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ORIGINAL ARTICLE

Supervisor behaviour and its associations with employees' health in Europe

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Abstract
Objectives To estimate the magnitude of the associations between different facets of supervisor behaviour and several health-related outcomes, and to assess whether these associations are mediated by known occupational health factors.
Methods Cross-sectional data from the European Working Conditions Survey were analysed by generalised linear mixed models (n = 32,770). Six regression models were estimated. Dependent variables include musculoskeletal (upper body, lower limbs, backache) and psychosomatic symptoms (stress and self-assessed general health). Independent variables correspond to several facets of supervisor behaviours such as supervisor support, feedback on work, ability to solve conflicts, encouragement to participate in decisions, and known occupational risk and protective factors.
Results Even though supervisor behaviour is mediated by several known occupational risk factors, it still accounts for a substantial proportion of explained variance. The order of magnitude of associations was comparable to the strength of associations of known occupational risk factors. Odds ratios vary from 0.79 95 % CI [0.73–0.86] to 1.12 95 % CI [0.97–1.29] for dichotomous dependent variables. Regression coefficients vary from –0.22 95 % CI [–0.28 to –0.17] to 0.07 95 % CI [0.04–0.10] for metric dependent variables. Results suggest that good conflict solving skills, supervisor's work-planning ability, and a participative leadership style have the strongest predictive power regarding all health-related outcomes considered.
Conclusion Supervisor behaviour seems to play a non-negligible role from an occupational health perspective concerning the prevalence of musculoskeletal and psychosomatic symptoms. Results suggest that supervisor behaviour should be routinely assessed and monitored, especially among occupational groups reporting a lower quality of supervisor behaviours.

Keywords Supervisor · Manager · Leadership · Leader · Musculoskeletal symptoms · Stress · General health

Introduction

Supervisors in occupational settings usually enact a large variety of different behaviours including communication behaviour, organisation and evaluation of work processes, planning and coordinating, and motivating personnel resources (Fleishman et al. 1991; Mintzberg 1973). Nonetheless, most research on the behaviour of supervisors and (line) managers in organisations has usually been conducted on the basis of leadership theories that have been proposed within the scientific paradigm of the managerial sciences and organisational psychology. In very general terms, these theories aim to identify the most "efficient" leadership behaviours and strategies to increase employee productivity and performance in order to accomplish strategic organisational goals (Yukl 2013). Even though the number of leadership theories and empirical studies is extremely large (Bass and Bass 2008), there are some important results that can be synthesised. First, leader

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behaviour can play an important role in motivational, cognitive, and emotional processes of followers concerning important organisational outcomes such as job satisfaction, employee turnover, and work climate (Judge and Piccolo 2004; Judge et al. 2004). Second, followers are not passive components of the leader–follower relationship; they may also influence the behaviour and attitudes of leaders and contribute to the overall quality of the leader–follower interaction (Junker and van Dick 2014). Third, the so-called destructive leadership, which is characterised by the violation of social norms and aggressiveness, may represent a serious occupational hazard for several health-related outcomes including follower affectivity, stress, and well-being (Schyns and Schilling 2013).

Only in recent decades, it has been recognised that supervisors and (line) managers should be considered from an occupational health perspective as important factors that may be involved in the aetiology of health-related outcomes. Previous systematic reviews have reported statistically significant associations between leadership styles, stress, burnout, well-being, self-evaluation, and overall satisfaction (Gregersen et al. 2011; Kuoppala et al. 2008; Nyberg et al. 2005; Schyns and Schilling 2013; Skakon et al. 2010). Moreover, a large-scale cohort study reported statistically significant associations between supervisor behaviour and ischemic heart disease (Nyberg et al. 2009).

In spite of these recent findings, our knowledge about the prevalence of managerial and/or supervisor behaviours and styles in organisations, and their occupational health implications for other important outcomes such as musculoskeletal symptoms, stress, and general health are largely unknown (Theorell et al. 2012). Moreover, it is not clear to what extent the behaviour of supervisors and (line) managers may account for unexplained variance of health-related outcomes in comparison with other factors such as sociodemographic characteristics of followers, structural features of the organisation (e.g. economic activity, company size), and several working conditions such as biomechanical, physical, and other psychosocial conditions. Given this research limitations, the present paper aims to (1) estimate the magnitude of the associations between supervisor behaviour and several health-related outcomes, and (2) to assess whether these associations are mediated by known occupational health factors. In particular, the following psychosocial facets of supervisor behaviour will be considered: supervisor support, feedback on work, respect, ability to solve conflicts, ability to plan, and encouragement to participate in work-related decisions. Thus, the present contribution intends to capture the role of supervisor behaviour from the perspective of its occupational health implications only, without taking into account, as usual, potential consequences for organisational outcomes or the "effectiveness" of managerial strategies concerning organisational goals.

