Work ability as a determinant of old age disability severity: evidence from the 28-year Finnish Longitudinal Study on Municipal Employees

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ABSTRACT. ***Background and aims:*** *Lower occupational class correlates with a higher disability risk later in life. However, it is not clear whether the demands made by mental and physical work relative to individual resources in midlife predict well-being in old age. This study investigated prospectively whether work ability in midlife predicts disability severity in activities of everyday living in old age.* ***Methods:*** *Data come from the population-based 28-year follow-up called Finnish Longitudinal Study of Municipal Employees. A total of 2879 occupationally active persons aged 44-58 years answered a questionnaire on work ability at baseline in 1981 and activities of daily living in 2009. At baseline, perceived work ability relative to lifetime best was categorized into excellent, moderate, and poor work ability. At follow-up, disability scales were constructed based on the severity and frequency of difficulties reported in self-care activities of daily living (ADL) and instrumental activities of daily living (IADL).* ***Results:*** *There was a graded prevalence of ADL and IADL disability severity, according to excellent, moderate and poor midlife work ability (p<0.001). Employees with moderate midlife work ability had an 11 to 20% higher mean ADL or IADL disability severity score, compared with those with excellent midlife work ability (reference), incidence rate ratios (IRR) ranging from 1.11 (95% CI 1.01-1.22) to 1.20 (95% CI 1.10-1.30). Those with poor midlife work ability had a mean ADL or IADL disability severity score 27 to 38% higher than the referent, IRRs ranging from 1.27 (95% CI 1.09-1.47) to 1.38 (95% CI 1.25-1.53). Adjusting for socio-economics, lifestyle factors and chronic diseases only slightly attenuated the associations.* ***Conclusions:*** *Work ability, an indicator of the demands made by mental and physical work relative to individuals' mental and physical resources, predicted disability severity 28 years later among middle-aged municipal employees.*

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INTRODUCTION

For the majority of their lives, most people work in various occupations, yet the effects of work-related factors on old age health and wellbeing have only infrequently been studied (1). Lower occupational class has been shown to predict increased morbidity, disability and mortality, and these health differentials have been found to increase as people enter old age (1, 2). Epidemiological studies have shown that high work-related mental strain is associated with an increased risk of cardiovascular disease and mortality (3, 4). Similarly, physical work strain is associated with increased mortality among the workforce (5).

High work-related physical and mental strain and lack of autonomy, together with absence of physical activity, poor musculoskeletal capacity, obesity and older age, are associated with poor work ability (6). An individual's work ability is defined as the degree of equilibrium between a person's perceived mental and physical work demands and perceived ability, as well as mental and physical resources to cope with those demands (7). Work ability is related to an individual's health and functional capacity, but also to professional knowledge, skills, attitudes, values and motives regarding the work itself (8). Poor work ability predicts work disability and earlier retirement among the working aged population (9, 10). However, little is known about the association of work ability and older age health outcomes (10).

Key words: Activities of daily living, aging, disability, instrumental activities of daily living, work ability.

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We found a graded risk for disability and mortality according to work ability in midlife among blue- and white-collar employees, although the mortality risk was generally higher among blue-collar employees (11). In the present study, we expected a higher level of work ability in midlife to be associated with a less severe disability grade in self-care activities of daily living (ADL) and instrumental activities of daily living (IADL) assessed in old age. Thus, we investigated whether work ability in midlife in men and women working in the public sector was associated with old age disability severity in ADLs and IADLs, both of which are important determinants for need of care in old age.

METHODS

Participants and design

The Finnish Longitudinal Study on Municipal Employees (FLAME) by the Finnish Institute of Occupational Health randomly selected 7344 municipal employees aged 44-58 years working in all municipal occupations in Finland (12). At baseline in 1981, altogether 5971 employees (45.4% men), with a response rate of 81.3%, answered the questionnaire on perceived work ability. Follow-up data were collected in 1985, 1992, 1997 and 2009. At the last follow-up in 2009, 2879 (71.0% of the survivors) had data available on activities of daily living.

