Original article

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Does age modify the association between psychosocial factors at work and deterioration of self-rated health?

by Hermann Burr, PhD,[1] Hans Martin Hasselhorn, MD,[2] Norbert Kersten, PhD,[1] Anne Pohrt, MSc,[1] Reiner Rugulies, PhD [3, 4, 5]

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Objectives Few epidemiological studies have examined whether associations of psychosocial working conditions with risk of poor health differ by age. Based on results from mostly cross-sectional studies, we test whether (i) psychosocial relational factors (social support) are more strongly associated with declining health of older than younger employees and (ii) psychosocial job factors (workpace, influence, possibilities for development) are more strongly associated with declining health of younger than older employees.

Methods We extracted two cohorts from the Danish Work Environment Cohort Study (DWECS): the 2000–2005 and 2005–2010 cohorts. The participating 5281 employees with good self-rated health (SRH) at baseline were observed in 6585 5-year time windows. Using log-binomial regression analyses, we analysed whether psychosocial factors at work predicted 5-year deterioration of SRH. Effect modification by age was estimated by calculating relative excess risk due to interaction (RERI).

Results High workpace among men, low influence at work as well as low social support from colleagues among women, and low possibilities for development and low social support from supervisors among both genders predicted 5-year decline in SRH. Of the 20 interaction analyses, only 1 was statistically significant and in the opposite direction of what was hypothesized (higher risk for declining SRH among middle-aged men with low possibilities for development compared to the young men with high possibilities for development).

Conclusions Psychosocial working conditions predicted decline in SRH in this 5-year follow-up study. The model did not support our hypotheses about effect modification by age.

Key terms ageing; COPSOQ; decision authority; DWECS; interaction; job factor; older worker; psychosocial work environment; relational factor; skill discretion.

The question whether age modifies the association between work and health is becoming increasingly relevant as the proportion of older workers in the workforce grows across many industrialized countries (1). This development is caused by the ageing of adult populations due to low birth rates and lower mortality and a reversal in pensioning policies in several countries in the last two decades (2). This makes it even more relevant to know if certain working conditions constitute higher risks especially for older workers (3). However, in most epidemiological psychosocial research it is assumed that the effect of psychosocial working conditions on health is independent of age, and age is usually used only as covariate in multivariate analyses (3).

The notion of age comprises not only chronological age, as measured and analyzed by statistical bureaus (1) and labor market and health researchers (2, 3), but also functional age (eg, health, workability, cognitive ability) (3–5). For example, older age is related to poor self-rated general health (6), but it is unclear if cognitive capabilities of older workers decrease (5). Also with older age, access to further vocational training is limited in many industrialized countries (7, 8). Additionally, as has been acknowledged by labor market and health

1 Federal Institute for Occupational Safety and Health (BAuA), Berlin, Germany.
2 Department of Occupational Science, University of Wuppertal, Wuppertal, Germany.
3 National Research Centre for the Working Environment, Copenhagen, Denmark.
4 Department of Public Health, University of Copenhagen, Copenhagen, Denmark.
5 Department of Psychology, University of Copenhagen, Copenhagen, Denmark.

Correspondence to: Hermann Burr, Federal Institute for Occupational Safety and Health (BAuA), Berlin, Germany. [E-mail: burr.hermann@baua.bund.de]

researchers, chronological age should be distinguished from different birth cohorts (9, 10). For example, various birth cohorts can experience quite different work life careers (10). Data collected in only one calendar year does not allow for the disentanglement of the role of chronological age from birth year; a range of data collection years are needed for that purpose (9).

So far only very few studies have analyzed whether the relations between psychosocial working conditions and health are dependent on age. These studies first fitted regression models within age strata and then compared the resulting models between strata (3, 11–13). One analysis was prospective (3), the others were cross-sectional. The outcomes investigated were emotional exhaustion and company satisfaction (3), work-related fatigue, stress complaints and burnout (12), job satisfaction (11) or job dissatisfaction and need for recovery (13). The longitudinal analysis was based on 686 employees from a sample of the total Dutch workforce (3), the other studies were based on 827 railway employees (12), 1112 university employees (11), and 591 university employees (13). The results seem to indicate that psychosocial job factors such as workpace (3), influence and possibilities for development (11, 13) have a greater impact on younger workers' health than that of older workers, whereas psychosocial relational factors, such as social support from supervisor and leadership quality, have a greater impact on older workers' than younger workers' health (3, 11, 12).