Methods

Samples and variables

The present paper is based on data from the European Working Conditions Survey 2010 (EWCS 2010), a representative cross-sectional survey of workers (employees and self-employed) in Europe (Eurofound 2012). The statistical population represents all non-institutionalised persons aged 15 and over whose usual place of residence is in one of the countries participating in the survey. In the majority of countries, the sampling scheme of the EWCS 2010 is a multistage stratified random sample. Strata are defined by the NUTS region level 2/3 or equivalent sample units (Gallup-Europe 2010). The survey consists of standardised questionnaires covering work conditions, health status, socio-demographic characteristics of participants, and general information about companies and employers. In this paper, countries of the European Union EU-28 only are considered. Included participants were employed persons aged 18–65 years who reported having a supervisor. A detailed list with descriptive statistics of the variables included, and the number of missing values for each variable are given in the supplementary file. The dependent and independent variables are described in the next sections.

Independent variables

Organisational variables

Economic sector was coded by using the European Classification of Economic Activities (NACE Rev. 2) which comprises the following categories: (a) agriculture, (b, c) mining and manufacturing, (d, e) electricity and water supply, (f) construction, (g) wholesale, (h) transportation, (i) accommodation, (j) information, (k) financial services, (l) real estate activities, (m) professional activities, (n) administration, (o–u) public administration and extraterritorial organisations, (p) education, (q) human health, (r) arts and entertainment, (s) other activities, and (t) activities in households (Eurostat 2006). Company size refers to the number of employees of the respondent's company.

Individual-level variables

Occupation was coded by using the International Standard Classification of Occupations 2008 (ISCO-08) whose main categories are as follows: ISCO 1: managers, ISCO 2: professionals, ISCO 3: technicians and associate professional, ISCO 4: clerical support workers, ISCO 5: service and sale workers, ISCO 6: skilled agricultural and fishery workers, ISCO 7: craft and related trade workers, ISCO 8: plant and machine operators, ISCO 9: elementary occupations (ILO

2008). Because participants in category ISCO 0 (armed force occupations) are not covered appropriately, this category was not included in the analyses. Education was assessed by the International Standard Classification of Education ISCED 2011 comprising six levels: (0) pre-primary education, (1) primary education, (2) lower secondary, (3) upper secondary, (4) post-secondary, (5) first stage of tertiary education and (6) second stage of tertiary education (UNESCO 2012). Income in the EWCS 2010 corresponds to a subjective assessment of financial vulnerability and is collected by asking whether the household can "make ends meet". Further variables at the individual level are desired work hours, years of experience, employment in the private, public, or joint private/public sector, information about occupational health risks, age, and gender.

Working condition variables

Biomechanical, psychosocial (job control, job demands, and job resources), working time, and physical conditions were included in the analyses. If the reliability was above 0.5, a general scale for each working condition was defined by normalising the corresponding variable to the interval [0,1] and building a total score. The general factor saturation (McDonald's omega) was utilised to assess the unidimensionality of the scale. McDonald's omega has been known to be a better lower-bound estimate of test reliability than Cronbach's alpha (alpha < omega) (Revelle and Zinbarg 2009). In particular, the working conditions included in the regression analyses are: (1) a scale of biomechanical conditions (four variables, McDonald's omega 0.71, range = [0,4]), (2) job demands (four variables), (3) a scale of job control (three variables, McDonald's omega = 0.71, range = [0,3]), (4) job resources (two variables), (5) a scale of working-time conditions (four variables, McDonald's omega = 0.55, range = [0,4]), and (6) physical conditions (three variables, McDonald's omega = 0.71, range = [0,3]). A detailed list of the variables and questionnaire items is included in the supplementary file.

Supervisor variables

Information on supervisor behaviour was collected by the following items: frequency of supervisor support (ordinal variable ranging from 1 = always to 5 = never), feedback on work, respect, ability to solve conflicts, ability to plan, encouragement to participate in decisions, and supervisor gender (dichotomous variables). Each of these variables entered the regression models described in the next section. In addition, for the purposes of a succinct presentation and discussion of the results of the regression analyses a supervisor scale was also defined by normalising each supervisor variable in the interval [0,1], and building a scale of supervisor behaviour from the total score (six variables, McDonald's omega = 0.65, range = [0,6]). The supervisor scale, however, was not used in the regression analyses.

