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Contribution of Psychological, Social, and Mechanical Work Exposures to Low Work Ability

A Prospective Study

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Objective: To determine the contribution of specific psychological, social, and mechanical work exposures to the self-reported low level of work ability. **Methods:** Employees from 48 organizations were surveyed over a 2-year period ($n = 3779$). Changes in 16 work exposures and 3 work ability measures—the work ability index score, perceived current, and future work ability—were tested with Spearman rank correlations. Binary logistic regressions were run to determine contribution of work exposures to low work ability. **Results:** Role conflict, human resource primacy, and positive challenge were the most consistent predictors of low work ability across test designs. Role clarity and fair leadership were less consistent but prominent predictors. Mechanical exposures were not predictive. **Conclusions:** To protect employee work ability, work place interventions would benefit from focusing on reducing role conflicts and on promoting positive challenges and human resource primacy.

The demographic development with the aging population poses a threat to the sustainability of welfare systems in most developed countries.[1] Early retirement from working life because of disability incurs large production losses for national economies as well as threats to the quality of life of the individuals. Therefore, understanding determinants of work ability should be of scientific and practical importance. Although occupational health research has provided tools for assessments of work ability and potential determinants,[2] the impact of many work factors in terms of role expectations, leadership, and organizational climate remains—to a large extent—unexplored. With a comprehensive set of factors the aim of this study was therefore to determine the effects of specific occupational psychological, social, and mechanical exposures on the level of work ability.

Work ability is a multidimensional concept. In population studies, physical and mental (work-related) capacities, perceived work ability (PWA) and impairment, and personal resources are all proposed to be key elements to a person' capability to perform work tasks.[3] Covering these aspects, questionnaire-based self-reports on the level of work ability has shown to be indicative of time of retirement,[4] sickness absence,[5,6] and disability pension.[7,8] Such and similar findings,[9] suggest that identification of important contributors to self-reported low work ability would be helpful in the understanding of temporal and permanent exit from working life.

Previous attempts to identify contributors have revealed that work factors (as opposed to individual and lifestyle factors) are of particular relevance to level of work ability.[10] Nevertheless, studies linking occupational psychological/social factors to work ability have most often investigated a relatively small selection of work exposures and commonly by cross-sectional research designs.[11–13] Although some follow-up studies have been conducted,[4,14,15] a systematic review on contributors to self-reported low work ability[2] concluded that the field of research is dominated by studies of municipal workers in Finland.

Recently, longitudinal investigations on work disability have been conducted on the basis of data from multiple countries and occupations.[16,17] Nevertheless, studies relating the components of the demand–control model and the effort–reward imbalance model to self-reported work ability have resulted in somewhat disparate findings. Rongen et al[18] found that besides low work engagement, high job demands, low decision authority, and low skill discretion had independent effects on the level of work ability. Bethge et al[19] did not find independent contributions of job control (a combination of decision authority and skill discretion) when accounting for the impact of effort–reward imbalance on the level of work ability. The constructs underlying the demand–control model and the effort–reward imbalance model, respectively, are well-defined but broad dimensions consisting of a range of aspects that may have differential impact on work ability. For instance, the psychological job demand component of the demand-control model contains aspects pertaining to both time pressure and role conflicts.[20] The effort scale of the effort–reward imbalance instrument includes measures of time pressure, decision demands, and an (optional) item on mechanical workload.[21] Thus, at this point in the work ability research it seems appropriate to address the relative contribution of psychological, social, and mechanical work exposures. Without knowledge of specific contributors, it remains unclear which aspects of the working environment that should be targeted to appropriately protect or improve employee work ability.

On the basis of responses from a cohort representing multiple occupations, this study aimed to identify the effects of a broad set of specific exposures previously found relevant to health perceptions and sickness absence.[22] With a full-panel prospective design, this study sought to answer the following questions:

(1) Which psychological, social, and mechanical work factors contribute to changes in self-reported work ability?
(2) Which specific psychological, social, and mechanical factors are predictive of self-reported low work ability?

METHODS

Study Design

The study was a prospective, full-panel design in which all independent and dependent variables were measured both at baseline

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(T1) and at follow-up (T2) 2 years later. A 2-year period has been found to be an appropriate compromise to detect effects of social work exposures on health symptoms.[23] A recent review on time lags supported the use of a 2-year follow-up period although stronger associations between work exposures and health may be detected with even longer follow-up periods.[24]

Several statistical designs were tested to elucidate effects that were consistent across designs. The full-panel design allows analyzing data (1) cross-sectionally at both measurement points, (2) prospectively with baseline exposure as a predictor of the outcome at follow-up, and (3) average exposure across time [(exposure-T1 + exposure-T2)/2] as a predictor of the outcome at follow-up.

Study Population

A cohort of employees recruited from 48 Norwegian-based organizations (31 private and 17 public) comprised the study population. The organizations represented a wide range of occupational sectors including health care, education, government and public administration, engineering, business, and industry.

All participating organizations provided a list of employees' departmental affiliation, home address, and occupational title according to the Norwegian standard classification of the occupations. STYRK, developed by Statistics Norway, is based on the International Classification of Occupation (ISCO-88).

Each employee received a letter containing information about the survey and a personalized code for logging into the web-based questionnaire or a paper version of the questionnaire if requested in advance. Written information specified aims of the survey, the strict confidentiality guidelines, as well as information about the license for data collection granted by the Norwegian Data Inspectorate. The questionnaire contained items on background information, work organization, psychological, social, and mechanical work factors, mastery of work, organizational change, attitudes to work, personality, coping strategies, physical activity, smoking, alcohol use, mental health, work ability, and health complaints. This study was based on parts of this information.

The first cross-sectional sample (T1) included 6774 responders representing 12,603 invited subjects (53.7%) (Fig. 1). Participants were defined as respondents when completing minimum one exposure measure and minimum one of the three work ability measures. At follow-up 6313 of the 12784 invited subjects (49.4%) responded and comprised the second cross-sectional sample (T2). Average follow-up period for respondents was 24 months (range, 17 to 36 months). Subjects not employed in a participating organization at both baseline (T1) and follow-up (T2) were only invited to participate on the time point being employed (T1 or T2). A total of 9304 subjects were invited at both time points. Of these, 3779 completed at least one exposure measure at T1 in addition to one of the three work ability measures and both T1 and T2, and thus comprised the prospective sample.

Outcome: Work Ability

Work ability was assessed with the work ability index (WAI),[7] which comprises seven items (see Supplemental Digital Content, Appendix 1, http://links.lww.com/JOM/A180). The WAI intends to capture both subjective evaluations to work ability, work impairment, and objectively verifiable information on health status. The WAI has shown adequate test-retest reliability, and classification of scores has been found stable over a 4-week period.[25] Although the WAI is a self-reported inventory, an advantage of the WAI is arguably that responses to certain items (eg, sickness absence during past year) can be verified by objective means (eg, organizational sickness register). The WAI sum score ranges from 7 to 49 points and was originally categorized, on the basis of the lowest 15th percentile, the median, and the highest 15th percentile, into the four groups: "poor" (index score <28), "moderate" (<37), "good" (<44), and "excellent" (≥44).[7] A substantial number of subsequent studies have classified WAI scores within the same scoring intervals.[4,5,7,10–13,26]

To identify subjects with a "low" WAI score, we chose to dichotomize scores on the basis of the distribution of the current prospective sample. Average scores below the average 15th percentile [(WAI-T1 + WAI-T2)/2] score ranged from 7 to 36 and were defined as "low." Scores at 37 points or higher were defined as "moderate-high." A total of 13.1% at baseline and 13.0% at follow-up scored within the low WAI category. A WAI score below 37 points has previously been found predictive of subsequent work disability,[8] and long-term sickness absence.[6]

Items of the WAI may be indirectly related to work ability (eg, number of diagnosis) or consequences of work ability (eg, sickness absence). Therefore, in the prospective analyses, we also determined work ability by two single items from the WAI. Perceived work ability, compared with the lifetime best, has previously shown adequate predictive validity.[5] The average [(PWA-T1 + PWA-T2)/2] 15th percentile score in the present cohort was 7.5 (scale ranging from 0 to 10). On the basis of the 15th percentile score of the current prospective sample, and in line with previous publications,[27,28] PWA scores were dichotomized into "low" (scores 0 to 7) and "moderate-high" (scores 8 to 10).