However, none of these studies have reported whether age interacted statistically with psychosocial factors nor have studies reported the confidence intervals (CI) of the risk estimates which would allow for the assessment of interaction. Drawing causal inference is further hampered by the fact that the majority of the studies were cross-sectional with only one year of data collection. This makes assessment of causality difficult (14).

In this article, we aim to overcome the limitations of these previous studies. Using a large-scale open cohort study of the Danish workforce, we examine the prospective association of psychosocial work factors with risk of decline in self-rated health (SRH) and analyze whether these associations are modified by employees' age. Based on the findings from the earlier studies, we test two hypotheses: First, psychosocial job factors (ie, high workpace, low influence, and low possibilities for development) are more strongly associated with declining SRH among younger than older workers. Second, psychosocial relational factors (ie, low social support from supervisors and low social support from coworkers) are more strongly associated with declining SRH among older than younger workers.

Method

Population

We extracted the 2000–2005 and 2005–2010 cohorts from the Danish Work Environment Cohort Study (DWECS) (baseline response of participants 71%, follow-up response of participants 72%, see table 1). DWECS is an open cohort study investigating work and health among the Danish working population by means of repeated questionnaire assessments every five years (15). So a DWECS participant could take part in both or one of the 5-year cohorts when he or she was an employee and aged 18–59 years (men) or 18–54 years (women) at baseline; gender-specific upper-age cut-off points were chosen so as to avoid strong selection due to withdrawal from the labor market near retirement (2). The data from the DWECS consisted of 6623 employees at baseline measured in at least two sequential waves 2000–2010. For the 6623 participating employees, a total of 8473 observed 5-year time windows were found (1850 employees were observed in both cohorts, 1674 in only the 2000–2005 cohort and 3099 only in the 2005–2010 cohort, mean observations per participant 1.28). Of the observations, 756 had missing information on at least one variable, leaving 7717 observations. Of these, 1264 observations had poor SRH at baseline and were excluded from the analyses. The analyses in the present paper were based on the remaining 6453 observations from 5182 employees (mean 1.25 five year windows per participant). Of the observations, 52% were women. The mean age was 41.2 and 39.2 years for men and women, respectively.

Variables

Outcome. SRH was measured by one single question at baseline and follow up: "How do you rate your health in general?" with the response categories "very good", "good", "fairly good", "poor" and "very poor". In order to assess Rothman's concept of biological interaction (16), we dichotomized the variable by collapsing "very good" and "good" into "good SRH" and the three other responses into "poor SRH" (17, 18). For a sensitivity analysis (see below), where a linear regression was carried out to assess interaction, the scale version of the variable was used where "very good" had the value 0 and "very poor" had the value 4.

Age and gender. Information on age and gender at baseline was derived from register data. All other variables were based on self-reports. Age was divided into tertiles; young (18–32 years), middle-aged (33–43 years) and old (44–59 for men and 44–54 for women). For some sensitivity linear regressions, age was used as a continuous variable.

Table 1. Participation in the two cohorts. [DC=data collection; SRH=self-rated health.]

	2000–2005 cohort (N=9338)				2005–2010 cohort (N=16 199)				Observations [b] (N=25 537)				Participants [c] (N=18 583)			
	N	%	Women (%)	Mean age [a]	N	%	Women (%)	Mean age [a]	N	%	Women %	Mean age [a]	N	%	Women	Mean age [a]
Baseline																
Deceased, emigrated, DC protected	55				50				105				105			
Participants	7030	76 [d]			9886	61 [d]			16 916	67 [d]			13 031	71 [d]		
Employees	5222		48	38.5/37.7	7769		50	40.9/38.8	12 991		49	39.9/38.4	10 279		49	40.1/38.4
Follow-up																
Deceased, emigrated, DC protected	550				514				1064				1064			
Participants	3524	75 [e]	50	40.1/38.7	4949	68 [e]	52	42.8/39.9	8473	71 [e]	51	41.7/39.4	6623	72 [e]	51	42.1/39.7
Missing information	207				549				756				530			
Information on all relevant variables	3317		50	40.0/38.7	4400		52	43.0/40.1	7717		51	41.7/39.5	6093		52	42.2/39.9
Poor SRH at baseline	433				831				1264				911			
Population analyzed	2884		50	39.6/38.3	3569		53	42.5/39.9	6453		52	41.2/39.2	5182		52	41.1/39.2
Mode of DC																
Baseline and follow-up interview	924								924				– [f]			
Baseline interview, follow-up questionnaire	1960				689				2649				– [f]			
Baseline and follow-up questionnaire					2880				2880				– [f]			

[a] Men/women.
[b] Total of the two cohorts.
[c] Some participants took part in only one cohort, other in both cohorts
[d] Participation at baseline as a fraction of baseline sample save deceased, emigrated, data collection protected.
[e] Participation at follow-up as a fraction of baseline participants save deceased, emigrated, data collection protected.
[f] As different modes of data collection were employed in each round of each cohort it is not possible to sum up number of respondents here.