Dependent variables

Health-related outcomes

Health-related outcomes correspond to self-reported assessments regarding the following musculoskeletal and psychosomatic symptoms: (1) musculoskeletal symptoms of the upper body, (2) musculoskeletal symptoms of lower limbs, (3) backache, (4) fatigue, (5) frequency of stress symptoms (Likert-type item ranging from 1 = "I always experience stress at work", to 5 = "I never experience stress"; in the regression analyses of the present paper this variable was reversed in order to ease the interpretation of results, i.e. 1 = "I never experience stress" to 5 = "I always experience stress"), and (6) self-assessment of general health (Likert-type item ranging from 1 = "My general health is very good", to 5 = "My general health is very bad"). Variables one to four are dichotomous variables with categories "0 = no symptoms" and "1 = yes, symptoms". Since it is known that depression and/or depressive symptoms are associated with cognitive distortions such as negative thinking and exaggeration (Beck 1963; Joormann and Quinn 2014), it is plausible to assume that the responses of respondents suffering from affective symptoms may confound the associations between supervisor behaviours and self-assessment of health-related outcomes. Due to the fact that the analyses are based on cross-sectional data, the risk of overestimating the associations is likely to be substantial. Hence, all models controlled for depressive symptoms by including the item: "Over the last 12 months, did you suffer from depression or anxiety?".

Data imputation

In order to account for the large proportion of non-response among supervisor variables, and to increase the statistical power of the regression analyses, the whole dataset was imputed by the method of chained equations (Van Buuren 2012). Categorical and metrical variables were imputed by multinomial log-linear models via neural networks, and predictive mean matching, respectively. A massive imputation was performed by using 20 different variables including alternative health-related outcomes, job characteristics, sex, gender, country, and contract type, among others. Since the variables of the first imputed dataset replicate satisfactorily the frequencies and median values of the variables of the non-imputed dataset, only the first imputation was used in the analyses (see supplementary file for a full description of variables and results of the imputation).