Work ability prognosis (WAP) assesses the perceived ability to perform the same work in 2 years (response categories: 1, "unlikely"; 2, "not certain"; and 3, "relatively certain"). WAP was dichotomized into "low" (categories 1 and 2) and "high" (category 3).

Psychological, Social, and Mechanical Work Factors

The psychological and social exposures were measured by a validated comprehensive instrument—the General Nordic Questionnaire for psychological and social factors at work (QPS_{Nordic}). Psychometric evaluations of QPS_{Nordic} have shown high validity and reliability of the scales included in this study.[29] The reliability analysis has been found consistent across a variety of occupational groups.[22] A full list of scale items has been published elsewhere.[22,29] Responses to items were given on a five-point Likert scale: 1, "very seldom or never"; 2, "somewhat seldom"; 3, "sometimes"; 4, "somewhat often"; and 5, "very often or always."

Mechanical exposure was measured with a three-item scale, *physical workload*, and a single item, *working with arms raised to or above shoulder level*. *Physical workload* was assessed by measuring the extent to which subjects were lifting or handling objects that weigh approximately 1 to 5 kg, 6 to 15 kg, and more than approximately 15 kg with own muscular strength. Response categories for both of the mechanical exposure measures were as follows: 1, "seldom or never"; 2, "sometimes"; 3, "daily"; and 4, "many times per day."

To accommodate nonlinear relationships, categorical levels of exposures were computed before entered into exposure-outcome models. As many of the exposure factors were substantially skewed, categorizing scales scores based on the distribution (tertile or quartile splits) would result in grouping together score levels, which may be differentially related to the level of work ability. For instance, by basing categorization on tertiles, scores reflecting lower exposure to *role clarity* (ie, 1, "very seldom/never"; and 2, "somewhat seldom") would be grouped together with scores reflecting higher exposure to the same factor (ie, 3, "sometimes"; and 4, "somewhat often"). Therefore, scale scores were categorized on the basis of the absolute values of the factors rather than on the distribution.

To determine associations between changes in levels of exposure and work ability across time, responses to the psychological and social exposure measures were divided into five levels. Only a limited number of respondents reported "extreme" scores (ie, 1 or 5) on all scale items of any of the factors. Hence, some variation within each score group was allowed for; scale scores from 1.00 through

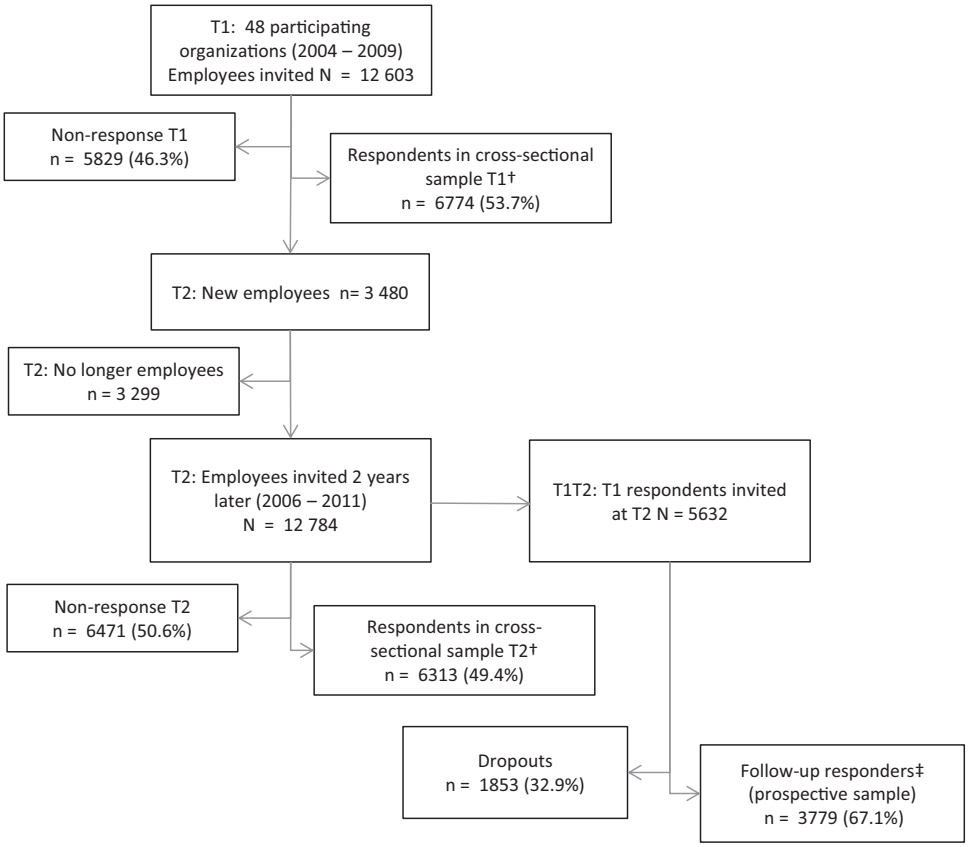

FIGURE 1. Flow diagram describing the sampling process. †Respondents were defined as having completed minimum one exposure measure and minimum one of the three work ability outcome measures. ‡Respondents were defined as having completed minimum one exposure measure at T1 and minimum one of the three work ability outcome measures twice (at T1 and T2).

1.80 were defined as 1, 1.81 through 2.60 as 2, 2.61 through 3.40 as 3, 3.41 through 4.20 as 4, and 4.21 through 5.00 as 5. Responses to *physical workload* were divided into four levels; scale scores from 1.00 through 1.50 were defined as 1, 1.51 through 2.50 as 2, 2.51 through 3.50 as 3, and 3.51 through 4.00 as 4.

To identify the differential impact of exposure levels on low work ability, we chose to trichotomize scale score responses because of statistical power issues. Hence, levels 1 and 2 of the psychological and social factors were collapsed and categorized as "low" exposure, level 3 was labeled "middle" exposure, and levels 4 and 5 were collapsed and categorized as "high" exposure. For the measures of mechanical demands, levels 1 and 2 were collapsed and categorized as "low" exposure, level 3 as "middle" exposure, and level 4 as "high" exposure.

Statistical Analysis

Nonresponse and Attrition Analyses

Univariate logistic regression analyses were conducted to estimate effects of age and sex on baseline participation (a nonresponse effect). Univariate analyses were also carried out to explore if age, sex, occupational group, skill level, baseline low work ability (WAI, PWA, and WAP), and the 16 baseline exposure measures (as continuous) predicted participation at follow-up (attrition effect). Significant variables from univariate analyses were controlled for each other in separate multivariate models to identify predictors with independent effects on follow-up participation.

Associations Between Changes in Exposures and Work Ability

Bivariate associations between changes in exposures and changes in the three work ability outcomes were examined by Spearman rank correlation coefficients. Before computing and entering change variables (score-T1 subtracted from score-T2) into bivariate models, thresholds for "change" were set. This was done to avoid categorizing small variations in raw scores from T1 to T2 as "substantial" increase/decrease in work exposure or work ability. For all exposure measures, change was defined as categorical increase/decrease ($\geq$1) from baseline to follow-up. Change in the WAI score has previously been classified as "substantial" when an increase of 3 points or more/a decrease of 10 points or more occurs.[30] Because of a shorter time span between baseline and follow-up ($>$10 years of the study referred to above), we defined change in the WAI by an increase of three points or more/a decrease of three points or more. Change in PWA was defined as one or more points increase/decrease from baseline to follow-up. Likewise, change in WAP was defined as one or more categories increase/decrease from baseline to follow-up.