Psychosocial job factors. Psychosocial working conditions were measured by items from the COPSOQ inventory, see below (19), which had the following response options (scale values): "always" (100), "often" (75), "sometimes" (50), "seldom" (25), and "never/hardly ever" (0).

Workpace was based on the question (19, 20): "Is it necessary to work very fast?". The item was dichotomized at the median so that values ≥75 were classified as high and <75 as low.

Influence was based on the four questions (19) "Do you have a large degree of influence concerning your work?", "Do you have a say in choosing who you work with?", "Can you influence the amount of work assigned to you?" and "Do you have any influence on what you do at work?". The scale was dichotomized at the median so that values ≤50 were classified as low and >50 as high.

Possibilities for development was based on the four questions (19), "Does your work require you to take the initiative?", "Do you have the possibility of learning new things through your work?", "Can you use your skills or expertise in your work?" and "Is your work varied". The latter question had the nonstandard response options (and values for the scale): "To a high degree" (100), "To some degree" (66 2/3), "Only to a lesser degree" (33 1/3), "No, or only to a slight degree" (0). The scale was dichotomized at the median so that values ≤77 were classified as low and >77 as high. For some sensitivity linear regressions, the scale versions of these variables were used.

Psychosocial relational factors. Social support from supervisor was measured by means of the two questions (19): "How often do you get help and support from your immediate superior?" and "How often is your immediate superior willing to listen to your work related problems?". The scale was dichotomized at the median so that values ≤62.5 were classified as low and >62.5 as high.

Social support from colleagues was measured by means of the two questions (19): "How often are your colleagues willing to listen to your problems at work?" and "How often do you get help and support from your colleagues?" The scale was dichotomized at the median so that values ≤75 were classified as low and >75 as high.

Covariates

Mode of data collection had the following categories (21): (i) interview at baseline and follow up, (ii) interview at baseline and questionnaire at follow up, and (iii) questionnaire at baseline and follow up.

Social class was measured by a modified version of

the European Socioeconomic Classification (ESeC) (22), with the categories (and values for the scale): "large employers, higher managers/professionals" (1), "lower managers/professionals, supervisors, technicians" (2), "intermediate occupations" (3), "lower sales and service" (4), "lower technical" (5), "routine" (6).

Occupational physical demands had the categories "high" and "low" and was based on a scale using the following questions: "Does your work involve sitting?" (reversed) , "Does your work involve squatting or kneeling?", "How much of your working hours do you carry or lift things/people?" and "What does the load you carry normally weigh?". The scale was dichotomized at the highest quartile.

Analyses

We carried out regression analyses stratified by gender and controlled for social class (linear) and age (categorical). Using the log-binominal method (23), we estimated prevalence ratios (PR) for prevalence of psychosocial working conditions (cross sectional analyses) and risk ratios (RR) with 95% CI for deterioration of SRH (analyses of change over time), assuming correlation between observations belonging to the same person. The log-binomial method [sometimes also called the multiplicative method (24)] can be used to estimate the ratio of risks – or prevalences – among exposed and unexposed. We used RR for interaction analyses to assess age modification, see below (25, 26).

The analyses were conducted in the following order: First, we determined whether psychosocial factors predicted five year deterioration of poor SRH.

Second, in a regression analysis to investigate whether age group (middle or older versus younger) modified the association of psychosocial working conditions with declining SRH, we performed interaction analyses. In general, interaction may be defined as either departure from additivity or from multiplicativity (16). We chose to analyze departure from additivity because this is relevant from a public health perspective and it helps to identify which groups might benefit from certain interventions (16). Interaction effects were thus analyzed by calculating the relative excess risk due to interaction (RERI) with the formula set out in equation 1 (16).

$$RERI = (RR_{\text{exposed \& higher age}} - 1) - (RR_{\text{exposed \& lower age}} - 1) - (RR_{\text{not exposed \& higher age}} - 1)$$

Equation 1

When RERI≠0, an additive interaction is present. RERI can take any real value. RERI <0 indicates subadditivity and RERI >0 indicates superadditivity. RERI can be understood as the amount of extra risk due to the combined effect of exposure to psychosocial working conditions and age as compared to the base risk. We used the delta method to calculate 95% CI (25, 26). More specifically, this calculation requests the estimation of RR (odds ratios can be used only as a substitute) for all combinations of the two variables in question (25, 26); as the log binomial method can estimate RR directly (23), we chose this regression method.

