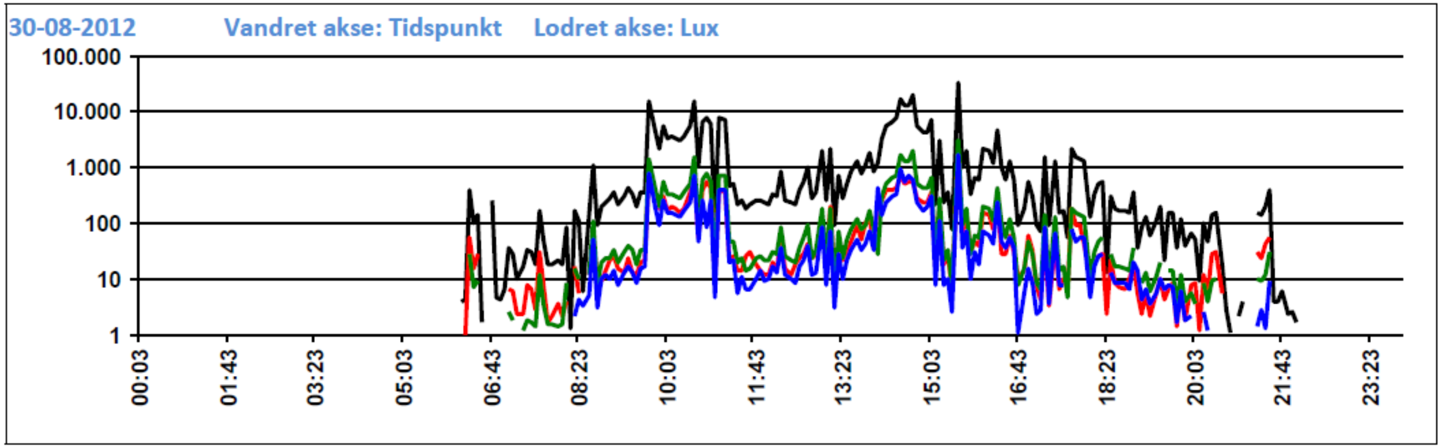
Materials and methods

– Measurements



- 1–7 workdays
- Daytime light = measured light 06:00–18:00

Light profile



Light measurements (1/min/day/person)

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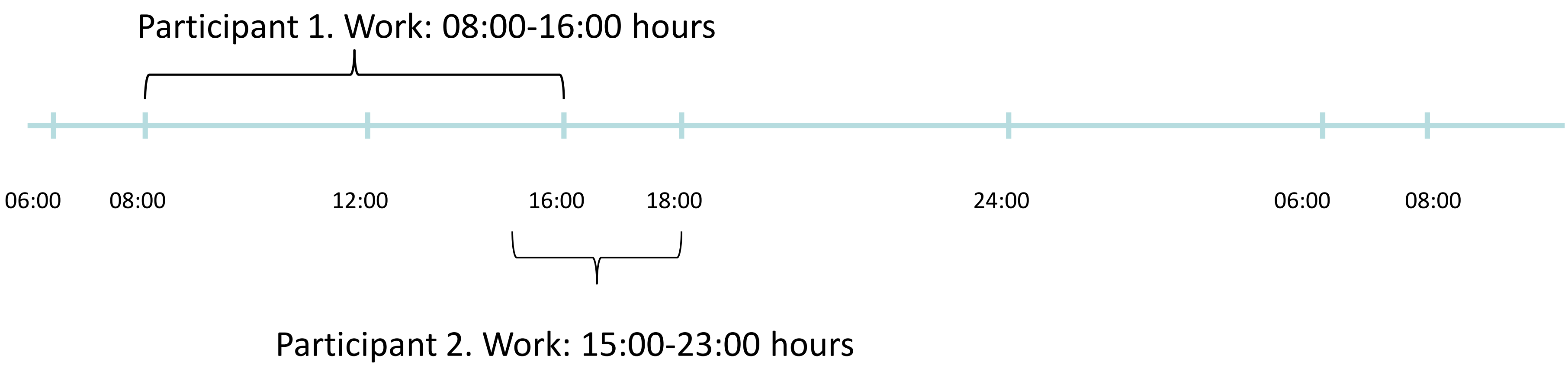
Materials and methods

– Work daylight measurements 06:00–18:00



Materials and methods

– Statistics

- Mixed effects models (SAS version 9.4)
  - Compound symmetry
  - Work hour means (06.00–18.00) natural log transformed

- n=695 persons
- n=2,199 days
- n=15,272 hours

Results

– Final model

- Fixed effects terms (β):
  - Month
  - Expert score
  - Hour
- Random effect terms (*b*):
  - Job
  - Industry nested in job
  - Subject id