Identification of Contributors to Low Work Ability

Binary logistic regression analyses were performed to identify contributors to low work ability. Cross-sectional analyses (with baseline sample, T1; and follow-up sample, T2) were run with low WAI score as outcome. Prospective analyses (with prospective sample, T1 and T2) were run with each of the three work ability measures: low WAI, PWA, and WAP as outcomes.

To determine associations between exposure levels and the occurrence of low work ability (ie, low WAI, PWA, and WAP), odds ratios were calculated. The lowest exposure category was set as a reference. This implies that the odds of low work ability by a given exposure category is estimated on the basis of the odds of low work ability given the lowest exposure category.

To evaluate whether effects of categorical variables were dependent on the cut-off points used, binary logistic regressions with the raw scale scores of all psychological, social, and mechanical measures were also conducted.

Statistically significant spurious associations may occur when investigating a large number of exposure-outcome associations. Thus, odds ratios with 99% confidence intervals were applied in all exposure-outcome analyses (threshold for statistical significance was set to $P < 0.01$). Because of multiple testing, statistical significance was also examined by the use of Bonferroni correction (ie, dividing the overall significance level, 0.01, by the number of tested factors, 16).

Potential Confounders

Sex, age, and skill level were controlled for in all exposure-outcome analyses. Skill level was determined by recoding the occupational groups (ISCO-88) in accordance with the International Standard for Classification of Education.

Raw baseline work ability scale scores (WAI, PWA, or WAP) were adjusted for in all prospective analyses. Without adjustment, it would be unclear whether low follow-up work ability resulted from higher baseline exposure or a decline in work ability status, which may have preceded baseline measurement. Employees with "suboptimal" work ability (already before baseline) may experience work exposures as more "demanding," and consequently, report them as higher at the baseline measure compared with employees with more satisfactory work ability. Thus, adjusting for baseline work ability reduces "reverse" effects as a plausible explanation for identified relationships between exposures and outcomes.

The observed effect of each work exposure on work ability may be confounded by the effects of other work exposures. Nevertheless, controlling for all other work exposures would likely result in overadjustment because the scales are interrelated.[22,29] A strategy described by Rothman et al[31] was used to identify influence by other work exposures above a certain threshold level. The procedure implied by the strategy was run separately with each of the three work ability measures (WAI, PWA, and WAP) as outcomes. The procedure was carried out as follows: (1) in a model controlling for baseline work ability, the effect of an exposure on work ability at follow-up was estimated, (2) in a second model, a second exposure was included, and (3) if the effect estimate of the original exposure changed 10% or more from the first model, the added exposure in the second model was defined as a confounder.[31] This procedure was carried out for each of the 16 work exposure measures, whereas the other 15 work exposure measures were included in separate models as potential confounders. All statistical analyses were carried out with SPSS version 20.0 (IBM, Armonk, NY).

RESULTS

Nonresponse and Attrition

Nonresponse analysis showed that subjects in the three middle age groups (30 to 39, 40 to 49, and 50 to 59 years) had significantly higher odds of responding in comparison to the lowest age group (<30 years) (Table 1). Being in the oldest age group (>59 years) was not predictive of baseline participation. Likewise, sex was not significantly predictive of responding at baseline.

Multivariate analysis revealed that age, occupational group, and skill level were predictive of follow-up participation for baseline respondents (Table 1). Low work ability at baseline (WAI, PWA, or WAP) did not significantly predict follow-up participation. Of the work exposures, higher baseline *social climate* and *physical workload*, and lower baseline *role clarity* were associated with increased odds of follow-up participation.

A decrease in the WAI (≥3 points), PWA (≥1 point), and WAP (≥1 category) from baseline to follow-up was reported by 598 (27.6%), 1090 (29.1%), and 162 (5.2%) subjects, respectively. In contrast, an increase in the WAI (≥3 points), PWA (≥1 point), and WAP (≥1 category) from baseline to follow-up was reported by 375 (17.3%), 1076 (28.7%), and 108 (3.5%) subjects, respectively.

Bivariate rank-correlation analysis showed that changes in 8 of the 16 exposures correlated significantly ($P < 0.01$) with changes in the WAI and PWA (Table 2). Of these, *role conflict*, *support from immediate superior*, and *fair leadership* also correlated significantly with changes in WAP. Changes in mechanical exposures (*physical workload, working with arms to/above shoulder level*) did not correlate significantly with changes in any of the work ability outcomes ($P > 0.01$).

Cross-Sectional Associations

All exposures except *control over work intensity*, *decision demands*, and *innovative climate* were associated with the low WAI in both the baseline and follow-up samples (see Supplemental Digital Content, Appendix 2, http://links.lww.com/JOM/A181). Significant odds ratios (99% confidence interval) ranged from 0.22 (high level of social climate) to 3.09 (high level of role conflict) in the baseline sample and from 0.25 (high level of positive challenge) to 3.07 (high level of role conflict) in the follow-up sample.

With a Bonferroni-corrected significance level, *quantitative demands* (at both time points), support from immediate superior (at follow-up), and *working with arms raised to/above shoulder level* (at follow-up) were not found significant ($P > 0.0006$).

Prospective Associations

Work Ability Index

The low follow-up WAI score was predicted by baseline levels of *decision demands*, *role conflict*, and *positive challenge* ($P < 0.01$) (Table 3). In the analyses with exposures averaged across time [(exposure-T1 + exposure-T2)/2], the above-mentioned exposures as well as *role clarity*, *support from immediate superior*, *empowering leadership*, *fair leadership*, *social climate*, and *human resource primacy* were predictive of the low WAI at follow-up. After Bonferroni correction of the significance level, *role conflict* (at baseline and averaged across time), *role clarity*, *positive challenge*, *empowering leadership, fair leadership*, and *social climate* (all averaged across time) remained significant ($P < 0.0006$).

Perceived Work Ability

Low follow-up PWA was predicted by baseline and average exposure levels of *role clarity*, *role conflict, fair leadership*, and *human resource primacy* ($P < 0.01$) (Table 4). An average level of *positive challenge* was also predictive. After Bonferroni correction, all predictors except *fair leadership*, as baseline exposure, remained significant ($P < 0.0006$).

Work Ability Prognosis

In the analyses of low follow-up WAP, higher baseline levels of *control over work intensity*, and *human resource primacy* were found predictive ($P < 0.01$) (Table 5). In terms of exposures averaged across time, these two factors, *role conflict*, *positive challenge*, and *social climate* were identified as significant predictors. With the Bonferroni-corrected significance level, only *role conflict* and *human resource primacy* (both averaged across time) remained significant.

Overall, the most consistent predictors of any follow-up work ability outcome (WAI, PWA, and WAP) were *role conflict*, *human*