We carried out four additional sets of sensitivity analyses. First, we repeated the main log binomial regression analysis adding a control for occupational physical demands in order to see whether they confounded the results.

Second, we repeated the main log binomial regression analysis also including observations, which at baseline had poor SRH and adding a control for baseline SRH in order to see what role the restriction of only looking at observations with good SRH at base line played.

Third, we carried out a linear regression analysis, where observations with poor SRH were excluded like in the main analysis. In this and the next set of linear regressions analyses, however, the independent and the dependent variables were treated as linear variables; the goal of these analyses was to see if more well-powered analyses would reveal more significant interactions than in the main analysis where variables were dichotomized. In these linear regressions, we again assumed correlation between observations belonging to the same person. Interactions were assessed by including the product of the psychosocial factor and age, as a deviation from the product of the psychosocial factor and age are deviations from additivity and as such it is the linear regression equivalent to the assessment of RERI when predicting discrete outcomes. In order to assess interaction, the scale versions of age and the psychosocial scales were z-standardized.

Fourth, we carried out a linear regression analysis, where also observations with poor SRH were included, with variables treated as continuous.

All analyses were conducted with SPSS version 20 and 21 (GENLIN, IBM Corp, Armonk, NY, USA).

Results

Tables 2a and 2b show the prevalence of psychosocial working conditions by age. For both men and women, the prevalence of most psychosocial working conditions was independent of age. However, the prevalence of low influence decreased in the age groups >32 years (table 2a). Regarding low possibilities of development,

prevalence significantly decreased among women aged 33–43 years compared to those aged 18–32 years. Also, low social support from colleagues was more prevalent among women aged 44–54 years than among the 18–32-year-old group (table 2b).

Tables 3a–3c show the association of baseline age and psychosocial working conditions with five years risk of deterioration of SRH during follow-up. Models with and without control for social class are shown. Among men, when not controlling for social class, increasing age and all psychosocial factors (except social support from colleagues) predicted deterioration of SRH. A further control for social class attenuated most associations, and they stayed significant only regarding workpace and social support form supervisor. Among women being 44–54 years old or exposed to any psychosocial factor – except workpace – predicted poor SRH. A control for social class did not change these associations.

Tables 4a and 4b show whether age modifies the association between psychosocial working conditions and the risk of poor SRH, that is whether age interacts with psychosocial working conditions when predicting SRH. Among men in the 33–43-year-old group with low possibilities for development, the expected RR was 0.85 (the sum of the risk for men <33 years reporting low possibilities for development plus the risk for men 33–43 years). The observed RR was substantially higher, namely 1.45. Thus the difference between the expected and observed RR, the RERI, was statistically significant (0.61; 95% CI 0.22–1.09).

Regarding all other 19 combinations of age and psychosocial factors in the two genders, no significant interactions were found (table 4a and 4b). Among men, insignificant RERI ≥0.2 were found for the interactions of all psychosocial job factors with age as well as for low social support (older men). This was also the case regarding possibilities for development among middle aged women. Insignificant negative RERI ≤-0.2 were found regarding the job factor influence among middle aged women, and regarding the relational factor support from colleagues among men.

Sensitivity analyses

When we further adjusted for physical demands, all results remained virtually the same (data not shown but available from the first author).

In a second sensitivity analysis, we repeated the analysis of age modification (RERI) again also including observations with poor SRH at baseline (Supplementary tables A1 and A2, www.sjweh.fi/index.php?page=data-repository). Compared with the main analysis, most RERI got considerably closer to zero. The only significant RERI (regarding possibilities for development among middle-aged men) decreased from 0.61 to 0.26 (95% CI= -0.06–0.59) (compare supplementary table A1, last columns, with table 4a, last columns). Only one other positive RERI was still ≥0.2: the one regarding possibilities for development among middle-aged women. A negative RERI was found regarding workpace among older men [-0.26 (95% CI -0.68–0.15)], which in the main analysis was positive (ie, 0.20).

