Determinants of work ability and its predictive value for disability

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Introduction

There is ample evidence that construction workers have a higher risk of work-related disability than workers in less physically demanding jobs [1–4]. Manual handling, awkward postures and repetitive movements are core determinants of physical load in the construction industry. With an ageing workforce, the proportion of construction workers at risk for disability is expected to increase in the near future [5]. Therefore, prevention of disability will become even more important in the construction industry.

In order to prevent workers from quitting the workforce due to (work-related) disability, the concept of measuring work ability has been developed as a valuable tool to tailor interventions at individual level. In order to assess work ability, Finnish researchers have constructed the work ability index (WAI). This combines subjective experiences of one’s ability to cope with physical and mental requirements at work (performance at work) with information on diseases and consequent functional limitations, sick leave and mental resources at work (enjoying daily tasks, active and vital life, optimism about the future) [6]. The index is sensitive to changes in work conditions, health status and physical fitness [7].

A study by Finnish researchers on work ability has demonstrated clear effects of work-related physical and psychosocial factors and individual characteristics on work ability [8]. However, these studies have not addressed which aspects of work ability are affected most by work-related risk factors and individual characteristics. In addition, the relative contribution of performance, health and mental resources in the predictive power of work ability for future disability is largely unknown. This is clearly important for prioritizing interventions...
in the workplace. Thus, the aims of this study were to analyse the effects of work-related physical and psychosocial factors and individual characteristics on work ability and to determine the predictive value of work ability and its underlying dimensions for future work-related disability.

**Methods**

A prospective longitudinal study was performed on male Dutch construction workers who had participated in voluntary periodic occupational health examination and were not (partially) disabled, retired or working outside the construction industry at the time of the examination. The initial selection started with a random sample of 1000 workers aged 40 years and over, who had participated in the examination during a 3-month period from September 2002 until November 2002. An additional selection of 195 workers was based on workers who started a counselling and education programme during the period April to December 2002. The aim of the programme was the enhancement of individual work ability and comprised of an assessment interview, additional assessment of labour market capabilities, devising an individual education programme, executing the individual education programme and a follow-up activity. Since the source of the study population did not affect the statistical analysis due to the fact that this programme did not have effects on future work disability [9], this population was added to the current study population.

During the medical examination, a questionnaire was filled out on individual characteristics, working conditions, health problems and work ability. In February 2003, workers were sent a first follow-up questionnaire to their home address, on average ~5 months after attending the periodic health examination (follow-up 1). Respondents to this first questionnaire were sent two further follow-up questionnaires at fixed time intervals of ~9 months (follow-up 2 and 3), resulting in an average follow-up period of ~23 months. All questionnaires contained questions on work ability as well as work status including change of job to a job outside the construction industry, partial and full disability pension or (early) retirement.

In each questionnaire, workers were asked about their current economic status with five mutually exclusive categories: paid work, retired, unemployed, disabled or other. During the study period, disability was defined by receiving a formal disability pension which is granted to a worker who has been on sick leave for 52 consecutive weeks and whose functional limitations are too severe to be able to continue in their regular job. The eligibility criteria for such a disability pension, as stated in national legislation, further stipulated that a substantial loss of income must be demonstrated as a result of the fact that the worker cannot perform paid employment at all or holds a new, less strenuous job with a much lower salary.

The WAI was measured during the medical examination as well as determined in each follow-up questionnaire [8,10]. The answers on each scale were translated into a weighted score and the index was derived as the sum of these scores. The range of this summative index is 7–49, which is classified into poor (7–27), moderate (28–36), good (37–43) and excellent (44–49) work ability [10]. For the purpose of this study, the original seven scales were also used as separate dependent variables in the analysis.

The questionnaire during the medical examination comprised questions on physical load and psychosocial factors at work. Physical load at work was determined by dichotomous questions on regular exposure to awkward postures, kneeling or squatting, manually handling of materials, whole-body vibration and hand–arm vibration [11]. A sum score across these five questions was also calculated (0–5) in order to dichotomize around the median value the study population into high and low physical load. Psychosocial factors were measured according to the demand–control model defined by Karasek on job demands, skill discretion and job control [12]. An abbreviated version of the original questionnaire was used and job demands were assessed by means of a seven-item sum score, skill discretion by a six-item sum score and job control by a five-item sum score [13]. The median of each sum score was used to dichotomize the study population into workers with a high and a low psychosocial load at work.