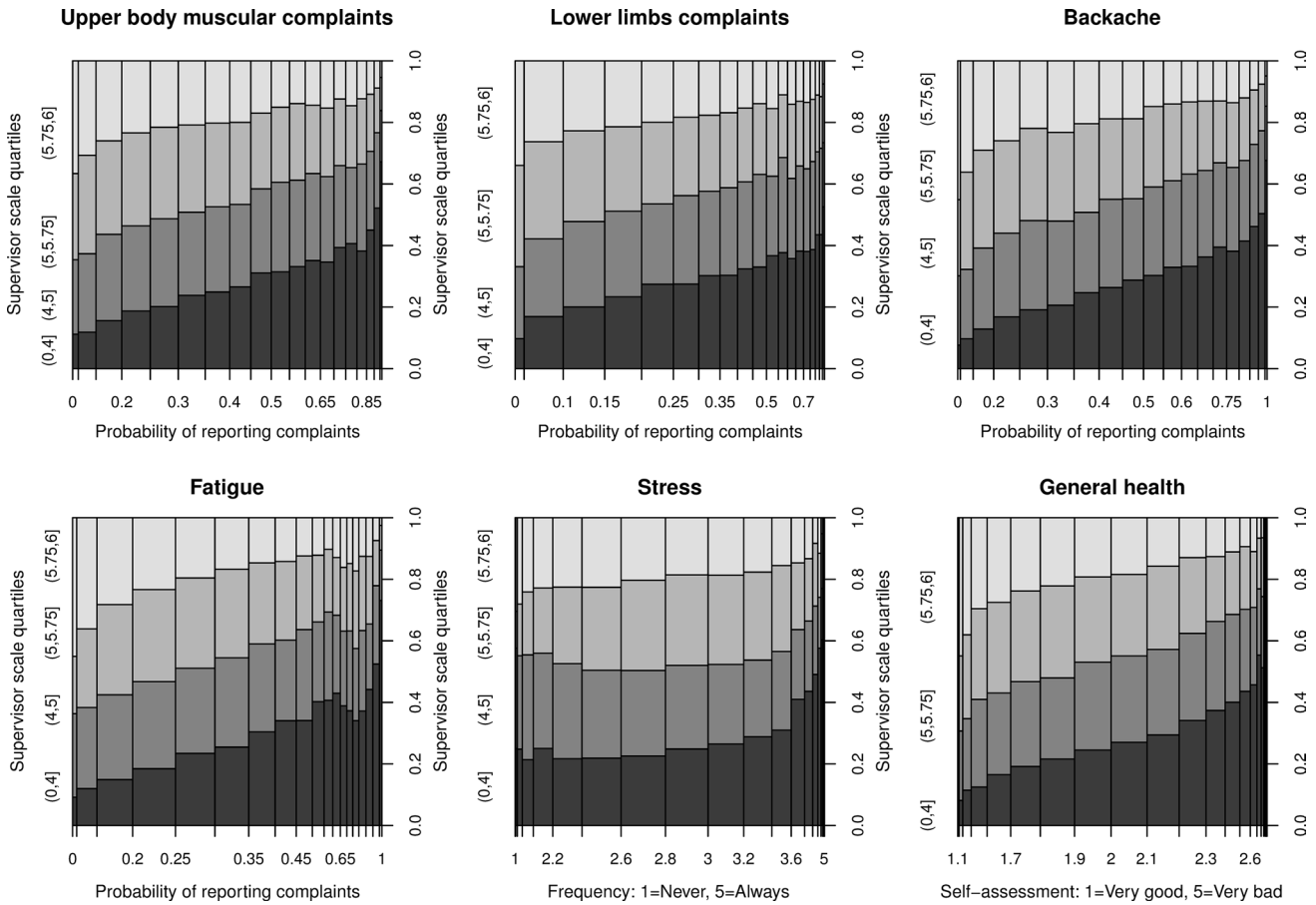

Fig. 1 Predicted probabilities of reporting musculoskeletal complaints and fatigue, and predicted values of stress levels and self-reported general health. Lower scores on the supervisor scale correspond to lower quality of supervisor behaviour. *Bar* width on the *x*-axis proportional to the frequencies of response values. Quartiles of the supervisor scale are plotted on the *y*-axes. $N = 32{,}770$

Regression models

Given the nested structure of the EWCS 2010, generalised linear mixed models (GLMM, in other contexts, also called multilevel models) were estimated (Fahrmeir et al. 2001). The dependent variables are the health-related outcomes described above. For the dichotomous variables, a logit link was defined (i.e. a mixed logistic regression), and for the ordinal variables, a gaussian link was used as an approximation (i.e. a linear mixed regression). All models were estimated by the Monte Carlo sampler in the framework of Bayesian inference (Gelman et al. 2013; Hadfield 2010). The Markov Chain was iterated 13,000 times with burn-in set at 3000. The random effects are nested by country and regions within countries (i.e. NUTS regions, see description of sampling scheme above). The priors of the covariate matrix of the random effects were defined by an inverse Wishart distribution with parameters V = 1, nu = 0.02 and V = 1, nu = 1000 for the mixed logistic and linear mixed models, respectively. After 13,000 iterations, the mixing properties of the chain were assessed graphically (graphics available from the author). All estimated parameters, even those corresponding to categories with lower sample sizes in the EWCS (e.g. employees in NACE category T, see Fig. 2), showed a satisfactory stability. In order to summarise the results of the regression analyses, fully adjusted prevalence estimates were predicted by marginalising over the random effects and residuals (see Fig. 1). For that purpose, the approximation formula suggested by Diggle and colleagues was applied (Diggle et al. 2002).

In addition, in order to assess the consistency of the estimates of the GLMM models, crude estimates obtained by simple logistic regression and ordinary least squares were used as reference estimates. These crude models include the supervisor variables only. All statistical analyses were performed with the statistical environment R, especially packages MCMCglmm and the routines implemented for generalised linear models. The statistical analyses adhered to the STROBE guidelines for cross-sectional studies in epidemiology (see supplementary file for further details).

Results

Descriptive statistics of all variables included in the model are reproduced in the supplementary file. In order to simplify the presentation of the large amount of information obtained from the regression analyses, only the associations between supervisor behaviour, individual characteristics, working conditions, and selected health-related outcomes are reported in the main manuscript. In Table 1 the results of the GLMM regression models are reproduced. The crude estimates from the logistic regression and ordinary least-squares regression are reproduced in Table 2.The results of the GLMM regressions for all other variables are included in Table 2A of the supplementary file. The comparison of the estimates for the variables corresponding to supervisor behaviours (see Tables 1, 2) indicates that supervisor behaviour is being partially mediated by individual characteristics of employees, the conditions of work, and organisational characteristics. Nonetheless, most of the supervisor behaviours included in the analyses still account for a significant proportion of explained variance. The results of the fully adjusted GLMM models across health-related outcomes confirm that good conflict solving skills, supervisor's work-planning ability, and a participative leadership style continue to account for a substantial proportion of explained variance. In general, these supervisor behaviours are associated with a reduced probability of reporting musculoskeletal and psychosomatic symptoms. In contrast, poor supervisor support is associated with a higher probability of reporting adverse health outcomes.

On the other hand, the variables corresponding to individual characteristics of employees suggest that females tend to report higher levels of health-adverse outcomes, especially for those survey participants who have experienced depressive symptoms in the last 12 months. The fact that employees having female supervisors also report higher rates of health-adverse outcomes might result from the gender-related labour market segmentation (e.g. nurses are almost always female). Interestingly, knowledge on the health risks associated with an occupation seems to remain a strong protective factor for reducing occupational health risks. At the same time, not surprisingly, the positive associations between poor working conditions and health-adverse outcomes emphasise once more the results of previous research. High biomechanical loads, low job control, noxious physical conditions, a higher intensity of working conditions, and high job demands are strong predictors across all regression models.

Concerning the organisational characteristics and additional control variables reported in Table 2A of the supplementary file, it should be remarked that the proportion of explained variance corresponding to this group of variables is substantially reduced. In contrast to the variables included in Table 1, the statistically significant associations in Table 2A are much more specific. For instance, whereas the levels of reported fatigue are much higher for employees in the agriculture, forestry, and fishing (NACE A) than for employees in the other economic sectors, the reported stress levels of employees in the transportation (NACE H), financial and real estate services (NACE K-L), and professional activities (NACE M) are much higher than those of employees in the agricultural sector. With regard to the occupational group of employees, it can be seen that service and sales workers (ISCO 5), skilled agricultural workers (ISCO 6), and workers in elementary occupations (ISCO 9) tend to report higher levels of lower limb symptoms than managers (ISCO 1), whereas, on the other side, managers tend to complaint much more often about high stress levels.

