

Longitudinal Changes in Work Ability, Well-Being, and Psychosocial Risk Factors Among Older Workers: The ProAgeing Study

ALICE FATTORI¹, TERESA BARNINI^{2,3}, ANNA COMOTTI², PASQUALE BUFANO⁴, MARCO LAURINO⁴, SIMONE RUSSO⁵, LUCA FERRARI¹, CATALINA CIOCAN⁶, MATTEO BONZINI^{1,2,*}

¹Department of Clinical Sciences and Community Health, University of Milan, Milan, Italy

²Occupational Medicine Unit, Foundation IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy

³Department of Psychology, University of Milano-Bicocca, Milan, Italy

⁴Institute of Clinical Physiology, National Research Council, Pisa, Italy

⁵Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, INAIL, Monte Porzio Catone, Rome, Italy

⁶Department of Public Health and Pediatrics, University of Turin, Turin, Italy

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ABSTRACT

Background: As the workforce ages, older employees face increasing challenges in adapting to changing job demands, including technological advances and ongoing occupational risks such as shift work and physically demanding tasks. Work ability is a reliable indicator of older workers' capacity to meet both physical and mental requirements of their jobs. The ProAgeing study, a multicenter investigation specifically focused on workers over 50 years old, examined long-term patterns in work ability, perceived health, and psychosocial risk factors, along with their interactions across this demographic. **Methods:** Participants completed self-reported questionnaires at baseline and after one year, including the Work Ability Index (WAI), technostress, sleep quality, perceived stress, health, and psychosocial risk factors. A first-difference linear regression model was used to assess predictors of changes in WAI. Subgroup analyses examined differences across occupational roles (bank employees, administrative employees, and manual workers). **Results:** Of the 470 workers enrolled, 356 (76%) completed the follow-up. A significant decline in average WAI score was observed over 12 months (-1.2 points, $p < 0.001$), mainly in subscales related to work demands and physical illness. Technostress levels slightly decreased, suggesting adaptation over time. Bank employees showed less favorable trends than manual workers, indicating that digitalization and higher job demands significantly affected employees' well-being, especially older workers. Improvements in perceived health and reduced stress mostly contributed to enhanced work ability. **Conclusions:** These findings highlight the importance of targeted interventions to enhance health and lower stress among aging workers, supporting their well-being and subsequently their work ability.

1. INTRODUCTION

Worldwide, the aging population and increased life expectancy are significantly transforming workplaces, with more workers over 50 remaining active.

These demographic shifts create new challenges, as age-related cognitive and physical decline can directly affect workplace performance [1, 2]. Previous literature highlights that work ability is a good indicator of aging quality, reflecting both workers' health

status and their capacity to meet job demands [3]. Work ability represents the balance between personal resources and work requirements, with higher levels linked to better performance and well-being, and lower levels associated with increased sickness absence and early retirement [4-6]. The likelihood of reduced work ability rises with age, as older workers may struggle to meet the physical demands of their roles and are more susceptible to health problems [7]. Studies emphasize that physical health is a key factor in work ability, with sensory and muscular functions typically declining after 45 years of age [2]. Additionally, chronic conditions such as musculoskeletal, gastrointestinal, and cardiovascular diseases can further impair work ability, leading to decreased productivity, sickness absence, and even exits from the labor force [8-10].

Beyond physical health, recent research has broadened the analysis of work ability determinants to include work-related and psychological factors. Organizational research on work ability commonly adopts the Job Demands-Resources (JD-R) model as a theoretical framework, which distinguishes between job demands—such as shift work, extended hours, and role demands—and job resources, including support from supervisors and colleagues, autonomy, and flexible work schedules [11-13]. In this context, essential resources such as relationship-oriented leadership, decision-making autonomy, skill-job fit, meaningfulness of work, and emotional resilience play crucial roles in enhancing work ability [14-17]. Conversely, job demands and work-related stress significantly reduce work ability [18]. Excessive mental and physical workloads, poor working conditions, and other stressors contribute to negative emotional states, which in turn reduce well-being, job satisfaction, and motivation. This, in turn, diminishes job performance, organizational commitment, and work ability, while increasing staff turnover.