During the medical examination, information on age and job title was collected by questionnaire. The information on job title was used to categorize subjects into white and blue-collar workers. Blue-collar workers were all workers who performed manual labour at a construction site and white-collar workers were all office workers and supervisors with primarily managerial tasks. The questionnaire during the medical examination also consisted of questions on mental and physical health. Mental health problems were ascertained using 11 questions on the presence (yes/no) of fatigue, sleep disturbance, gloomy feeling, nervousness, irritability, stress, being excited, memory and concentration problems and depression. These questions were largely similar to the EURO-D scale for depression diagnosis which defines a clinically relevant depression by a sum score >3 [14,15]. The sum score was used to dichotomize subjects to poor (>3 positive answers) and good mental health. Aspects of physical health were ascertained by dichotomous questions on the presence of regular chest pain, regular shortness of breath and four questions on regular pain in the back, neck, upper and lower extremities. The latter four questions were used to define the presence of musculoskeletal problems.
Multiple linear regression models were used to analyse the associations between individual characteristics and work-related risk factors with work ability at baseline and with its separate scales. In each model, a backward selection approach was used with a P-value of 0.10 or less for the initial selection of relevant variables, and only variables statistically significant at $P < 0.05$ were retained in the final models.

Kaplan–Meier curves were produced to describe the trend over time in proportion of workers without a disability pension relative to the time since inclusion in the cohort. The analysis was stratified by a poor, moderate and good/excellent work ability measured at baseline. A Cox regression analysis was performed with the hazard ratio (HR) as measure of association to study the relation between work ability and disability. The HR in a survival analysis is an approximation of the relative risk, expressing the likelihood that a particular risk factor predicts disability relative to the likelihood of disability in the absence of this risk factor. Disability pension, loss to follow-up because of early retirement and moving to another job outside the construction industry were considered censoring. All statistical analyses were carried out with SAS 8.2 and SPSS 15 statistical software package.

**Results**

From this initial study population of 1195 subjects, two subjects were excluded due to an incomplete medical examination, eight were excluded due to receiving a partial disability pension and 31 were excluded as they were female (a too small group for analysis), resulting in 1154 eligible participants.

The response to the first follow-up questionnaire was 74% ($n = 850$), with non-response ($n = 303$) partly due to 41 (14%) incomplete questionnaires. The response to the second and third questionnaires, relative to the response to the first follow-up questionnaire, was 70% ($n = 592$) and 69% ($n = 583$). In total, 450 workers completed all three questionnaires. Loss-to-follow-up ($n = 267$) was partly determined by workers changing job to other parts of industry ($n = 30$) and workers taking (early) retirement ($n = 13$).

Table 1 shows the baseline characteristics of the study population. The mean WAI was 38.7 and the proportion of workers with a poor or moderate work ability was 5% and 24%, respectively. The seven scales within the WAI were highly correlated, with highest associations between scales 1 and 2 ($r = 0.59$), scales 2 and 7 ($r = 0.43$), scales 1 and 4 ($r = 0.41$) and scales 2 and 6 ($r = 0.41$). The average score on the scale on current diseases was 56% of the maximum score, whereas on all other scales the average score varied from 73 to 86% of the maximum score.

The loss to follow-up during the consecutive measurements was not related to work ability, but respondents in the first and second follow-up reported a slightly higher physical load, lower work demands, lower job control and less skill discretion than construction workers who dropped out of the study.

In the univariate analyses, all work-related factors were significantly associated with a lower work ability at baseline (Table 2). In the multivariate model, all factors except job type remained statistically significant, albeit with a lower magnitude of the regression coefficient. These factors explained 15% of the variability in the WAI at baseline. Similar analyses for each dimension of the WAI showed that the highest age group had statistically significantly lower scores on all scales, except sick leave and mental resources. Work-related risk factors were more strongly associated with the two scales on work ability compared with the three scales on health.

During the follow-up period (with a mean of 22 months), 40 persons became partially or fully work disabled and were granted a disability pension. Figure 1
presents the Kaplan–Meier curve describing the proportion of workers without disability relative to time since follow-up for three categories of work ability. From the original population of 850 workers, 7 of 606 (1%) workers with a good/excellent work ability, 19 of 204 (9%) with a moderate work ability and 14 of 40 (35%) with a poor work ability at baseline became disabled. Table 3 shows that the workers between 45 and 50 years were more likely to become disabled compared with workers under 45 years (HR 3.1, 95% CI 1.3–7.5), but the risk on disability was no longer statistically significant among workers aged 50 year and over (HR 1.6, 95% CI 0.7–3.8). A poor and moderate work ability score were highly predictive for becoming disabled with HRs of 32 and 8, respectively. Adjustment for age did not influence the predictive power to a large extent. Interaction terms between work-related factors and work ability score were not statistically significant. The analyses for each separate scale of the WAI showed statistically significant HRs for all scales, with the highest predictive value for work ability in relation to demands at work (HR \(5^{1.96}\) per point decrease) and the lowest predictive value for current diseases diagnosed by a physician (HR \(5^{1.37}\) per point decrease).