The associations between supervisor behaviours and health-related outcomes are summarised in Fig. 1 by considering the quartiles of the supervisor scale described in the "Methods" section, and the predicted values from the fully adjusted models reported in Table 1 and Table 2A. The results depicted in Fig. 1 suggest that the probability of reporting musculoskeletal symptoms (upper body, lower limbs, and backache), and the probability of reporting fatigue increase monotonically for decreasing levels of supervisor behaviour quality. Similarly, stress levels and general health problems are inversely associated with higher scores of supervisor quality.

The associations between supervisor behaviours and employees' health may have a stronger impact for certain occupations and economic sectors as indicated by the results reproduced in Fig. 2, where the prevalence rates of the supervisor scale quartiles are plotted for each ISCO occupational group and NACE economic sector, respectively. Results in Fig. 2 suggest an occupation-specific gradient of supervisor behaviour beginning with higher quality of supervision for managers and professionals (ISCO 1 and ISCO 2), to lower quality of supervisor behaviours for operators and workers in elementary occupations (ISCO 8 and ISCO 9). On the other hand, employees in information and communication services (NACE J), financial and real estate services (NACE K-L), and education (NACE P) report more often a higher quality of supervisor behaviours. In contrast, employees in administrative and support service activities (NACE N), in other service activities (NACE S), and activities of households (NACE T) tend to report a lower quality of supervision.

Table 1 Associations between supervisor behaviour, individual characteristics, working conditions, and selected health-related outcomes