Recent research concentrates on these factors to sustain work ability and promote a healthier, more engaged workforce [7]. However, the impact of these variables depends on the nature of the job, as different occupations impose distinct physical, cognitive, and psychological demands on workers [18, 19]. While some longitudinal studies have

examined aspects of work ability, to our knowledge, no studies have comprehensively integrated all these previously mentioned factors. The aim of this study is to explore longitudinal work ability, health, work-related, and psychosocial factors, as well as their interactions, in a population of older workers across various occupations.

2. METHODS

This multicenter longitudinal study invited eligible workers to participate during routine medical surveillance visits, as mandated by Italian occupational safety regulations (Legislative Decree No. 81/2008). Data were collected from three selected companies representing different sectors—finance, packaging, and steel—to capture diverse roles and work environments. Eligibility criteria required participants to be full-time employees over 50 years old, with at least 10 years of seniority in their current role. There were no exclusion criteria regarding gender, ethnicity, or clinical characteristics. All participants provided written informed consent before enrolling, and participation was voluntary. Participants completed a series of self-reported questionnaires administered through the REDCap platform [20]. They were followed up after one year. The same set of questionnaires was administered, and information on any changes in job roles during the follow-up period was collected. The study protocol has been previously published [21].

The set of questionnaires included the Work Ability Index (WAI, [22]), a technostress scale specifically designed for older adults [23, 24], the Pittsburgh Sleep Quality Index (PSQI, [25]) to evaluate sleep quality, and the Perceived Stress Scale (PSS, [26]). Additionally, it incorporated measures of perceived general health (one item), job satisfaction (one item, [27]), and psychosocial risk factors (Management Standard (MS) Indicator Tool, [28, 29]). We also collected socio-demographic data (e.g., age, gender, BMI) and occupational information (e.g., role, shift work, job seniority).

Descriptive statistics included mean values and standard deviations for continuous variables and frequencies and percentages for categorical variables. Differences in scores between baseline (T0)

and follow-up (T1) were analyzed using paired t-tests. For each variable, the change over time was calculated as the difference between T1 and T0 scores. Positive or negative scores indicated an improvement or deterioration in work ability, job satisfaction, perceived general health, psychosocial risk factors, technostress, sleep quality, and perceived stress. Subgroup analyses were performed to examine differences between occupational roles (bank employees, administrative employees, and manual workers) using one-way ANOVA. A first-difference linear regression model was employed to investigate the factors associated with changes in work ability, considering variations in WAI scores as the primary outcome and changes in other variables as potential predictors. The first-difference approach estimates the relationship between within-individual changes over time, effectively controlling for unobserved time-invariant confounders and reducing the risk of omitted variable bias. The model was adjusted for gender, occupational role, and whether participants experienced any job changes in the past year. There was no missing data. All analyses were performed using R software.

3. RESULTS

Of the 470 subjects who participated at T0 (November 2021–November 2022), 356 (76%) completed the follow-up (November 2022–November 2023). Socio-demographic and occupational characteristics of follow-up participants were comparable to those of the original sample [19]. The mean age of participants was 55 years, with 78% men ($N=279$). A total of 148 (41%) were manual workers, while 208 (59%) were white-collar workers, including 157 (44%) employed in banking and 51 (14%) in administrative roles. Additionally, 24 individuals (7%) reported a change in job role within the past year. Overall, a significant decrease of approximately 1.2 points in the average level of work ability was observed ($T0: 42.8 \pm 4.6$, $T1: 41.4 \pm 4.6$, $p<0.001$). Notably, the WAI subscales of work demands and physical illnesses showed the most significant decrease (Table 1).

Technostress showed a significant decrease of 0.6 points ($T0: 12.9 \pm 2.1$, $T1: 13.3 \pm 2.8$, $p<0.001$),

particularly in the areas of overload and complexity. Job satisfaction also showed a significant decline (from 5.6 to 5.4, $p<0.001$). In contrast, perceived stress levels decreased slightly. Among psychosocial risk factors, significant reductions were observed in role clarity ($p = 0.03$) and change ($p = 0.003$) domains. Perceived overall health and sleep quality remained stable.

Significant changes in work ability, perceived health, sleep quality, social support, and relationships were observed across different roles (Table 2).