TABLE 1. Sample Characteristics and Estimated Nonresponse and Attrition Bias

	Invited to the First Survey ($N = 12,603$)			Invited to the First and Second surveys ($N = 9304$)		
	Respondents at Baseline[a] ($n = 6774$) *n* (%)	Nonresponders at Baseline ($n = 5829$) *n* (%)	Nonresponse Analysis OR (95% CI)	Respondents at the First and Second surveys[b] ($n = 3779$) *n* (%)	Dropouts ($n = 1853$) *n* (%)	Attrition Analysis[c] OR (95% CI)
Sex						
Male	2648 (39.1)	2035 (34.9)	1 (reference)	1529 (40.5)	675 (36.4)	1 (reference)
Female	4123 (60.9)	3266 (56.0)	0.97 (0.90–1.04)	2250 (59.5)	1178 (63.6)	0.96 (0.82–1.13)
Missing data	3 (0.0)	528 (9.1)				
Age, yrs, mean (SD)	44.3 (10.7)	44.0 (11.8)		45.1 (4.8)	44.4 (10.6)	
<30	612 (9.0)	669 (11.5)	1 (reference)	239 (6.3)	168 (9.1)	1 (reference)
30–39	1766 (26.1)	1309 (22.5)	1.47 (1.29–1.68)*	939 (24.8)	474 (25.6)	1.33 (0.99–1.78)
40–49	2070 (30.6)	1433 (24.6)	1.58 (1.39–1.80)*	1242 (32.9)	558 (30.1)	1.54 (1.15–2.06)*
50–59	1768 (26.1)	1301 (22.3)	1.49 (1.30–1.69)*	1090 (28.8)	515 (27.8)	1.61 (1.20–2.18)*
>59	555 (8.2)	594 (10.2)	1.02 (0.87–1.20)	269 (7.1)	138 (7.4)	1.56 (1.04–2.35)*
Missing data	3 (0.0)	523 (9.0)				
Classification of occupation						
Legislators, senior officials, and managers	640 (9.4)	–	–	420 (11.1)	123 (6.6)	1 (reference)
Professionals	1812 (26.7)	–	–	1063 (28.1)	411 (22.2)	0.96 (0.70–1.30)
Technicians and associate professionals	2345 (34.6)	–	–	1278 (33.8)	693 (37.4)	0.68 (0.50–0.91)*
Clerks	554 (8.2)	–	–	292 (7.7)	178 (9.6)	0.59 (0.41–0.86)*
Service workers and shop and market sales workers	1146 (16.9)	–	–	592 (15.7)	347 (18.7)	0.66 (0.46–0.94)*
Skilled agricultural and fishery workers	2 (0.0)	–	–	1 (0.0)	1 (0.1)	0.37 (0.02–6.20)
Craft and related trades workers	85 (1.3)	–	–	43 (1.1)	24 (1.3)	0.54 (0.26–1.10)
Plant and machine operators and assemblers	12 (0.2)	–	–	1 (0.0)	9 (0.5)	–
Elementary occupations	94 (1.4)	–	–	51 (1.3)	30 (1.6)	0.52 (0.26–1.06)
Armed forces and unspecified	3 (0.0)	–	–	2 (0.1)	1 (0.1)	–
Missing data	81 (1.2)	–	–	36 (1.0)	36 (1.9)	
Skill level						
Competence equivalent to ≥4 yrs of higher education (>15 yrs)	1812 (26.7)	–	–	1063 (28.1)	411 (22.2)	1 (reference)
Competence equivalent to 1–3 yrs of higher education (13–15 yrs)	2345 (34.6)	–	–	1278 (33.8)	693 (37.4)	0.70 (0.57–0.86)*
Competence equivalent to high school (10–12 yrs)	1799 (26.6)	–	–	929 (24.6)	559 (30.2)	0.63 (0.50–0.81)*
Occupations that do not require high school (<10 yrs)	94 (1.4)	–	–	51 (1.3)	30 (1.6)	0.54 (0.27–1.06)
Occupations with unspecified requirements for competence	643 (9.5)	–	–	422 (11.2)	124 (6.7)	1.06 (0.78–1.44)
Missing data	81 (1.2)	–	–	36 (1.0)	36 (1.9)	
The work ability index, mean (SD)	41.8 (4.9)			41.9 (4.8)	41.5 (5.0)	

(*continues*)

TABLE 1. (*Continued*)

	Invited to the First Survey ($N = 12,603$)			Invited to the First and Second surveys ($N = 9304$)		
	Respondents at Baseline[a] ($n = 6774$) *n* (%)	**Nonresponders at Baseline ($n = 5829$) *n* (%)**	**Nonresponse Analysis OR (95% CI)**	**Respondents at the First and Second surveys[b] ($n = 3779$) *n* (%)**	**Dropouts ($n = 1853$) *n* (%)**	**Attrition Analysis[c] OR (95% CI)**
Low (<37 points)	645 (9.5)			340 (9.0)	204 (11.0)	1 (reference)
Moderate/high (≥37 points)	4262 (62.9)			2444 (64.7)	1101 (59.4)	1.16 (0.97–1.45)
Missing data	1867 (27.6)			995 (26.3)	548 (29.6)	
Perceived work ability, mean (SD)	8.5 (1.7)			8.6 (1.6)	8.5 (1.7)	
Low (<8 points)	1204 (17.8)			626 (16.6)	352 (19.0)	1 (reference)
Moderate/high (≥8 points)	5545 (81.9)			3144 (83.2)	1491 (80.5)	1.15 (0.97–1.37)
Missing data	25 (0.4)			9 (0.2)	10 (0.5)	
Work ability prognosis, mean (SD)	2.9 (0.3)			2.9 (0.3)	2.9 (0.3)	
Low (categories 1 and 2)	469 (6.9)			213 (5.6)	145 (7.8)	1 (reference)
High (category 3)	5593 (82.6)			3174 (84.0)	1504 (81.2)	1.20 (0.92–1.58)
Missing data	712 (10.5)			392 (10.4)	204 (11.0)	
Exposures, mean (SD)						
Decision demands,	3.5 (0.7)			3.5 (0.7)	3.5 (0.7)	0.96 (0.85–1.08)
Quantitative demands	3.0 (0.8)			3.0 (0.7)	2.9 (0.8)	0.96 (0.86–1.07)
Role clarity	4.3 (0.7)			4.2 (0.7)	4.3 (0.7)	0.85 (0.75–0.95)*
Role conflict	2.5 (0.8)			2.5 (0.8)	2.4 (0.8)	1.02 (0.91–1.14)
Positive challenge	4.0 (0.8)			4.1 (0.7)	4.0 (0.8)	1.03 (0.91–1.16)
Control over work intensity	3.3 (1.1)			3.4 (1.0)	3.2 (1.0)	1.09 (0.99–1.19)
Decision control	3.0 (0.8)			3.1 (0.8)	3.0 (0.8)	1.10 (0.98–1.25)
Predictability during the next month	4.2 (0.7)			4.3 (0.7)	4.2 (0.8)	1.04 (0.93–1.16)
Support from immediate superior	3.9 (0.9)			3.9 (0.9)	3.9 (0.9)	1.04 (0.91–1.19)
Empowering leadership	3.1 (1.0)			3.2 (1.0)	3.1 (1.0)	1.03 (0.93–1.14)
Fair leadership	3.9 (0.9)			4.0 (0.8)	3.9 (0.9)	1.10 (0.98–1.24)
Innovative climate	3.6 (0.8)			3.7 (0.7)	3.6 (0.8)	0.95 (0.82–1.10)
Social climate	3.8 (0.7)			3.8 (0.7)	3.8 (0.8)	1.17 (1.03–1.34)*
Human resource primacy	3.1 (0.9)			3.1 (0.9)	3.1 (0.9)	0.89 (0.80–1.00)
Physical workload	1.6 (0.8)			1.6 (0.8)	1.7 (0.8)	1.18 (1.05–1.33)*
Working with arms raised to or above shoulder level	1.5 (0.8)			1.5 (0.8)	1.5 (0.9)	0.98 (0.88–1.10)

[a]Completed minimum one exposure measure and minimum one of the three work ability outcome measures.
[b]Completed minimum one exposure measure at baseline and minimum one of the three work ability outcome measures twice (at baseline and follow-up).
[c]Adjusted for variables found significant ($P < 0.05$) in univariate attrition analysis.
*$P < 0.05$.
CI, confidence interval; OR, odds ratio; SD, standard deviation.