Supervisor variables	Upper body symptoms		Lower limb symptoms		Backache		Fatigue		Stress		General health	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	Beta	95 % CI	Beta	95 % CI
Poor supervisor support	1.02	[0.99, 1.05]	1.02	[0.99, 1.05]	1.05	[1.02, 1.08]	1.05	[1.02, 1.08]	0.03	[0.02, 0.04]	0.01	[0.00, 0.02]
Feedback? Yes	1.00	[0.93, 1.07]	0.99	[0.91, 1.07]	1.09	[1.01, 1.17]	1.02	[0.95, 1.11]	0.07	[0.04, 0.10]	0.00	[−0.03, 0.02]
Respectful behaviour? Yes	1.05	[0.91, 1.21]	0.91	[0.79, 1.06]	1.12	[0.97, 1.29]	1.05	[0.91, 1.23]	−0.22	[−0.28, −0.17]	−0.06	[−0.11, 0.00]
Good conflict abilities? Yes	0.79	[0.73, 0.86]	0.92	[0.84, 1.01]	0.80	[0.74, 0.87]	0.81	[0.74, 0.88]	−0.12	[−0.15,−0.08]	−0.04	[−0.08, −0.01]
Good at planning? Yes	0.82	[0.75, 0.90]	0.89	[0.82, 0.98]	0.81	[0.74, 0.89]	0.86	[0.79, 0.94]	−0.07	[−0.10,−0.03]	−0.04	[−0.07, 0.00]
Participation on decisions? Yes	0.93	[0.88, 1.00]	0.93	[0.86, 1.00]	0.86	[0.80, 0.92]	0.93	[0.86, 1.00]	−0.03	[−0.06,−0.01]	−0.03	[−0.05, 0.00]
Supervisor's gender (female)	1.05	[0.98, 1.13]	1.08	[1.01, 1.16]	1.09	[1.02, 1.17]	1.09	[1.01, 1.17]	0.01	[−0.02, 0.03]	0.00	[−0.02, 0.03]
Individual characteristics												
Age	1.03	[1.02, 1.03]	1.04	[1.03, 1.04]	1.03	[1.02, 1.03]	1.01	[1.01, 1.01]	0.00	[0.00, 0.00]	0.02	[0.02, 0.02]
Female	1.66	[1.55, 1.78]	1.22	[1.13, 1.32]	1.34	[1.24, 1.44]	1.47	[1.37, 1.58]	0.03	[0.00, 0.06]	0.04	[0.01, 0.07]
No depressive symptoms	0.37	[0.33, 0.41]	0.40	[0.37, 0.45]	0.37	[0.34, 0.41]	0.14	[0.12, 0.16]	−0.48	[−0.51,−0.44]	−0.36	[−0.39, −0.32]
Well informed about occ. risks	1.13	[1.06, 1.20]	1.13	[1.06, 1.21]	1.17	[1.10, 1.25]	1.15	[1.08, 1.23]	0.04	[0.01, 0.06]	0.10	[0.07, 0.12]
Not very well informed about occ. risks	1.34	[1.19, 1.51]	1.33	[1.18, 1.50]	1.39	[1.24, 1.57]	1.55	[1.37, 1.75]	0.11	[0.07, 0.16]	0.17	[0.13, 0.22]
Not at all informed about occ. risks	1.44	[1.19, 1.75]	1.45	[1.19, 1.77]	1.46	[1.20, 1.77]	1.91	[1.56, 2.33]	0.08	[0.00, 0.15]	0.16	[0.09, 0.24]
Working conditions												
Better biomechanical conditions	0.45	[0.43, 0.47]	0.51	[0.49, 0.54]	0.47	[0.45, 0.49]	0.69	[0.66, 0.72]	−0.11	[−0.12, −0.09]	−0.09	[−0.11, −0.08]
Better job control	0.95	[0.91, 0.99]	0.96	[0.93, 1.01]	0.93	[0.90, 0.97]	0.94	[0.90, 0.97]	−0.04	[−0.05, −0.02]	0.00	[−0.02, 0.01]
Better physical conditions	0.96	[0.90, 1.02]	0.83	[0.78, 0.88]	0.98	[0.93, 1.05]	0.80	[0.75, 0.85]	−0.08	[−0.10, −0.05]	−0.02	[−0.05, 0.00]
Better working-time conditions	0.92	[0.88, 0.97]	0.90	[0.85, 0.94]	0.95	[0.90, 0.99]	0.84	[0.80, 0.88]	−0.26	[−0.28, −0.24]	−0.01	[−0.03, 0.01]
Few interruptions at work	0.87	[0.84, 0.90]	0.93	[0.89, 0.96]	0.87	[0.84, 0.90]	0.86	[0.83, 0.89]	−0.12	[−0.13, −0.10]	−0.02	[−0.03, 0.00]
Not enough time to finish work?	1.10	[1.07, 1.14]	1.04	[1.01, 1.08]	1.08	[1.05, 1.12]	1.15	[1.12, 1.19]	0.17	[0.16, 0.18]	0.03	[0.02, 0.05]
Job tasks are clear	0.87	[0.83, 0.92]	0.90	[0.86, 0.95]	0.90	[0.86, 0.95]	0.93	[0.88, 0.98]	−0.04	[−0.06, −0.02]	0.03	[0.01, 0.05]
Not emotionally involved at work	0.95	[0.93, 0.97]	0.96	[0.94, 0.98]	0.96	[0.94, 0.99]	0.91	[0.89, 0.93]	−0.17	[−0.18, −0.16]	0.00	[−0.01, 0.01]
No support from colleagues	1.01	[0.98, 1.05]	1.01	[0.97, 1.04]	1.02	[0.99, 1.05]	1.04	[1.01, 1.07]	0.01	[0.00, 0.02]	0.02	[0.01, 0.03]
Not able to apply own ideas	1.04	[1.02, 1.07]	1.02	[0.99, 1.05]	1.04	[1.01, 1.07]	1.06	[1.02, 1.09]	0.01	[0.00, 0.02]	0.02	[0.01, 0.03]

Generalised linear mixed models (GLMM). *OR* odds ratio for the models with logit link, Beta = regression coefficients of the models with gaussian link. Scale for stress: 1 = I never experience stress, 5 = I always experience stress. Scale for general health: 1 = very good health, 5 = very bad health. For variables with several categories, the first category is always the reference one. $N = 32{,}770$

Table 2 Crude associations between supervisor behaviour, individual characteristics, working conditions, and selected health-related outcomes

Supervisor variables	Upper body symptoms		Lower limb symptoms		Backache		Fatigue		Stress		General health	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	Beta	95 % CI	Beta	95 % CI
Poor supervisor support	1.11	[1.08, 1.13]	1.10	[1.07, 1.13]	1.15	[1.12, 1.18]	1.08	[1.05, 1.11]	0.09	[0.07, 0.10]	0.07	[0.06, 0.07]
Feedback? Yes	1.06	[0.98, 1.13]	1.00	[0.93, 1.08]	1.12	[1.05, 1.21]	1.08	[1.00, 1.16]	0.21	[0.17, 0.25]	−0.02	[−0.04, 0.01]
Respectful behaviour? Yes	0.87	[0.76, 1.00]	0.69	[0.60, 0.79]	0.83	[0.73, 0.96]	0.66	[0.57, 0.75]	−0.41	[−0.49, −0.33]	−0.22	[−0.27, −0.17]
Good conflict abilities? Yes	0.73	[0.66, 0.79]	0.90	[0.82, 0.99]	0.80	[0.73, 0.87]	0.83	[0.76, 0.91]	−0.26	[−0.31, −0.21]	−0.05	[−0.08, −0.01]
Good at planning? Yes	0.79	[0.72, 0.86]	0.99	[0.91, 1.09]	0.87	[0.79, 0.94]	0.86	[0.79, 0.94]	−0.21	[−0.26, −0.16]	−0.04	[−0.07, 0.00]
Participation on decisions? Yes	0.85	[0.80, 0.90]	0.77	[0.72, 0.82]	0.76	[0.71, 0.81]	0.84	[0.79, 0.89]	0.09	[0.05, 0.12]	−0.09	[−0.11, −0.06]
Supervisor's gender (female)	1.20	[1.13, 1.27]	1.16	[1.09, 1.23]	1.13	[1.06, 1.19]	1.27	[1.20, 1.34]	0.04	[0.01, 0.07]	0.06	[0.04, 0.08]