**Discussion**

This study found that the self-reported work ability of construction workers aged 40 and over strongly predicted receiving a disability pension during the 23-month follow-up period. Current work performance, health problems and associated consequences for functioning and sick leave and mental resources were all important predictive factors. Work-related physical and psychosocial factors were associated with a lower work ability at baseline, but had limited predictive value for work disability during the follow-up.

The strength of this study is its longitudinal design. However, a limitation is the substantial dropout during...
follow-up measurements, since only 49% of the selected construction workers completed the last questionnaire. The loss to follow-up was not influenced by work ability, but respondents in the first and second follow-up reported a slightly higher occurrence of physical and psychosocial factors at work than those workers who dropped out of the study. This differential selection in self-reported exposure may have resulted in some underestimation of the predictive value of work-related factors for disability.

A second limitation of the study is the use of self-reported disability pension as a proxy for work-related disability. The eligibility criteria for a disability pension only partly depended on a deterioration in health affecting the worker’s ability to perform his regular job. The assessment of loss of income associated with the level of disability is also part of the formal decision process. In addition, we did not investigate other mechanisms of displacement from work, such as unemployment, retirement or change of job to other parts of industry, due to the small number of these events in the study population.

At baseline, age and work-related factors determined 15% of the variation in work ability among workers, which is in agreement with studies in other occupational groups [16–21]. It has to be noted that in this study, the best part of the variability in work ability could not be explained by physical and psychosocial workload. An important reason is most likely the crude assessment of workload based on dichotomous parameters. Another explanation is the importance of variables not accounted for in this study, most notably physical activity in leisure time [17,19], mental stress [18] and body mass index [19,22].

During the follow-up period, the average work ability changed little and the duration of follow-up may have been too short to notice a substantial decrease in work ability. In a randomized controlled trial on a physical activity programme, the work ability also remained stable during the 24 months of follow-up [23]. In addition, Tuomi et al. [24] have shown in an 11-year follow-up study that both the improvement and decline in work ability were associated more strongly with changes in work and lifestyle during the follow-up than with their initial variation.

Our study has confirmed that a poor or moderate work ability predicts the risk of a work-related disability pension [10]. The fact that work-related risk factors were associated with work ability at baseline, but not predictive for disability during the follow-up period, suggests that physical and psychosocial factors at work are especially important in the balance between physical and mental requirements of the job and the capabilities of the worker. Every separate scale of the WAI showed a statistically significant HR, and the overall index was highly predictive for future work disability. Age has been acknowledged as a risk factor for work-related disability [25]. The fact that the HR for receiving a disability pension among workers aged higher than 50 was not statistically significant in this study might partly reflect a healthy worker survival effect.

Given the predictive power of the WAI for work-related disability, it offers a suitable framework for preventive interventions. These interventions should address the determinants of work ability, such as physical and psychosocial factors at work. However, the low explained variance in the analysis of determinants of work ability at baseline suggests that interventions on working conditions may have only a modest impact on work ability in the short term. As a consequence, interventions may need to focus more on the imbalance between health problems and associated functional limitations and an individual’s capabilities to cope with the physical and mental requirements of work rather than addressing working conditions or health independently.

In conclusion, among construction workers a moderate or poor work ability was highly predictive for receiving a disability pension. Preventive measures should facilitate a good balance between work performance, health and mental resources in order to prevent quitting labour participation.

Key points
- Among construction workers, self-reported work ability proved to be a strong risk factor for future work-related disability.
- Current work performance, health problems and associated consequences for functioning and sick leave and mental resources were important prognostic factors for future disability.
- Work-related physical and psychosocial factors were associated with lower work ability at baseline, but had limited predictive value for future work disability during the follow-up.

Conflicts of interest
None declared.

References
3. Guberan E, Usel M. Permanent work incapacity, mortality and survival without work incapacity among occupations