TABLE 2. Bivariate Spearman Rank Correlations Between Changes in Exposures[a] and Changes in Each of the Work Ability Outcomes[b] (WAI, PWA, and WAP) from Baseline to Follow-Up ($n = 92$ to 1266)

Δ Exposure	Δ WAI	Δ PWA	Δ WAP
Δ Decision demands	− 0.02	− 0.02	− 0.07
Δ Quantitative demands	− 0.06	− 0.09*	− 0.21
Δ Role clarity	0.10	0.14*	0.10
Δ Role conflict	− 0.13*	− 0.11*	− 0.24*
Δ Positive challenge	0.17*	0.12*	0.22
Δ Control over work intensity	0.04	0.01	− 0.01
Δ Decision control	0.06	0.06	0.06
Δ Predictability during the next month	0.04	0.09	0.01
Δ Support from immediate superior	0.20*	0.18*	0.23*
Δ Empowering leadership	0.15*	0.16*	0.17
Δ Fair leadership	0.22*	0.20*	0.24*
Δ Innovative climate	0.13*	0.17*	0.06
Δ Social climate	0.23*	0.13*	0.19
Δ Human resource primacy	0.17*	0.18*	0.16
Δ Physical workload[c]	− 0.08	− 0.02	− 0.09
Δ Working with arms raised to or above shoulder level[c]	− 0.06	− 0.09	− 0.23

[a] Δ Change was calculated by subtracting the baseline categorical score (1 to 5) from the follow-up categorical score (1 to 5).
[b] Δ Change was calculated by subtracting the obtained baseline score from the obtained follow-up score. Δ WAI ≥ ±3 points; Δ PWA ≥ ±1 point; Δ WAP ≥ ±1 category.
[c] Category range: 1 to 4.
*$P < 0.01$.
PWA, perceived work ability; WAI, work ability index; WAP, work ability prognosis.

resource primacy, and *positive challenge*, whereas the first two were statistically significant in 5 of the 6, and the latter in 4 of the 6 regression analyses, respectively. Mechanical exposures (*physical workload* and *working with arms to/above shoulder level*) were not significant predictors in any of the prospective analyses.

DISCUSSION

This study demonstrated that several psychological and social work factors contribute to self-reported work ability. *Role conflict, human resource primacy,* and *positive challenge* were the most consistent contributors and showed both temporal and longitudinal associations with the level of work ability.

Role conflict (conflicting role expectations) was a consistent risk factor to the level of work ability (all three outcomes). To our knowledge, this is the first study to uncover the effects of this specific exposure on work ability. Some studies have implicated conflicting expectations in composite measures of job demands. Of note, a recent cross-sectional study failed to find significant associations between role demands (measured by questions on time constraints and conflicting expectations) and self-reported work ability in different national samples.[32] The occurrence of time constraints (in terms of *quantitative demands*) was not predictive in any of our analyses. Thus, the present results clearly suggest that levels of time constraints and conflicting expectations have differential impact on work ability.

Independent of estimated confounders (ie, *supervisor support* and level of *social climate*), our analysis revealed that *role clarity* (clarity of expectations at work) had a protective role of the WAI score. This is in agreement with Tuomi et al[30] who found that role ambiguity was linked with a decline in the WAI score among aging municipal workers. We also found *role clarity* protective of perceived current work ability (PWA). Nevertheless, this did not pertain to work ability prognosis (WAP). Thus, perceptions of future ability to perform work do not seem to be influenced by clarity of role expectations.

The overall contribution of influence at work, use of special skills, and meaningfulness at work has repeatedly been investigated with single measures.[13,30,33] These aspects may have differential impact on work ability. By disentangling the effects of what we would argue to be two different constructs (ie, *decision demands* and *positive challenge*), we did not find *decision demands* significant to all work ability outcomes. *Positive challenge* on the other hand (ie, usefulness of skills and meaningfulness of work) was a consistent protective factor. The relatively strong relationship between this factor and the level of work ability may not be surprising. In fact, it has been argued that usefulness of skills and knowledge represents an integral part of the ability to perform work.[34]

Supervisory support has not unequivocally shown contributions to work ability in previous studies.[11,13,14,30,32] For instance, improved supervisor–employee cooperation was only predictive of improvements in the WAI score among municipal workers with physically challenging work.[30] McGonagle et al[32] reported that supervisor support correlated substantially with work ability perceptions in only one of the six examined cross-national samples. This study did not find that *support from immediate superior* was statistically significantly associated with the WAI score in the cross-sectional samples. Nevertheless, the average high level of *support from the immediate superior* over time was predictive of the WAI and PWA at follow-up. Given that the level of support was constant across the 2-year follow-up period, this finding suggests that certain exposure effects are substantive only after a relatively extensive exposure period.[35]

Organizationally communicated interest in employee well-being has been found relevant to outcomes such as job satisfaction, long-term sick leave, and health perceptions.[22,36] In this study, *human resource primacy* was identified as a prominent protective factor of the level of work ability (all three outcomes). Nevertheless, organizational focus on human resources has previously received limited attention in research of self-reported work ability. One notable exception is a cohort study among metal industry workers in Finland

TABLE 3. Prospective Analysis: Psychological, Social, and Mechanical Factors as Independent Variables and Low WAI (<37 points) at Follow-Up as Outcome—Binary Logistic Regressions, Odds Ratios Adjusted for Baseline WAI

		Baseline Exposure as Predictor		Average Exposure as Predictor[b]	
Work Exposure	**Confounders Included[a]**	***n***	**OR (99% CI)**	***n***	**OR (99% CI)**
Decision demands					
Category					
Low		165	1 (reference)	159	1 (reference)
Middle		833	0.50 (0.26–0.96)*	714	0.50 (0.26–0.96)*
High		1064	0.61 (0.32–1.16)	1120	0.62 (0.33–1.16)
Continuous		2062	0.84 (0.64–1.10)	1993	0.84 (0.62–1.14)
Quantitative demands					
Category					
Low		672	1 (reference)	548	1 (reference)
Middle		817	1.37 (0.87–2.17)	1020	0.98 (0.62–1.55)
High		627	1.55 (0.95–2.53)	507	1.56 (0.93–2.64)
Continuous		2116	1.25 (0.97–1.61)	2075	1.31 (0.98–1.74)
Role clarity					
Category					
Low		61	1 (reference)	42	1 (reference)
Middle		225	0.75 (0.27–2.04)	173	0.50 (0.16–1.49)
High		1845	0.57 (0.23–1.39)	1906	0.29 (0.11–0.79)*
Continuous		2131	0.81 (0.64–1.03)	2121	0.68 (0.52–0.90)**
Role conflict					
Category					
Low		1124	1 (reference)	1258	1 (reference)
Middle		818	1.38 (0.93–2.07)	708	1.30 (0.87–1.95)
High		188	2.29 (1.28–4.12)**	156	2.92 (1.59–5.38)**
Continuous		2130	1.42 (1.12–1.80)**	2122	1.51 (1.15–2.00)**
Positive challenge					
Category					
Low		65	1 (reference)	54	1 (reference)
Middle		298	0.42 (0.17–1.04)	247	0.45 (0.17–1.17)
High		1658	0.35 (0.15–0.80)*	1639	0.26 (0.11–0.64)**
Continuous		2021	0.75 (0.58–0.96)*	1940	0.58 (0.44–0.78)**
Control over work intensity					
Category					
Low		525	1 (reference)	494	1 (reference)
Middle		389	0.72 (0.40–1.29)	450	0.74 (0.43–1.30)
High		1214	0.98 (0.60–1.59)	1164	0.95 (0.57–1.57)
Continuous		2128	1.01 (0.83–1.22)	2108	0.99 (0.81–1.22)
Decision control					
Category					
Low		653	1 (reference)	555	1 (reference)
Middle		774	0.99 (0.63–1.55)	806	0.83 (0.53–1.31)
High		615	1.14 (0.69–1.89)	628	0.89 (0.52–1.52)
Continuous		2042	0.97 (0.75–1.26)	1989	0.90 (0.67–1.20)
Predictability during the next month					
Category					
Low		67	1 (reference)	40	1 (reference)
Middle		183	0.62 (0.20–1.94)	160	0.55 (0.16–1.92)
High		1888	0.85 (0.32–2.25)	1926	0.44 (0.15–1.33)
Continuous		2138	0.94 (0.73–1.21)	2126	0.86 (0.64–1.16)
Support from immediate superior					
Category					
Low		166	1 (reference)	127	1 (reference)