We carried out two additional sets of sensitivity analyses, treating the outcome, age and the psychosocial factors as continuous variables in linear regressions in order to increase statistical power. In the first set, we excluded people with the poor SRH categories at baseline like in the main analysis. There were no significant interactions between age and the psychosocial factors (supplementary tables B1 and B2). Two interactions had a P-value <0.2, namely regarding influence and possibilities for development among women. The insignificant negative betas indicate that the associations of influence and possibilities for development with deterioration of SRH may be stronger among younger than older employees. In the last set of linear regressions all people regardless of SRH status at baseline were included. Still no significant interactions between age and the psychosocial factors were found

Table 2a. Prevalence of psychosocial job factors by gender and age: 6453 observations from 5182 employees [a] without poor self–rated health (SRH) at the baselines 2000 and 2005. **Bold denotes significant prevalence ratios (PR).**[b] [95% CI=95% confidence interval.]

	N	High work pace			Low influence			Low possibilities for development		
		%	PR	95% CI	%	PR	95% CI	%	PR	95% CI
Men (age)										
18–32	727	37	1		57	1		50	1	
33–43	1011	41	1.11	0.98–1.25	42	**0.76**	**0.69–0.84**	49	0.97	0.88–1.07
≥44	1374	38	1.01	0.90–1.14	42	**0.76**	**0.69–0.83**	48	0.94	0.86–1.03
Women (age)										
18–32	845	44	1		64	1		52	1	
33–43	1267	42	0.94	0.85–1.04	54	**0.86**	**0.80–0.92**	47	**0.90**	**0.83–0.98**
≥44	1229	46	1.01	0.92–1.12	51	**0.82**	**0.76–0.88**	50	0.94	0.87–1.03

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.

[b] A PR can be interpreted as the fraction of the prevalence in the age group of the prevalence in the comparison age group (younger employees).

(supplementary tables C1 and C2, www.sjweh.fi/index.php?page=data-repository). Here, two interactions had a P<0.2. One was the above mentioned interaction regarding influence among women, the other was regarding social support among women. The – insignificant – negative betas indicate that the association between influence and social support was stronger among younger employees than among older employees.

Discussion

High workpace among men, low influence, low possibilities for development, and low social support from colleagues among women and low social support from supervisors among both genders predicted a decline in SRH during a 5-year follow-up in this large prospective study of the Danish work-force. However, our analyses did not indicate that psychosocial working conditions had substantially different effects on SRH for employees depending on their age.

The sensitivity analyses (including also people with poor health at baseline or using a linear regression approach or both) did not support the only significant finding of a modifying effect of age on the relation between a psychosocial working condition (namely that low possibilities for development among middle-aged men had a stronger effect than on younger men) and SRH. Our hypothesis suggested that younger men should have had the highest risk, but this was not confirmed.

Strengths and limitations

It is a strength of the study that the DWECS offered 6453 5-year windows from 5182 employees for the main analyses (mean 1.25 5-year windows per participant), as large statistical power is needed to determine interaction effects (27). In fact the study is larger than the previous studies on this subject (3, 11–13). However, for determining smaller age-dependent associations between psychosocial factors and SRH, more observations than the in present study are needed. Second, it is a strength that the study allows for observing changes of SRH in 5-year time windows in order to better assess causation. Third, DWECS contains information on social class. We considered a control for social class as relevant (tables 3 and 4), as especially psychosocial job factors are correlated with low social class (28), which thus confounds their associations to SRH (compare models in table 3).

The strengths of the study need to be balanced against some weaknesses. First, the main analysis of the present paper was restricted to people with good SRH at baseline (table 4), thus the older people are in

Table 2b. Prevalence of psychosocial relational factors by gender and age: 6453 observations from 5182 employees [a] without poor self–rated health (SRH) at the baselines 2000 and 2005. **Bold denotes significant prevalence ratios (PR).**[b] [95% CI=95% confidence interval]

	N	Low social support from supervisor			Low social support from colleagues		
		%	PR	95% CI	%	PR	95% CI
Men (age)							
18–32	727	41	1		27	1	
33–43	1011	43	1.02	0.91–1.14	35	**1.20**	**1.04–1.38**
≥44	1374	46	1.07	0.96–1.18	37	**1.26**	**1.10–1.44**
Women (age)							
18–32	845	38	1		22	1	
33–43	1267	40	1.01	0.91–1.13	25	1.05	0.90–1.22
≥44	1229	42	1.05	0.94–1.16	30	**1.19**	**1.03–1.38**

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.

[b] A PR can be interpreted as the prevalence in the age group compared to the comparison age group (younger employees).