Work ability

At baseline, work ability was elicited as a subjective assessment of present work ability compared with the lifetime best, with the question: 'Imagine that if you had been asked to rate your work ability on a scale from 0 to 10, when it was at its best, you would have given it a score of 10. What score would you give to your present work ability?' This question is included in the seven-item Work Ability Index (WAI) and has been shown to capture most of the individual differences of the index (13). The WAI was developed at the Finnish Institute of Occupational Health in the 1980s and is based on the concepts of stress-strain and balance (14), in which individual mental and physical resources are assessed in relation to job demands. The WAI has been validated against clinical data (15). The correlation in this study between the work ability score (single item) and the work ability index (seven-item scale) was Pearson correlation r=0.836, $p<0.001$ for men, and Pearson correlation r=0.811, $p<0.001$, for women. We used the work ability score to indicate an individual's work ability in our analyses. Scores ranged from 0, 'unable to work', to 10, 'work ability at its best', and were stratified into three categories: excellent (scores 9-10, highest quartile), moderate (scores 7-8, two middle quartiles) and poor (scores 0-6, lowest quartile) work ability, modified from Gould et al. (16). To account for the change which might have occurred in work ability in late careers, a change score in work ability from 1981 to 1992 was calculated (1992 score subtracted from 1981 score).

Disability in activities of daily living

Participants reported perceived difficulties in five basic self-care activities of daily living, ADLs (feeding, bathing, dressing, transferring to and from bed, toileting) (17) and in seven instrumental activities of daily living, IADLs (preparing meals, doing laundry, shopping, coping with light housework, administering and taking medication, using the telephone, handling finances) (18). ADL and IADL tasks may be viewed as hierarchical in that difficulties are first and most frequently perceived in the more complex tasks. With declining functional abilities, difficulties also develop in the easier tasks (19). In these data, the order in which difficulties most frequently occurred was in the ADLs of transferring to and from bed, dressing, bathing, toileting, and feeding, and in the IADLs of coping with light household tasks, doing laundry, preparing food, shopping, handling finances, administering and taking medication, and using the telephone. Exploiting knowledge on how commonly a specific difficulty was reported, we constructed ADL and IADL disability scales with exclusive categories based on the hierarchy and severity of difficulty, in a way similar to that previously done for functional limitations (20). The ADL disability scale was categorized as follows: 1= independent, without difficulties in any of the five tasks; 2= some difficulties in at least one task; 3= category 2 + many difficulties in or unable to perform at least one of the three hardest tasks of transferring, dressing or bathing; and 4= category 3 + many difficulties in or unable to perform toileting and/or feeding. The IADL disability scale was categorized as follows: 1= independent, without difficulties in any of the seven tasks; 2= some difficulties in at least one of the four hardest tasks of coping with light housework, doing laundry, preparing food and shopping; 3= category 2 + some difficulties in at least one of the three easiest tasks of handling finances, administering and taking medication, and using the telephone; 4= category 3 + many difficulties or unable to perform at least one of the four hardest tasks of coping with light housework, doing laundry, preparing food and shopping; and 5= category 4 + many difficulties in or unable to perform at least one of the three easiest tasks of handling finances, administering and taking medication, and using the telephone.

Baseline covariates

Socio-economic status was assessed with the occupational group defined as participants' jobs at baseline. The 133 occupational titles identified were clustered into 13 occupations, based on job analysis at participants' workplaces (12). These were further grouped into blue-collar (e.g., maintenance, cleaning, nursing assistant), lower

white-collar (transport work, nursing) and upper white-collar (e.g., administrator, physician, teacher) employees, according to objective assessment of job characteristics. Lifestyle habits included smoking (never smoked, ex-smoker or current smoker), alcohol intake (never, twice a month at most, or at least once a week) and level of physical activity during the previous year (vigorous activity at least once a week, some form of physical activity once a week at most, or physically inactive). Participants were asked whether they had any illnesses or injuries that a physician had diagnosed or treated. Musculoskeletal diseases (e.g., arthritis, degenerative diseases of the back and extremities), cardiovascular diseases (e.g., hypertension and angina pectoris), respiratory diseases (e.g., chronic obstructive pulmonary disease and asthma), and metabolic diseases (e.g., diabetes and obesity) were included in the analyses.