(*continues*)

TABLE 3. (*Continued*)

Work Exposure	Confounders Included[a]	Baseline Exposure as Predictor		Average Exposure as Predictor[b]	
		n	OR (99% CI)	*n*	OR (99% CI)
Middle	Social climate	401	0.91 (0.42–1.95)	380	0.49 (0.23–1.05)
High	Fair leadership	1499	0.89 (0.41–1.96)	1473	0.40 (0.18–0.89)*
Continuous		2066	0.87 (0.65–1.15)	1980	0.72 (0.50–1.02)
Empowering leadership					
Category					
Low		505	1 (reference)	515	1 (reference)
Middle		714	0.87 (0.56–1.37)	688	0.69 (0.44–1.08)
High		913	0.74 (0.46–1.18)	914	0.59 (0.37–0.94)*
Continuous		2132	0.88 (0.74–1.06)	2117	0.75 (0.61–0.92)**
Fair leadership					
Category					
Low		126	1 (reference)	101	1 (reference)
Middle		398	0.61 (0.30–1.26)	315	0.71 (0.32–1.53)
High		1596	0.54 (0.29–1.02)	1668	0.41 (0.21–0.83)*
Continuous		2120	0.81 (0.66–1.01)	2084	0.64 (0.50–0.81)**
Innovative climate					
Category					
Low	Positive challenge	125	1 (reference)	94	1 (reference)
Middle	Support from immediate superior	570	1.73 (0.77–3.88)	469	1.05 (0.43–2.56)
High	Fair leadership	1211	1.58 (0.66–3.82)	1176	1.22 (0.46–3.23)
Continuous	Social climate	1906	1.27 (0.87–1.86)	1739	1.55 (0.95–2.54)
Social climate					
Category					
Low		89	1 (reference)	77	1 (reference)
Middle		509	0.83 (0.38–1.83)	395	0.83 (0.35–1.94)
High		1520	0.62 (0.29–1.33)	1613	0.55 (0.25–1.24)
Continuous		2118	0.89 (0.69–1.15)	2085	0.66 (0.50–0.89)**
Human resource primacy					
Category					
Low		470	1 (reference)	471	1 (reference)
Middle		799	0.88 (0.56–1.39)	742	0.62 (0.39–0.99)*
High		784	0.72 (0.43–1.19)	784	0.57 (0.35–0.93)*
Continuous		2053	0.84 (0.67–1.04)	1997	0.73 (0.57–0.94)*
Physical workload					
Category					
Low		1268	1 (reference)	1300	1 (reference)
Middle		517	1.11 (0.70–1.76)	483	1.32 (0.83–2.10)
High		318	0.99 (0.54–1.81)	285	1.20 (0.64–2.26)
Continuous		2103	1.04 (0.80–1.34)	2068	1.13 (0.85–1.49)
Working with arms raised to or above shoulder level					
Category					
Low		1399	1 (reference)	1553	1 (reference)
Middle		486	1.38 (0.88–2.15)	407	1.24 (0.78–2.00)
High		247	0.99 (0.53–1.86)	160	0.98 (0.47–2.04)
Continuous		2132	1.06 (0.83–1.36)	2120	1.12 (0.84–1.49)

[a]Age, sex, skill level, and baseline WAI adjusted for in all analyses.
[b]Exposure averaged across time [(T1 + T2)/2].
*$P < 0.01$.
**$P < 0.0006$; Bonferroni-corrected significance level (0.01/16).
CI, confidence interval; OR, odds ratio; WAI, work ability index.

TABLE 4. Prospective Analysis: Psychological, Social, and Mechanical Factors as Independent Variables and Perceived Low Work Ability (PWA, <8 points) at Follow-Up as Outcome—Binary Logistic Regressions, Odds Ratios Adjusted for Baseline PWA

		Baseline Exposure as Predictor		Average Exposure as Predictor[b]	
Work Exposure	**Confounders Included[a]**	***n***	**OR (99% CI)**	***n***	**OR (99% CI)**
Decision demands					
Category					
Low		281	1 (reference)	260	1 (reference)
Middle	Positive challenge	1371	1.05 (0.65–1.71)	1130	1.10 (0.66–1.83)
High		1728	1.04 (0.64–1.71)	1746	1.10 (0.66–1.84)
Continuous		3380	1.00 (0.82–1.21)	3136	1.06 (0.84–1.35)
Quantitative demands					
Category					
Low		1110	1 (reference)	910	1 (reference)
Middle		1457	1.03 (0.76–1.39)	1752	0.89 (0.66–1.20)
High		1049	1.11 (0.81–1.54)	861	1.03 (0.73–1.47)
Continuous		3616	1.06 (0.90–1.26)	3523	1.07 (0.89–1.30)
Role clarity					
Category					
Low		103	1 (reference)	69	1 (reference)
Middle		393	1.12 (0.55–2.26)	300	0.51 (0.23–1.11)
High		3183	0.70 (0.36–1.33)	3283	0.36 (0.18–0.73)**
Continuous		3679	0.77 (0.65–0.91)**	3652	0.66 (0.55–0.79)**
Role conflict					
Category					
Low		1909	1 (reference)	2135	1 (reference)
Middle		1462	1.27 (0.98–1.65)	1244	1.46 (1.12–1.90)**
High		302	2.13 (1.43–3.17)**	254	2.45 (1.60–3.74)**
Continuous		3673	1.32 (1.12–1.55)**	3633	1.49 (1.23–1.79)**
Positive challenge					
Category					
Low	Human resource primacy	115	1 (reference)	94	1 (reference)
Middle		506	0.89 (0.46–1.71)	376	0.84 (0.42–1.70)
High		2629	0.61 (0.33–1.13)	2504	0.45 (0.23–0.88)*
Continuous		3250	0.84 (0.70–1.00)	2974	0.70 (0.56–0.87)**
Control over work intensity					
Category					
Low		918	1 (reference)	845	1 (reference)
Middle		691	0.78 (0.54–1.12)	786	0.73 (0.51–1.05)
High		2049	0.78 (0.57–1.06)	1974	0.76 (0.55–1.05)
Continuous		3658	0.92 (0.81–1.04)	3605	0.89 (0.77–1.02)
Decision control					
Category					
Low		1087	1 (reference)	916	1 (reference)
Middle		1358	0.98 (0.73–1.31)	1383	0.89 (0.65–1.21)
High		1015	0.83 (0.59–1.18)	1028	0.73 (0.51–1.05)
Continuous		3460	0.92 (0.77–1.10)	3327	0.83 (0.68–1.02)
Predictability during the next month					
Category					
Low	Role conflict	84	1 (reference)	43	1 (reference)
Middle	Positive challenge	275	0.87 (0.34–2.20)	208	0.67 (0.21–2.15)
High	Decision control	2828	1.24 (0.54–2.84)	2630	1.00 (0.35–2.88)
Continuous		3187	1.08 (0.88–1.32)	2881	1.10 (0.85–1.42)
Support from immediate superior					
Category					
Low	Human resource primacy	284	1 (reference)	220	1 (reference)
Middle		719	0.90 (0.56–1.44)	635	0.94 (0.57–1.55)

(*continues*)

TABLE 4. (*Continued*)