Table 3a. Five-year deterioration of self-rated health (SRH): 6453 observations from 5182 Danish employees [a] without poor health at the baselines 2000–2005 by psychosocial job factors, stratified by gender. **Bold denotes significant risk ratios (RR)**. Baseline data from 2000 and 2005 and follow–up data from 2005 and 2010. Relative risks controlled for repeated measurements. [95% CI=95% confidence interval; Obs=observed.]

	High workpace						Low influence						Low possibilities for development					
	N	Obs (%) [b]	RR [c]	95% CI	RR [d]	95% CI	N	Obs (%) [b]	RR [c]	95% CI	RR [d]	95% CI	N	Obs (%) [b]	RR [c]	95% CI	RR [d]	95% CI
Men																		
Exposed	1203	18	**1.25**	**1.07–1.47**	**1.28**	**1.09-1.50**	1415	**18**	**1.26**	**1.07–1.49**	1.16	0.98–1.37	1521	18	**1.30**	**1.11–1.53**	1.17	0.99–1.40
Not exposed	1909	15	1		1		1697	15	1		1		1591	14	1		1	
Women																		
Exposed	1472	18	1.12	0.96–1.31	1.12	0.97-1.31	1858	18	**1.33**	**1.14–1.56**	**1.25**	**1.06–1.47**	1661	19	**1.29**	**1.14–1.55**	**1.21**	**1.03–1.43**
Not exposed	1869	16	1		1		1483	16	1		1		1680	14	1		1	

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.

[b] New cases of poor SRH at follow-up.

[c] Adjusted for baseline age and mode of data collection at baseline and follow-up.

[d] Addtionally adjusted for social class (linear).

Table 3b. Five-year deterioration of self-rated health (SRH): 6453 observations from 5182 Danish employees [a] without poor health at the baselines 2000–2005 by psychosocial relational factors, stratified by gender. **Bold denotes significant risk ratios (RR).** Baseline data from 2000 and 2005 and follow–up data from 2005 and 2010. Relative Risks controlled for repeated measurements. [95% CI=95% confidence interval; obs=observed.]

	Low social support from supervisor						Low social support from colleagues					
	N	Obs (%) [b]	RR [c]	95% CI	RR [d]	95% CI	N	Obs (%) [b]	RR [c]	95% CI	RR [d]	95% CI
Men												
Exposed	1367	19	**1.37**	**1.17–1.61**	**1.34**	**1.14–1.58**	1059	17	1.07	0.91–1,27	1.05	0.88–1.24
Not exposed	1745	14	1		1		2053	16	1		1	
Women												
Exposed	1353	18	**1.21**	**1.04–1.42**	**1.21**	**1.01–1.38**	864	21	**1.40**	**1.19–1.66**	**1.39**	**1.18–1.64**
Not exposed	1988	15	1		1		2477	15	1		1	

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.
[b] New cases of poor SRH at follow-up
[c] Adjusted for baseline age and mode of data collection at baseline and follow-up.
[d] Addtionally adjusted for social class (linear).

Table 3c. Five-year deterioration of self-rated health (SRH): 6453 observations from 5182 Danish employees [a] without poor health at the baselines 2000–2005 by age, stratified by gender. **Bold denotes significant risk ratios (RR)**. Baseline data from 2000 and 2005 and follow–up data from 2005 and 2010. Relative Risks controlled for repeated measurements. [95% CI=95% confidence interval; obs=observed.]

	N	Obs (%) [b]	RR [c]	95% CI
Men age, years				
18–32	727	13	1	
33–43	1011	16	**1.35**	**1.07–1.72**
44–59	1374	18	**1.46**	**1.16–1.83**
Women age, years				
18–32	845	15	1	
33–43	1267	16	1.12	0.89–1.38
44–59	1229	18	**1.25**	**1.02–1.53**

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.
[b] New cases of poor SRH at follow-up
[c] Adjusted for baseline social class and mode of data collection at baseline and follow-up.