Statistical analyses

Participants' baseline characteristics were compared with χ^2 tests for categorical variables and analysis of variance for continuous variables. Negative binomial regression models were used to assess the association of work ability in midlife, stratified into three categories, and the risk of ADL and IADL disability in older age. This method allows for skew outcome distributions and clumping at zero (21). Risk values are expressed as incidence rate ratios, obtained by exponentiation of regression coefficients, exp[β], and their 95% confidence intervals (CI). The expression 100*(exp[β]-1) indicates the percent change in the mean ADL and IADL disability scores relative to work ability reported in midlife. The crude model was adjusted for age. Second, we adjusted the models by occupational group, change in work ability from 1981 to 1992, alcohol intake, smoking history, and level of physical activity. Lastly, we included the main chronic diseases in the models as covariates. The likelihood ratio test was used to assess the interaction effect between gender and work ability. Modeling was performed with STATA 10.0 software.

Sensitivity analyses were conducted in order to account for possible selection bias. At the follow-up in 2009, of the

Table 1 - *Descriptive characteristics (percentages, unless stated otherwise) according to midlife work ability of men and women participating in follow-up in 2009.*

	Men				Women			
	Excellent WA[a] n=299	**Moderate WA[a] n=554**	**Poor WA[a] n=221**	***p*-value[b]**	**Excellent WA[a] n=577**	**Moderate WA[a] n=912**	**Poor WA[a] n=316**	***p*-value[b]**
Age, mean (SD)	48.8 (3.2)	49.8 (3.3)	50.2 (3.2)	<0.001	49.1 (3.2)	49.7 (3.4)	50.3 (3.5)	<0.001
Body mass index (kg/m^2), mean (SD)	25.3 (2.7)	26.1 (2.8)	26.3 (3.1)	<0.001	24.5 (3.2)	25.1 (3.4)	25.6 (3.5)	<0.001
Occupation group				<0.001				<0.001
Upper white-collar	38.8	24.9	13.1		32.4	22.1	18.4	
Lower white-collar	16.1	13.4	9.0		52.9	55.0	50.0	
Blue-collar	45.2	61.7	77.8		14.7	22.8	31.6	
Married/Cohabiting	93.3	94.9	90.5	0.074	63.6	66.5	66.8	0.466
Net family income over 1700 € per month	86.4	71.3	64.1	<0.001	66.1	63.7	62.3	0.485
Began full-time work at less than 18	53.7	70.3	80.2	<0.001	26.6	31.5	36.8	0.006
Smoking history				0.033				0.479
Never smoked	43.9	35.8	35.3		76.5	80.2	79.1	
Ex-smoker	41.9	47.6	42.5		14.1	12.5	12.2	
Current smoker	14.2	16.6	22.2		9.1	7.3	8.7	
Alcohol intake				0.446				0.610
None	12.9	12.3	15.4		39.3	42.0	43.9	
Max. 2 times per month	72.9	72.2	66.0		57.2	54.9	53.8	
At least once a week	14.2	15.5	18.6		3.5	3.1	2.3	
Physical exercise				<0.001				<0.001
Vigorous activity	67.2	49.7	44.5		61.1	50.2	40.5	
Moderate activity	27.4	46.3	48.6		34.5	43.2	49.0	
Inactive	5.4	4.0	6.9		4.4	6.6	10.5	
Musculoskeletal disease	16.4	31.2	61.5	<0.001	18.0	42.8	65.5	<0.001
Heart and circulatory disease	11.7	16.1	29.9	<0.001	8.7	19.3	26.6	<0.001
Respiratory disease	4.3	10.1	17.6	<0.001	5.4	10.9	19.6	<0.001
Metabolic disease	3.0	6.0	11.8	<0.001	5.5	11.1	15.8	<0.001

[a]WA: Work ability; [b]Age and body mass index test with ANOVA; others with chi-square test.

5971 participants, 1918 had died, 1174 were alive but had no data on disability, and 2879 had data on disability. Of the 1174 persons with missing information on disability, we were able to impute data for 597 persons using the most recent data available (from 1997 or 1992 data wave). The number of chronic diseases, work ability, and functional ability sum score (coping with heavy household chores, lifting and carrying over 10 kg, and climbing three flights of stairs without resting, walking 2 km and running 100 meters) were used for the regression imputation. Tests were performed as two-tailed in SPSS 15.0, with significance level $p<0.05$.