Work Exposure	Confounders Included[a]	Baseline Exposure as Predictor		Average Exposure as Predictor[b]	
		n	OR (99% CI)	*n*	OR (99% CI)
High		2417	0.93 (0.59–1.47)	2365	0.69 (0.42–1.14)
Continuous		3420	0.97 (0.82–1.14)	3220	0.84 (0.69–1.04)
Empowering leadership					
Category					
Low	Human resource primacy	841	1 (reference)	812	1 (reference)
Middle		1182	1.28 (0.92–1.79)	1064	1.01 (0.72–1.41)
High		1419	1.09 (0.75–1.58)	1383	0.86 (0.58–1.27)
Continuous		3442	1.05 (0.90–1.22)	3259	0.98 (0.81–1.19)
Fair leadership					
Category					
Low		212	1 (reference)	170	1 (reference)
Middle		683	1.00 (0.59–1.68)	554	0.69 (0.41–1.19)
High		2736	0.84 (0.52–1.35)	2825	0.44 (0.27–0.72)**
Continuous		3631	0.83 (0.72–0.96)*	3549	0.66 (0.56–0.78)**
Innovative climate					
Category					
Low	Support from immediate superior	222	1 (reference)	194	1 (reference)
Middle		1087	1.15 (0.69–1.94)	901	1.22 (0.71–2.11)
High	Human resource primacy	2092	1.12 (0.65–1.93)	2084	1.03 (0.58–1.84)
Continuous		3401	1.05 (0.84–1.30)	3179	1.00 (0.76–1.30)
Social climate					
Category					
Low	Empowering leadership	158	1 (reference)	122	1 (reference)
Middle		843	0.83 (0.48–1.46)	645	0.79 (0.43–1.47)
High		2412	0.75 (0.43–1.31)	2444	0.72 (0.39–1.32)
Continuous		3413	0.92 (0.75–1.12)	3211	0.79 (0.62–1.01)
Human resource primacy					
Category					
Low		820	1 (reference)	783	1 (reference)
Middle		1367	0.72 (0.53–0.97)*	1260	0.62 (0.45–0.84)**
High		1288	0.58 (0.42–0.80)**	1272	0.51 (0.36–0.70)**
Continuous		3475	0.78 (0.68–0.90)**	3315	0.69 (0.58–0.81)**
Physical workload					
Category					
Low		2252	1 (reference)	2316	1 (reference)
Middle		892	0.97 (0.72–1.32)	802	1.19 (0.88–1.63)
High		487	1.08 (0.72–1.62)	424	1.16 (0.75–1.79)
Continuous		3631	1.03 (0.86–1.23)	3542	1.11 (0.92–1.34)
Working with arms raised to or above shoulder level					
Category					
Low		2482	1 (reference)	2703	1 (reference)
Middle		783	1.21 (0.89–1.63)	679	1.17 (0.85–1.61)
High		415	1.00 (0.66–1.52)	263	1.09 (0.66–1.80)
Continuous		3680	1.03 (0.88–1.22)	3645	1.09 (0.90–1.33)

[a]Age, sex, skill level, and baseline level of perceived work ability adjusted for in all analysis.
[b]Exposure averaged across time [(T1 + T2)/2].
*$P < 0.01$.
**$P < 0.0006$; Bonferroni-corrected significance level (0.01/16); the reference exposure category.
CI, confidence interval; OR, odds ratio.

TABLE 5. Prospective Analysis: Psychological, Social, and Mechanical Factors as Independent Variables and Low Work Ability Prognosis (Categories 1 and 2) at Follow-Up as Outcome—Binary Logistic Regressions, Odds Ratios Adjusted for Baseline WAP

		Baseline Exposure as Predictor		Average Exposure as Predictor[b]	
Work Exposure	**Confounders Included[a]**	***n***	**OR (99% CI)**	***n***	**OR (99% CI)**
Decision demands					
Category					
Low		255	1 (reference)	243	1 (reference)
Middle		1185	1.04 (0.52–2.08)	1024	0.72 (0.36–1.46)
High		1478	1.00 (0.50–2.01)	1547	0.89 (0.45–1.77)
Continuous		2918	0.94 (0.71–1.24)	2814	0.97 (0.70–1.33)
Quantitative demands					
Category					
Low		953	1 (reference)	780	1 (reference)
Middle		1178	1.19 (0.75–1.90)	1443	1.24 (0.76–2.02)
High		855	1.02 (0.59–1.75)	697	1.42 (0.79–2.56)
Continuous		2986	1.03 (0.79–1.36)	2920	1.10 (0.81–1.49)
Role clarity					
Category					
Low	Support from immediate superior	83	1 (reference)	47	1 (reference)
Middle	Positive challenge	298	1.38 (0.39–4.85)	224	0.44 (0.13–1.52)
High		2421	0.93 (0.28–3.07)	2352	0.35 (0.11–1.09)
Continuous		2802	0.95 (0.70–1.29)	2623	0.93 (0.64–1.34)
Role conflict					
Category					
Low		1524	1 (reference)	1644	1 (reference)
Middle	Human resource primacy	1115	1.40 (0.90–2.20)	914	2.04 (1.28–3.24)**
High		238	1.37 (0.66–2.87)	194	2.18 (1.01–4.72)*
Continuous		2877	1.18 (0.89–1.57)	2752	1.40 (1.01–1.95)*
Positive challenge					
Category					
Low		89	1 (reference)	75	1 (reference)
Middle	Human resource primacy	419	0.99 (0.34–2.89)	319	0.34 (0.12–0.95)*
High	Social climate	2186	0.67 (0.24–1.87)	2082	0.32 (0.12–0.81)*
Continuous		2694	0.80 (0.60–1.07)	2476	0.65 (0.46–0.92)*
Control over work intensity					
Category					
Low		756	1 (reference)	708	1 (reference)
Middle		576	0.56 (0.32–1.00)*	638	0.76 (0.44–1.31)
High		1686	0.55 (0.34–0.90)*	1636	0.56 (0.34–0.94)*
Continuous		3018	0.81 (0.67–0.99)*	2982	0.78 (0.63–0.97)*
Decision control					
Category					
Low	Positive challenge	806	1 (reference)	619	1 (reference)
Middle	Control over work intensity	983	0.89 (0.52–1.53)	938	0.80 (0.44–1.44)
High	Social climate	748	0.99 (0.51–1.95)	712	0.71 (0.33–1.57)
Continuous	Human resource primacy	2537	1.02 (0.71–1.47)	2269	1.07 (0.67–1.71)
Predictability during the next month					
Category					
Low	Support from immediate superior	79	1 (reference)	41	1 (reference)
Middle	Empowering leadership	239	0.61 (0.17–2.15)	196	1.42 (0.28–7.24)
High	Social climate	2465	0.86 (0.29–2.53)	2342	1.31 (0.29–5.89)
Continuous	Human resource primacy	2783	0.85 (0.64–1.14)	2579	0.93 (0.65–1.34)
Support from immediate superior					
Category					
Low		237	1 (reference)	193	1 (reference)

(*continues*)

TABLE 5. (*Continued*)