the analyzed population, the more selected they are (6). When instead we also included people with poor SRH at baseline, indications of modifying effects of age got less clear (supplementary table A). Second, as the study used data from only two base-lines five year apart, it could only to a limited extent disentangle the role of chronological age from the role of birth cohort (younger workers belonged to the 1968–1987 birth cohorts, middle-aged workers to the 1957–1972 cohorts, and older workers to the 1941[men]/1946[women]–1961 cohorts). Third, in order to calculate RERI in the main analysis, we dichotomized psychosocial factors and SRH and divided age into three categories. The dichotomization of the psychosocial scales was based on their median, which relies on the observation that psychosocial factors were linearly associated with SRH (18). Fourth, by categorizing psychosocial factors and age for the interaction analyses, one loses statistical power to assess RERI (29). But in sensitivity analyses, where we treated age, psychosocial factors and SRH as continuous variables, we essentially found the same results (supplementary table B). Fifth, this study is observational and thus, as always in such studies, selection occurs. To address this bias we only included people at baseline not yet undergoing the strong – partly health-related – selection processes arising at the end of the labor market career (2). Further, the analyses took another aspect of the selection issue into account as we also included participants at follow-up who left work due to poor health. Sixth, the 5-year follow up timeframe of the present study does not allow for the investigation of short-term effects of the psychosocial factors. Seventh, it can be seen as a drawback that we did multiple significance tests with a significance level of 0.05 (two-sided) as we have investigated 20 interactions between psychosocial working conditions and age (two genders×five exposures×two age groups=20). That means that this study by chance should find one significantly deviating RERI due to interactions; in fact we found one.

Comparison with other findings

A number of studies have concluded that some psychosocial job factors, such as high workpace, poor influence, and poor possibilities for development, have a stronger impact on health among younger employees, whereas poor psychosocial relational factors have a stronger impact among older employees (3, 11–13). However, none of these studies tested for interaction. Our interaction analyses could not support these findings. We found only one indication that age modified the association between job factors and SRH among men, and this was in the opposite direction of what the

Table 4a. Five-year deterioration of self-rated health (SRH): 6453 observations from 5182 Danish employees [a] without poor health at baseline (2000–2005) by combinations of psychosocial job factors and age group. **Bold numbers denote significant risk ratios (RR)**. Baseline data: 2000, 2005 and follow-up data: 2005, 2010. Controlled for repeated measurements. [95% CI=95% confidence interval, Obs=observed; RERI=relative excess risk due to interaction.]

Exposed (E) versus not exposed (NE) in age groups	High workpace and age						Low influence and age						Low possibility for development and age					
	N	Obs (%) [b]	RR [c]	95% CI	RERI [d]	95% CI	N	Obs (%) [b]	RR [c]	95% CI	RERI [d]	95% CI	N	Obs (%) [b]	RR [c]	95% CI	RERI [d]	95% CI
Men																		
NE: 18–32	461	12	1				313	13	1				365	13	1			
E: 18–32	266	14	1.28	0.87–1.88			414	12	0.91	0.62–1.34			376	12	0.84	0.58–1.26		
NE: 33–43	600	14	1.30	0.95–1.79			587	14	1.17	0.82–1.65			520	13	1.01	0.71–1.43		
E: 33–43	411	19	**1.78**	**1.29–2.44**	0.20	-0.40–0.80	424	19	1.41	0.99–1.99	0.33	-0.14–0.80	502	20	**1.45**	**1.05–1.99**	**0.61**	**0.19–1.04**
NE: ≥44	848	17	**1.48**	**1.10–1.99**			797	15	1.24	0.89–1.74			730	16	1.22	0.89–1.68		
E: ≥44	526	19	**1.83**	**1.34–2.48**	0.20	-0.36–0.76	577	21	**1.52**	**1.10–2.12**	0.37	-0.07–0.81	676	20	**1.44**	**1.06–1.96**	0.38	-0.05–0.80
Women																		
NE: 18–32	469	14	1				302	12	1				405	13	1			
E: 18–32	376	16	1.08	0.78–1.50			543	16	1.35	0.93–1.95			455	17	1.20	0.85–1.68		
NE: 33–43	733	15	1.10	0.83–1.46			583	14	1.26	0.87–1.83			683	12	0.99	0.71–1.37		
E: 33–43	534	17	1.26	0.94–1.69	0.08	-0.37–0.53	684	17	**1.45**	**1.02–2.06**	-0.25	-0.72–0.41	624	20	**1.49**	**1.10–2.02**	0.30	-0.13–0.74
NE: ≥44	667	17	1.22	0.92–1.62			598	15	1.31	0.91–1.89			620	17	**1.38**	**1.01–1.88**		
E: ≥44	562	19	**1.38**	**1.04–1.83**	-0.07	-0.38–0.44	631	21	**1.71**	**1.20–2.42**	0.05	-0.50–0.60	629	19	**1.38**	**1.02–1.88**	-0.19	-0.71–0.32

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.

[b] New cases of poor SRH at follow-up

[c] Adjusted for baseline social class (linear) and mode of data collection at baseline and follow-up.