RESULTS

A comparison of those with data on ADLs at follow-up in 2009 (n=2879) and the surviving non-respondents (n=1174, 29.1% of survivors) showed that respondents at baseline were slightly younger (49.6 years, standard deviation [SD]=3.4 *vs* 50.4 years, SD=3.6, $p<0.001$), more often upper or lower white-collar employees (63.9% *vs* 51.3%, $p<0.001$) and more frequently reported excellent work ability (30.4% *vs* 27.1%, $p=0.007$). The number of self-reported physician-diagnosed illnesses or injuries (mean 4.8, SD=2.1 *vs* mean 4.8, SD=2.1, $p<0.34$) did not differ among the respondents and surviving non-respondents. For the majority (69.8%), work ability was stable, with zero or a 1-point change between 1981 and 1992. An increase in the work ability score of 2 points or more was found for 5.7% and a decrease of 2 points or more for 24.5%.

The midlife health and socio-economic status of the participants, stratified according to work ability and gender, are listed in Table 1. Those with excellent midlife work ability were slightly younger than those with moderate or poor work ability ($p<0.001$). Among men, those with poor midlife work ability worked more often in a blue-collar profession and had more frequently started full-time work aged less than 18, than those with moderate or excellent work ability ($p<0.001$). Among women, those with excellent work ability were more frequently upper white-collar than those with lower work ability ($p<0.001$). Those with poor midlife work ability were more frequently physically inactive and had more chronic illnesses than those with better work ability ($p<0.001$).

Men and women were analysed separately, because the interaction effect between gender and work ability on disability was statistically significant. The prevalence of IADL disability was higher (men: 52.6% and women: 36.2%, χ^2 test $p<0.001$ for gender) than that of ADL disability (men: 27.6% and women: 24.3%, χ^2 test $p<0.234$ for gender). There was a graded prevalence of ADL and IADL disability severity according to excellent, moderate and poor midlife work ability (χ^2 test $p<0.001$), shown in Figure 1.

Table 2 shows the incidence rate ratios (IRR) and 95% confidence intervals [CI] for men and women, which