Work Exposure	Confounders Included[a]	Baseline Exposure as Predictor		Average Exposure as Predictor[b]	
		n	OR (99% CI)	*n*	OR (99% CI)
Middle	Empowering leadership	585	0.56 (0.27–1.18)	522	1.33 (0.61–2.93)
High	Human resource primacy	2021	0.55 (0.25–1.18)	1970	0.81 (0.34–1.92)
Continuous		2843	0.92 (0.67–1.25)	2685	0.84 (0.57–1.23)
Empowering leadership					
Category					
Low	Human resource primacy	708	1 (reference)	693	1 (reference)
Middle		981	0.99 (0.59–1.66)	900	0.74 (0.44–1.27)
High		1192	0.86 (0.48–1.56)	1162	0.62 (0.33–1.16)
Continuous		2881	0.94 (0.74–1.20)	2755	0.87 (0.65–1.18)
Fair leadership					
Category					
Low	Support from immediate superior	169	1 (reference)	126	1 (reference)
Middle	Empowering leadership	526	1.17 (0.48–2.85)	414	0.87 (0.34–2.25)
High	Human resource primacy	2117	0.98 (0.38–2.50)	2072	0.74 (0.28–2.01)
Continuous		2812	1.11 (0.79–1.55)	2612	0.93 (0.61–1.42)
Innovative climate	Positive challenge				
Category					
Low	Support from immediate superior	167	1 (reference)	136	1 (reference)
Middle	Empowering leadership	824	1.20 (0.49–2.93)	657	0.97 (0.37–2.56)
High	Social climate	1644	1.39 (0.53–3.66)	1578	1.55 (0.53–4.54)
Continuous	Human resource primacy	2635	1.19 (0.78–1.82)	2371	1.65 (0.95–2.86)
Social climate					
Category					
Low		123	1 (reference)	102	1 (reference)
Middle	Empowering leadership	703	0.68 (0.28–1.65)	543	0.37 (0.16–0.87)*
High	Human resource primacy	2011	0.56 (0.23–1.38)	2034	0.39 (0.17–0.93)*
Continuous		2837	0.87 (0.62–1.21)	2679	0.76 (0.51–1.14)
Human resource primacy					
Category					
Low		694	1 (reference)	680	1 (reference)
Middle		1140	0.93 (0.58–1.49)	1057	0.67 (0.42–1.08)
High		1072	0.55 (0.32–0.96)*	1065	0.46 (0.27–0.78)**
Continuous		2906	0.78 (0.63–0.98)*	2802	0.66 (0.51–0.86)**
Physical workload					
Category					
Low	Control over work intensity	1806	1 (reference)	1837	1 (reference)
Middle		722	1.05 (0.63–1.75)	644	1.13 (0.66–1.92)
High		424	1.21 (0.65–2.26)	374	1.32 (0.69–2.55)
Continuous		2952	1.13 (0.86–1.48)	2855	1.21 (0.90–1.64)
Working with arms raised to or above shoulder level					
Category					
Low	Control over work intensity	1996	1 (reference)	2159	1 (reference)
Middle		649	1.30 (0.79–2.12)	560	1.25 (0.74–2.10)
High		345	1.14 (0.61–2.11)	215	1.69 (0.85–3.36)
Continuous		2990	1.07 (0.83–1.37)	2934	1.31 (0.97–1.76)

[a]Age, sex, skill level, and baseline work ability prognosis adjusted for in all analysis.
[b]Exposure averaged across time [(T1+T2)/2].
*$P < 0.01$.
**$P < 0.0006$; Bonferroni-corrected significance level (0.01/16).
CI, confidence interval; OR, odds ratio.

that found promotion of employee well-being (ie, higher interest in employee well-being and increased attempts to improve employee work conditions) predictive of elevations in the WAI score.[14]

The job content questionnaire[20] is commonly used in research aiming to identify the impact of psychological work exposures on work disability[37–39] and sickness absence.[6,26,40,41] Time pressure (a component of the psychological job demand dimension) has not been found significantly important to WAI scoring.[11,30] In accordance with earlier cross-sectional findings, *quantitative demands* was consistently unrelated to all work ability outcomes in this study.

A central component of control of the job content questionnaire is decision authority. A cross-sectional study found a single-item measure on influence of decision making associated with the WAI.[11] A prospective study using a measurement scale resembling this study's *decision control* (ie, influence on methods, decisions important to own work, and collaboration with colleagues) found positive score change on this scale to be predictive of the elevated WAI score from baseline to follow-up 2 years later.[14] *Decision control* did not predict the level of work ability in any of our prospective analyses. The divergence of findings may be attributable to differences in cohorts. Tuomi et al[14] analyzed industry and retail employees, whereas the present results were based on responses from a variety of occupational groups.

The current results did not support the notion that higher mechanical demands (*physical workload, working with arms raised*) have long-term effects on the level of work ability. The systematic review of van den Berg et al[42] concluded that four of the seven studies (with acceptable quality) showed significant associations between mechanical demands and the WAI level. Nevertheless, three of these four positive studies reported from the same cohort of middle-aged employees and two of these had a substantially longer follow-up period than this study. Thus, conflicting results could be due to differences in cohorts and methodological designs. On the basis of a cohort representing a wide range of the working population, it seems relevant for future studies to estimate effects of mechanical demands on work ability over longer periods. It is important to keep in mind, however, that substantial physical exertions at work are not as common as before. Thus, further investigations may also want to consider whether the contribution of mechanical demands to the level of work ability depends on occupational group. Plausibly, mechanical demands may be of particular relevance to the reported level of work ability among employees in occupations, which still implies high biomechanical loads.

Methodological Considerations

There are several known method biases that may threaten the validity of conclusions in epidemiological studies on the basis of self-reported data. Some measures have been taken to mitigate the potential confounding influence of biases on the present results.

Associations between baseline exposure and follow-up work ability may be influenced by the relationship between baseline exposure and baseline work ability. Adjusting for baseline work ability should help diminish this influence. At the same time, adjustment may have underestimated associations. The most consistent predictors were related to the level of work ability at baseline and to the level of work ability at follow-up. Thus, the variation in follow-up work ability explained by baseline work ability may, to some extent, result from baseline exposure. Nevertheless, this study was not designed to provide information about the mechanisms by which work exposures relate to work ability—merely to establish prospective associations.

Of the employees invited at baseline, 53.7% answered all the questions required to be included in the T1 analyses. Systematic nonresponse may compromise internal validity. We have no reason to suspect, however, that response status was systematically related to both work exposure and work ability levels, as would be necessary for nonresponse bias to occur.[43]

Background characteristics were predictive of response at baseline (ie, age) and dropout at follow-up (ie, age, occupational group, and skill level). Background characteristics may also have influenced exposure–outcome associations. Thus, the adjustment of these should have served to protect the internal validity of the study.

Selective follow-up participation could indicate a healthy worker effect. Cross-sectional analyses with the baseline WAI as outcome were rerun to determine whether baseline-only participants responded differently from prospective participants. Generally, direction and strength of associations showed to be similar in the two groups. One notable exception was that *role clarity* was a significant factor among baseline-only responders but not among two-time responders. Thus, although the majority of baseline participants responded at follow-up (67. 1%), it is apparent that loss to follow-up may have resulted in underestimation of some effects.

The participants represented a wide range of occupational sectors. Nevertheless, generalizing the results to the whole Norwegian working population would call for random sampling. Post hoc stratification by sex revealed that baseline WAI scoring of men in the current sample was comparable to that of men from a representative Swedish sample.[44] Nevertheless, women scored somewhat higher in the current sample. Although national differences (between Norwegian and Swedish women) may play a role, the divergence of findings could be due to the fact that women were overrepresented in the present sample. Therefore, caution should be taken when inferring the current results to the whole working population.

Data were obtained by a questionnaire designed to overcome issues relating to certain well-known methodological biases.[29] Work exposures were ranged on frequency scales (and not attitudinal scales) to minimize yea-saying/nay-saying[45] and bias in responses due to mood state. Exposure and outcome measures were placed in different sections of the questionnaire with different scale formats. Furthermore, participants responded to a questionnaire assessing not only the exposures and outcomes in focus by this study but a wide range of factors (eg, organizational change, health complaints, and coping strategies). Presumably, this should have prevented responses being guided by implicit theories of the exposure-outcome associations presented in this study. Nevertheless, we cannot rule out the possibility that sources of common method biases[45] influence the presented associations to some extent.

Categorization of exposures may lead to misclassification.[43] Average *social climate* was predictive of the low WAI as a continuous variable only. Likewise, baseline *role clarity* and *fair leadership* were predictive of low PWA as continuous variables only. For these variables, the threshold points chosen to distinguish between exposure levels (ie, low, medium, high) may not have been optimal to detect effects on the low WAI and low PWA, respectively. At the same time, most other exposures were significantly related to the work ability outcomes both as categorical and continuous. Thus, in general, the choice of categorical cut points seems to have been appropriate to provide information on dose–response effects.

CONCLUSIONS

Our findings from a prospective cohort representing a wide variety of occupations suggest that levels of *role conflict, human resource primacy*, and *positive challenge* are predictive of the low WAI score and perceived low current and future work ability. Mechanical demands were not found predictive. To protect employee work ability, workplaces are advised to consider the importance of the specific psychological and social predictors presented in this study.

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