Banking professionals experienced the biggest drop in overall work ability across all areas, while manual workers saw a slight increase in WAI scores. Bank employees reported declines in perceived health and sleep quality, whereas administrative workers showed improvements in these areas, as well as in management support and relationship domains.

Significant changes in perceived health and perceived stress were marginally significantly linked to positive changes in work ability ($\beta=0.92$ and $\beta=-0.11$, respectively) (Table 3).

4. DISCUSSION

This study examined changes in work ability, technostress, perceived stress and health, sleep quality, psychosocial risk factors, and job satisfaction over one year in a sample of older workers. Overall, we found that work ability, job satisfaction, role clarity, and change management showed significant declines during the study period. Conversely, technostress and perceived stress improved significantly. However, these changes varied across occupational roles, with opposite trends emerging between banking professionals and other occupations. Manual workers, in particular, showed relatively stable trends.

The decline in WAI scores, especially in the health-related subscales, is expected among workers over 50, as work ability typically decreases with age-related physical and health challenges. This trend aligns with previous research on work ability in older workers [30]. Interestingly, technostress showed a slight improvement, particularly in areas related to complexity and workload. This suggests that, despite initial challenges with new technologies, older workers gradually adapt over time. As

Table 1. Summary statistics (mean $\pm$ sd). Questionnaire's score at T0 and at T1 and corresponding p-value (paired t-test).

	T0	T1	T1-T0	p-value
<i>Work ability (WAI)</i>	42.8 $\pm$ 4.4	41.6 $\pm$ 4.5	-1.2 $\pm$ 4.6	<0.001
Current work ability compared with the lifetime best	8.2 $\pm$ 1.4	8.3 $\pm$ 1.1	-0.1 $\pm$ 1.5	0.16
Work ability in relation to the demands of the job	8.8 $\pm$ 1.3	8.5 $\pm$ 1.3	-0.3 $\pm$ 1.6	<0.001
Current disease diagnosed by a physician	5.1 $\pm$ 1.5	4.6 $\pm$ 1.9	-0.5 $\pm$ 1.9	<0.001
Estimated work impairment due to disease	5.8 $\pm$ 0.6	5.8 $\pm$ 0.6	-0.04 $\pm$ 0.7	0.30
Sick leave during the past year (12 months)	4.3 $\pm$ 0.9	4.3 $\pm$ 0.8	0 $\pm$ 1.1	1
Own prognosis of work ability two years from now	6.7 $\pm$ 1.0	6.7 $\pm$ 1.1	-0.05 $\pm$ 1.4	0.50
Mental resources	3.6 $\pm$ 0.6	3.6 $\pm$ 0.6	-0.04 $\pm$ 0.7	0.33
<i>Technostress</i>	12.9 $\pm$ 2.1	12.3 $\pm$ 2.8	-0.6 $\pm$ 2.3	<0.001
Overload	2.3 $\pm$ 0.7	2.2 $\pm$ 0.9	-0.1 $\pm$ 0.8	0.003
Invasion	2.5 $\pm$ 0.9	2.4 $\pm$ 1.1	-0.1 $\pm$ 1.1	0.06
Complexity	2.5 $\pm$ 0.7	2.2 $\pm$ 0.9	-0.2 $\pm$ 0.7	<0.001
Privacy	2.2 $\pm$ 0.7	2.2 $\pm$ 0.9	-0.04 $\pm$ 0.9	0.38
Inclusion	3.3 $\pm$ 0.6	3.3 $\pm$ 0.8	-0.06 $\pm$ 0.7	0.12
<i>Perceived health</i>	3.9 $\pm$ 0.7	3.9 $\pm$ 0.7	0.01 $\pm$ 0.7	0.70
<i>Job satisfaction</i>	5.6 $\pm$ 1.2	5.4 $\pm$ 1.4	-0.2 $\pm$ 1.3	<0.001
<i>Sleep quality (PSQI)</i>	5.5 $\pm$ 3.1	5.4 $\pm$ 2.8	-0.1 $\pm$ 2.4	0.34
<i>Perceived stress (PSS)</i>	12.4 $\pm$ 6.1	11.6 $\pm$ 6.1	-0.7 $\pm$ 5.0	0.02
<i>Demands (MS)</i>	4.1 $\pm$ 0.8	4.1 $\pm$ 0.8	-0.02 $\pm$ 0.9	0.64
<i>Control (MS)</i>	3.7 $\pm$ 0.8	3.7 $\pm$ 1.0	0.02 $\pm$ 0.9	0.65
<i>Colleagues' support (MS)</i>	4.1 $\pm$ 0.5	4.1 $\pm$ 0.7	0.01 $\pm$ 0.7	0.65
<i>Management's support (MS)</i>	4.0 $\pm$ 0.6	4.0 $\pm$ 0.8	-0.003 $\pm$ 0.8	0.95
<i>Role clarity (MS)</i>	4.6 $\pm$ 0.7	4.5 $\pm$ 0.7	-0.1 $\pm$ 0.9	0.03
<i>Change (MS)</i>	3.6 $\pm$ 0.7	3.5 $\pm$ 0.8	-0.1 $\pm$ 0.9	0.003
<i>Relationships (MS)</i>	4.7 $\pm$ 0.5	4.7 $\pm$ 0.5	0.04 $\pm$ 0.6	0.21