- The model structure:

$$\mathrm{Ln}(Y):\ \beta_{0\ (\text{model intercept})} + \beta_M + \beta_E + \beta_H + bj_{1\text{-}387}J + bij_{1\text{-}39}({}_{1\text{-}387}IJ) + b_{i(1\text{-}695)}S$$

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Results

– Variance components

	Basic model with random effects only[a]		Model with random effects and months and hours as fixed effects[b]			Final model with random effects and months, hours, and expert score as fixed effects[c]		
	Variance component	SE[d]	Variance component	SE	% reduction	Variance component	SE	% reduction
Between jobs	0.82	0.25	0.53	0.16	35 %	0.14	0.08	83 %
Between industries nested in jobs	0.49	0.16	0.25	0.09	49 %	0.21	0.08	57 %
Between workers	0.82	0.06	0.47	0.04	43 %	0.47	0.04	43 %
Within worker	2.32	0.03	1.97	0.02	15 %	1.97	0.02	15 %
Total variance	4.45		3.22		28 %	2.79		37 %

[a]Basic model includes job, industry, and subject as random effects, [b]model includes job, industry, and subject as random effects, and month and hours as fixed effects, [c]Final model includes job, industry, and subject as random effects and expert score, months and hours as fixed effects, [d]Standard error, % reduction compared to basic model.

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Results Fixed effects model parameters and occupational daylight estimates

Model parameters		*β-estimate*	*Standard Error*	*Geometric Mean*	*P-value*
Fixed effect terms					
Intercept		5.33	0.26	206.81	<0.0001
Expert score	0	-1.70	0.23	37.77	<0.0001
	2	-1.45	0.34	47.80	<0.0001
	4	-1.24	0.30	59.67	0.0003
	5	-0.38	0.30	140.96	0.20
	6	0		206.81	
Month	January	0.34	0.18	290.41	0.06
	February	1.24	0.17	716.01	<0.0001
	March	1.57	0.17	998.65	<0.0001
	April	1.90	0.17	1378.98	<0.0001
	May	2.00	0.15	1528.28	<0.0001
	June	1.79	0.16	1233.49	<0.0001
	July	2.19	0.21	1853.63	<0.0001
	August	2.06	0.19	1626.04	<0.0001
	September	1.50	0.18	929.27	<0.0001
	October	1.09	0.18	617.20	<0.0001
	November	0.49	0.16	337.15	0.003
	December	0		206.81	
Hour	6	-1.57	0.11	43.10	<0.0001
	7	-6.66	0.10	107.30	<0.0001
	8	-0.005	0.09	205.73	0.96
	9	0.48	0.09	334.19	<0.0001
	10	.078	0.09	449.30	<0.0001
	11	0.87	0.09	494.38	<0.0001
	12	0.96	0.09	537.65	<0.0001
	13	0.92	0.09	521.23	<0.0001
	14	0.81	0.09	463.22	<0.0001
	15	0.62	0.10	385.37	<0.0001
	16	0.34	0.11	289.75	0.002
	17	0		206.81	

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Results

– Daylight exposure levels

DISCO-88 code	Job description	Daytime light exposure level (lux)
Three highest exposed jobs		
9313	Bouilding construction workers	2064
8332	Construction plant operators	2050
9312	Construction and maintenance laboures	2001
Three lowest exposed jobs		
3133	Medical equipment operators	66
2230	Nursing and midwifery professionals	99
3224	Opticians	109

Ln(Y): β0 (model intercept) + β*M* + β*E* + β*H* + *bj1-387J* + *bij1-39(1-387IJ)*

Example for Building construction workers:
exp((5.33+((0.34+1.24+1.57+1.90+2.00+1.79+2.19+2.06+1.50+1.09+0.49+0)/12)+0+((-1.57)+(-0.66)+(-00.005)+0.48+0.78+0.87+0.96+0.92+0.80+0.62+0.34+0)/12)+0.04+0.63)

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Discussion

- Strengths:
  - Field measurements
  - Repeated measurements
  - Use expert scores of probability and duration to assign exposure to jobs with no measurements
  - Use diary information and actigraph to exclude measurements where the light watch was not worn
  - First quantitative daylight JEM
  - Fairly comparable with light levels from other studies

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- Limitations:
  - Only 71 out of 387 jobs with measurements
  - A substantial number of the shifts were night shifts (hospital)
  - The JEM is latitude specific
  - Subjects were not selected at random

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Conclusion and perspectives

- This first quantitative JEM of daylight exposure enables assessment of job and calendar month specific lux exposure levels and provides applicability for epidemiological research of occupational daylight exposure and health effects

- Next step:
  - Investigate the association between occupational daytime light exposure and depression

- Epidemiological research of light exposure and other diseases

Acknowledgements

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Thank you!

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