Generalised linear models (GLM). *OR* odds ratio, Beta = regression coefficients of the models with gaussian link. Scale for stress: 1 = I never experience stress, 5 = I always experience stress. Scale for general health: 1 = very good health, 5 = very bad health. For variables with several categories, the first category is always the reference one. Sample sizes N = 23,090, 23,083, 23,084, 23,066, 23,064, and 23,098, respectively

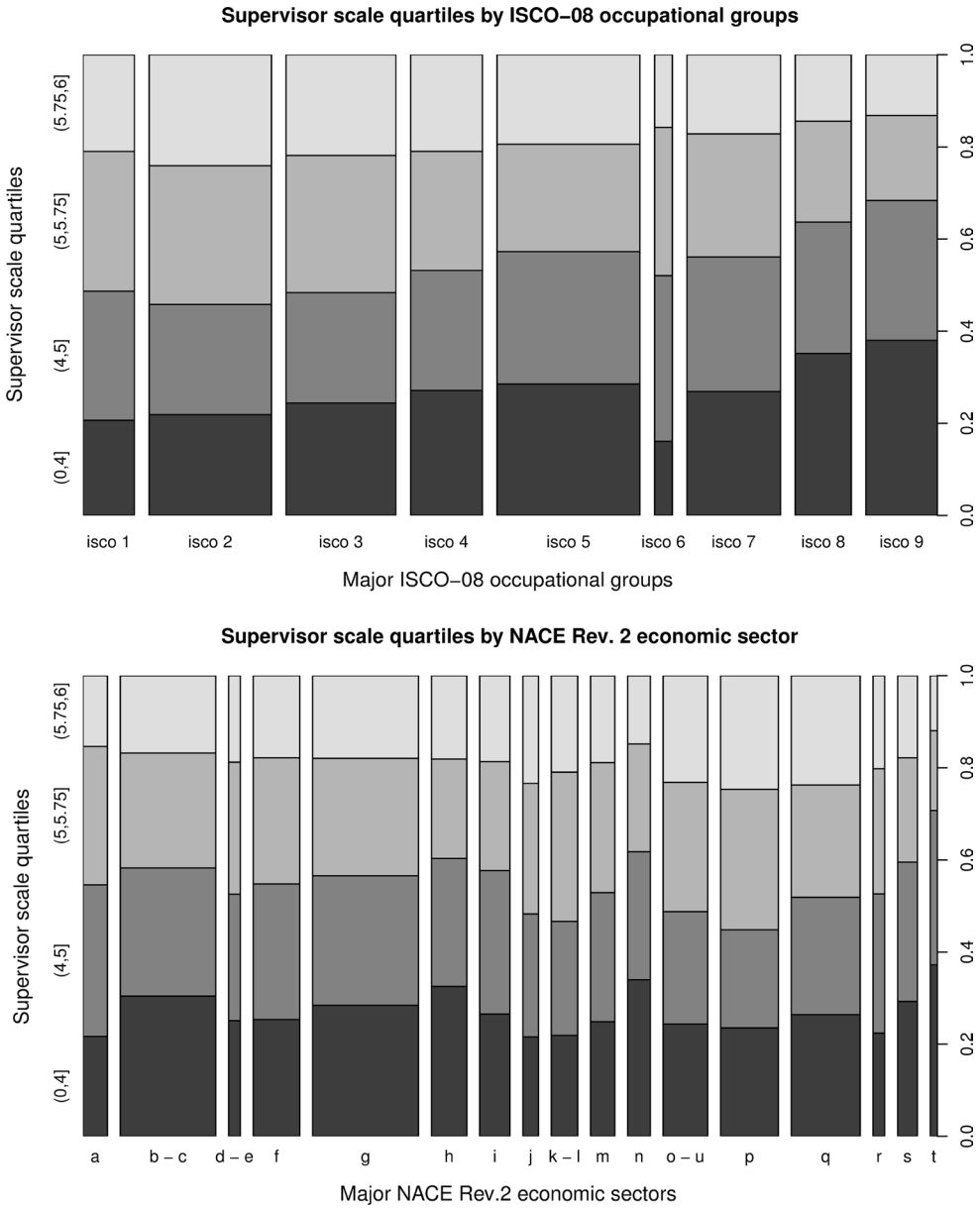

Fig. 2 Cross-tables of the supervisor scale quartiles by ISCO occupational group and NACE economic sector. *Bar* width on the *x* axis proportional to the frequencies of response values. Quartiles of the supervisor scale are plotted on the *y*axes. $N = 32{,}770$. See the Methods section for a detailed description of the ISCO occupational categories and NACE sectors