[d] RERI=[RR (poor psychosocial working conditions & higher age)–1] – [RR (poor psychosocial working conditions & lower age)–1] – [RR (good psychosocial working conditions & higher age)–1].

Table 4b. Five-year deterioration of self-rated health (SRH): 6453 observations from 5182 Danish employees [a] without poor health at baseline (1990–2005) by combinations of psychosocial relational factors and age group. **Bold numbers denote significant risk ratios (RR)**. Baseline data: 2000, 2005 and follow-up data: 2005, 2010. Controlled for repeated measurements. [95% CI=95% confidence interval, obs=observed; RERI=relative excess risk due to interaction.]

Exposed (E) versus not exposed (NE) in age groups	Low social support from supervisor						Low social support from colleagues					
	N	Obs (%) [b]	RR [c]	95% CI	RERI [d]	95% CI	N	Obs (%) [b]	RR [c]	95% CI	RERI [d]	95% CI
Men												
NE: 18–32	431	11	1				532	12	1			
E: 18–32	296	14	1.26	0.86–1.86			195	15	1.30	0.86–1.96		
NE: 33–43	574	15	1.36	0.98–1.89			660	16	**1.45**	**1.09–1.93**		
E: 33–43	437	18	**1.69**	**1.21–2.35**	0.07	-0.54 –0.67	351	17	**1.48**	**1.06–2.07**	-0.27	-0.94–0 .41
NE: ≥44	740	15	1.34	0.98–1.84			861	18	**1.57**	**1.19–2.07**		
E: ≥44	634	21	**1.95**	**1.43–2.86**	0.35	-0.19–0.89	513	17	**1.58**	**1.16–2.14**	-0.29	-0.94–0.35
Women												
NE: 18–32	525	14	1				658	13	1			
E: 18–32	320	16	1.16	0.84–1.82			187	20	**1.52**	**1.07–2.17**		
NE: 33–43	756	15	1.11	0.84–1.46			952	15	1.17	0.91–1.50		
E: 33–43	511	18	1.31	0.99–1.74	0.04	-0.43–0.51	315	19	**1.51**	**1.12–2.04**	-0.18	-0.80–0.44
NE: ≥44	707	17	1.22	0.93–1.60			867	16	1.25	0.97–1.60		
E: ≥44	522	20	**1.46**	**1.11–1.93**	0.08	-0.39–0.55	362	23	**1.78**	**1.35–2.35**	0.01	-0.60–0.62

[a] Men aged 18–59 years; women aged 18–54 years. Regarding the gender-specific upper-age cut points, see population subsection in the Methods section.

[b] New cases of poor SRH at follow-up.

[c] Adjusted for baseline social class (linear) and mode of data collection at baseline and follow-up.

[d] RERI=[RR (poor psychosocial working conditions & higher age)–1] – [RR (poor psychosocial working conditions & lower age)–1] – [RR (good psychosocial working conditions & higher age)–1].

above-mentioned studies indicated (11, 13). Whereas these studies concluded that poor job factors were especially detrimental for younger employees, we could not detect larger age dependent differences. An explanation, albeit speculative, could be that age only modifies the effect of psychosocial job factors in specific populations; most of the earlier studies focused on either railway or university employees whereas our study was based on the general workforce. In our case, it may also have been a chance finding.

It might be that the findings of these studies reflect factors associated with chronological age present in the populations being studied such as cognitive abilities of the workers. Maybe the relative lack of opportunities for vocational training throughout working life for the birth cohorts in the country being studied [Netherlands (3, 11–13)] as compared to the country studied in the present paper (Denmark) could explain the findings (2, 8). Or it could be that the more dynamic Danish labor market [having a lower average tenure than the Netherlands (2, 8)] allows workers to change to jobs suiting them better, which could buffer effects of psychosocial working conditions on health.

Perspectives

The results of the present study suggest, in a general population of employees, psychosocial factors do not have substantially different effects on the incidence of poor SRH depending on age. The present study's results should be tested longitudinally in studies of other populations. The main reason for this suggestion is that, to our knowledge, the present study is the only published study directly examining potential interaction effects of psychosocial occupational factors and age. In future studies, it would also be of interest to analyze cohorts with shorter follow-ups and larger populations allowing for detection of smaller potential interaction effects. Also it would be relevant to investigate people of the same age, but from a large span of data collection years, in order to disentangle effects of age and birth cohort. Finally, one should also study what age is supposed to indicate (3, 5), for example by investigating if worker's specific cognitive abilities modify associations of psychosocial working conditions on health.

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