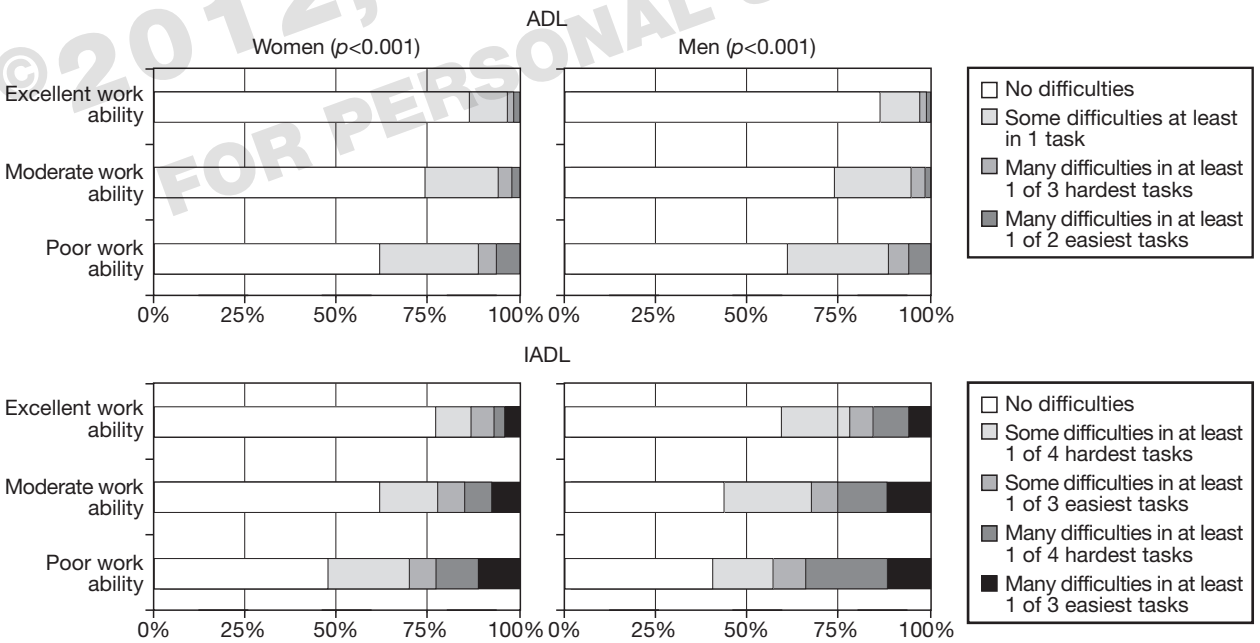

Fig. 1 - *ADL and IADL disabilities at follow-up in 2009 for men and women, according to midlife work ability at baseline in 1981.*

Table 2 - *Incidence rate ratios and 95% confidence intervals (CI) for men and women for ADL and IADL disabilities in old age, according to work ability in midlife in a 28-year prospective follow-up.*

	ADL disability[a]			IADL disability[b]		
	Incidence rate ratio and 95% CI			Incidence rate ratio and 95% CI		
	Model 1[c]	Model 2[d]	Model 3[e]	Model 1[c]	Model 2[d]	Model 3[e]
Men						
Midlife work ability:						
Excellent work ability	1	1	1	1	1	1
Moderate work ability	1.14 (1.01-1.30)	1.12 (0.98-1.29)	1.12 (0.97-1.28)	1.18 (1.07-1.31)	1.16 (1.04-1.30)	1.16 (1.04-1.29)
Poor work ability	1.27 (1.09-1.47)	1.29 (1.09-1.52)	1.26 (1.05-1.50)	1.29 (1.14-1.45)	1.28 (1.12-1.46)	1.26 (1.09-1.45)
Women						
Midlife work ability:						
Excellent work ability	1	1	1	1	1	1
Moderate work ability	1.11 (1.01-1.22)	1.10 (1.00-1.22)	1.06 (0.96-1.18)	1.20 (1.10-1.30)	1.18 (1.08-1.28)	1.14 (1.04-1.25)
Poor work ability	1.28 (1.14-1.44)	1.30 (1.15-1.48)	1.21 (1.06-1.39)	1.38 (1.25-1.53)	1.37 (1.23-1.53)	1.29 (1.14-1.45)

[a]Activities of daily living (ADL) disability scale between 1=no difficulties in ADL tasks, and 4=many difficulties in at least 1 of 2 easiest ADL tasks. [b]Instrumental activities of daily living (ADL) disability scale between 1=no difficulties in IADL tasks, and 5=many difficulties in at least 1 of 3 easiest IADL tasks. [c]Model 1 adjusted for age. [d]Model 2 adjusted for age + occupational group + change in work ability from 1981 to 1992 + alcohol intake + smoking history + physical activity. [e]Model 3 adjusted for model 2 + main chronic diseases.

represent the change in mean ADL and IADL disability scores relative to midlife work ability. After adjusting the negative binomial regression models for age, those men and women with moderate midlife work ability had mean ADL or IADL disability scores which were 11 to 20% higher (IRRs ranging from 1.11 [95% CI 1.01-1.22] to 1.20 [95% CI 1.10-1.30]), meaning an increase in disability severity, compared with those with excellent midlife work ability. Similarly, those with poor midlife work ability had mean ADL or IADL disability scores which were 27 to 38% higher (IRRs ranging from 1.27 [95% CI 1.09-1.47] to 1.38 [95% CI 1.25-1.53]) than those with excellent midlife work ability.

Adjustment for midlife socio-economic status and lifestyle factors, chronic diseases and the change in work ability during late careers attenuated the risk of ADL disability for men and women with moderate midlife work ability, whereas there was only a small decrease in the incidence rate ratios for those with poor midlife work ability, men: 1.26 (95% CI 1.09-1.47) and women: 1.21 (95% CI 1.06-1.39). For IADL disability, the incidence rate ratios decreased only slightly after adjustments, and were significantly higher for men and women with moderate and poor work ability, compared with those with excellent work ability.