Discussion

The main aims of this paper were (1) to estimate the magnitude of the associations between supervisor behaviour and several health-related outcomes, and (2) to assess whether these associations are mediated by known occupational health factors. Regarding the first aim, it was found that the strength of these associations is of a similar order of magnitude as for other known occupational health factors such as biomechanical, physical, and several other psychosocial exposures (i.e. job demands, job control, working-time conditions; compare also (Farioli et al. 2014) for comprehensive prevalence and risk ratio estimates of musculoskeletal symptoms with EWCS data). Concerning the second aim, the analyses suggest that supervisor behaviours are only partially mediated by other known occupational risk factors, and hence, they still account for a substantial proportion of explained variance.

Consequently, the present paper provides additional support to previous studies showing significant associations between supervisor characteristics and several health outcomes. For instance, it has been reported that an inspirational and motivating leadership style correlates with increased levels of well-being (Arnold et al. 2007), and reduced emotional exhaustion (Green et al. 2014). In contrast, the so-called abusive supervision, which maps different forms of aggressive supervisor behaviour, has been associated with increased levels of emotional exhaustion

and psychological distress (Wu and Hu 2009; Tepper 2000).

It is worth mentioning that these results not only emphasise the need of extending the scope of psychosocial factors in modern work environments, but also represent a challenge both for occupational risk assessments and the planning of occupational health interventions. This is due to the fact that research on the behaviour of supervisors and (line) managers, as stated in the introduction, has usually been conducted for establishing effective ways of increasing labour productivity, and reducing personnel turnover costs. Thus, a truly occupational health perspective of supervisor behaviour has been limited so far, and, consequently, the collection of corresponding data and the development of specific measure instruments assessing the health impact of supervisor and manager behaviours are to some extent still pending in spite of some recent progresses in this direction (Franke et al. 2014; Gurt et al. 2011).

Finally, the results of the present study underline the necessity of a health-oriented supervisor training and education concerning psychosocial facets of supervisor behaviours. In particular, organisations should integrate into their supervisor training programmes that appropriate behavioural skills including a participative leadership style, clear communication, proper supervisor support, respectful interpersonal relationships, conflict solving strategies, and sufficient feedback channels.

Limitations

First, the estimated associations are based on cross-sectional data. Thus, causal hypotheses could not be tested appropriately. Second, all information analysed was collected from the same source. This might imply additional confounding due to inaccurate responses and response tendencies of the survey participants in the different countries. However, the present analyses tackled to some extent self-assessment bias by including depressive symptoms as an individual-level variable. The fact that one of the most serious problems concerning confounding effects is the presence of depressive symptoms implies that, on that account, the present paper has reduced to some extent self-assessment bias and has delivered more robust parameter estimates. Third, there is additional confounding related to the survey itself which cannot be controlled for in secondary statistical analyses such as undersampling of certain occupational groups, economic activities, interpretation problems of the translated questionnaires, and low overall response rates of the EWCS (about 44 %), among others. Fourth, the EWCS does not include psychometrically validated scales as such, even though it is possible to define for some items general scales covering different working condition dimensions (e.g. job control). Hence, the reproducibility of results may be to some extent limited, and there still may be some risk of parameter underestimation due to very short scales. Finally, the items utilised to assess the quality of supervisor behaviour are not exhaustive and show a large proportion of missing values (see Table 1A and Fig. 1A of the supplementary file). The frequencies of missing values within countries (see Fig. 1A of the supplementary file) show that the variables "supervisor encourages participation of employees", "planning skills", "conflict solving skills", and "supervisors feedback" account for most of the missing data regarding supervisor behaviour. It is thus possible that respondents may have difficulties in evaluating very specific supervisor behaviours or, in case of more than one supervisor, respondents may not be sure which supervisor to evaluate. Nonetheless, the regression analyses were based on an imputed dataset which revealed a satisfactory agreement with the non-imputed datasets (see Table 1A of the supplementary file). Hence, it can be assumed that both datasets are comparable, and the parameter estimates reported here are likely to be appropriate approximations of the true estimates.

Conclusion

Supervisor behaviour seems to play a non-negligible role from an occupational health perspective regarding the prevalence of musculoskeletal and psychosomatic symptoms. Results suggest that supervisor behaviour should be routinely collected and monitored for the assessment of occupational risk and/or protective psychosocial factors, especially for those occupational groups reporting a lower quality of supervisor behaviours.

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Conflict of interest The author declares that he has no conflict of interest.

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