Stratifying the study population according to baseline age with cut-off at mean age (44-49 years and 50-55 years) did not change the results in the age groups. We used imputed data to repeat the analyses on 86.4% of the participants who were alive at the follow-up in 2009. The associations between midlife work ability and old age disability were similar to those reported above (data not shown).

DISCUSSION

Work ability in midlife predicted disability severity 28 years later among municipal employees who had retired from white- and blue-collar occupations. Accounting for socio-economic status, lifestyle factors and long-standing illnesses only slightly decreased the effect of the association between perceived midlife work ability and old age disability. In addition, the balance between physical and mental work demands and individual physical and mental resources predicted the severity of disability in the basic and more complex activities of daily living several decades later. Thus, our results expand the current knowledge on the long-term effects of work on functioning in later life.

The association between work-related mental and physical strain and old age disability has only infrequently been studied. Britton et al. reported that mental job demands, decision latitude and work support among 35- to 55-year-old British civil servants did not correlate with health and functioning in early old age (22). This lack of an association may be due to the fact that the persons were younger and that the analyses included psychosocial rather than physical factors, which already in midlife mark wellbeing in old age (23).

We found in an earlier study that work ability in midlife predicted decline in health and functioning three decades later (11). Several mechanisms may explain this association. First, work ability and disability share several earlier life predictors which may partly explain the association found in this study. Chronic states such as cardiovascular diseases have been shown to predict decline in work ability among occupationally active adults (13). Similarly, there is evidence that the presence of long-term dis-

eases, such as coronary heart disease, predicts old age disability (24). Lower socio-economic status has been linked to lower educational attainment and occupational grade in adult life (25). Higher educational attainment has been shown to correlate both with better perceived work ability among the working population and better functioning in old age (26). Second, work ability and disability are both indicated by the balance between the resources and demands of the environment in performing a given task. Work ability has been described as an activity which is the result of the balance between work demand and strain, and the individual resources and ability to cope with those demands (7). Similarly, disability in old age has been defined as the gap between a person's abilities and the demands posed by the living environment (27). This may indicate that individuals who have poor work ability in midlife are already on a trajectory leading to worse health and physical functioning, which will become more evident in old age.

In the present study, we found a graded association in disability severity in old age, according to the level of work ability reported in midlife. The prevalence of disability was higher for the more complex IADL tasks than for basic self-care-related ADL tasks, at each work ability level and for both men and women. Interestingly, men reported more disability than women. One explanation for this gender difference is that more men than women had worked in blue-collar occupations, a fact which is known to be related to increased disability in old age (1). For both genders, midlife work ability correlated more strongly with IADL disability than ADL disability, the latter tending to be the last to occur (28). The respondents were 72-86 years old at follow-up and mostly community-dwelling. Overall, they managed ADL tasks quite well, whereas, at that age, difficulties in IADL tasks start to increase, which may explain the stronger association observed for IADL disability.

Some limitations of the present study should be acknowledged. First, in such a long follow-up, drop-out may have been selective. The 'healthy worker survivor effect' is an ongoing process, in which those who stay in a specific profession tend to be healthier than those who exit the labor market. Those in lower-grade occupations are more likely to drop out or have missing data at later periods. Second, work ability and disability were self-reported, which may have caused some reporting bias. All the respondents had been in working life for many years and were assumed to be familiar with what paid employment entails. In addition, the disability scales we used have been shown to be valid predictors of health and functioning among older persons (29, 30). Third, ADL or IADL disabilities were not elicited at baseline; however, their prevalence in the middle-aged workforce is virtually non-existent (31). Thus, we are confident that decline in work ability preceded declines in ADL and IADL tasks over the long follow-up period. Lastly, when generalizing the results on a population level, it should be noted that occupational groups tend to be healthier than the general population, which includes persons outside the workforce.

The strengths of the study include a long prospective follow-up in a large population-based cohort consisting of a wide variety of municipal occupations. Large datasets which include information on work-related factors and old age outcomes with follow-up over many decades are rare.

CONCLUSION

This study shows that work ability in midlife can predict disability severity in old age. This is a major current and future health concern in Western countries. The current work ability status of middle-aged employees may be a predictor of old age functioning, indicating that working life has a far-reaching impact on the health of the aging population in the future. However, more research is needed to confirm these findings.

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