workers become more familiar with technological tools and their work environments evolve, they perceive less stress related to technological demands [31]. A small but significant decrease was observed in job satisfaction, as well as in two distinct psychosocial risk factors, namely role clarity and change, whereas demands, control, social support, and interpersonal relationships remained stable over time. Similarly, sleep quality, perceived health, and perceived stress did not change significantly. The modest magnitude of these changes may be attributed to the short one-year interval between assessments and the absence of substantial interventions aimed at reducing stress or improving worker well-being within the three companies. Effective strategies to reduce or prevent stress-related outcomes generally

involve a multilevel approach that includes both organizational and individual interventions [33, 34]. Research indicates that job satisfaction tends to remain relatively stable over time because it is partly influenced by dispositional factors beyond job-related variables [35]. Additionally, all average scores on the psychosocial risk scales were favorable, indicating relatively good conditions.

Significant differences appeared across occupational roles, with each variable showing different trends. The decline in work ability, perceived health, and sleep quality among banking professionals may be linked to the ongoing transformation of their work environment, which increasingly demands adaptation to technological tools, higher cognitive loads, and pressure to maintain performance

Table 2. Changes (mean $\pm$ sd) in work ability, technostress, perceived health, job satisfaction, sleep quality, perceived stress and psychosocial risks between different populations. P-values from one-way ANOVA.

	Bank employees N=157	Administrative employees N=51	Manual Workers N=148	p-value
<i>Work ability (WAI)</i>	-2.77 $\pm$ 3.33	-0.86 $\pm$ 3.98	0.46 $\pm$ 5.36	<0.001
Current work ability compared with the lifetime best	-0.17 $\pm$ 1.24	0.04 $\pm$ 1.18	0.43 $\pm$ 1.78	0.002
Work ability in relation to the demands of the job	-0.64 $\pm$ 1.12	-0.60 $\pm$ 1.14	-0.02 $\pm$ 1.99	0.001
Current disease diagnosed by a physician	-1.36 $\pm$ 1.79	-0.39 $\pm$ 1.64	0.29 $\pm$ 1.81	<0.001
Estimated work impairment due to disease	-0.19 $\pm$ 0.63	0.06 $\pm$ 0.37	0.09 $\pm$ 0.84	0.001
Sick leave during the past year (12 months)	-0.18 $\pm$ 0.88	0.14 $\pm$ 0.94	0.14 $\pm$ 1.25	0.02
Own prognosis of work ability two years from now	-0.15 $\pm$ 0.95	0.06 $\pm$ 1.27	0.02 $\pm$ 1.87	0.49
Mental resources	-0.10 $\pm$ 0.52	-0.25 $\pm$ 0.72	0.11 $\pm$ 0.85	0.002
<i>Technostress</i>	-0.54 $\pm$ 2.04	-0.77 $\pm$ 2.33	-0.52 $\pm$ 2.63	0.79
Overload	-0.17 $\pm$ 0.71	-0.10 $\pm$ 0.76	-0.09 $\pm$ 0.86	0.65
Invasion	-0.09 $\pm$ 0.97	-0.15 $\pm$ 1.31	-0.11 $\pm$ 1.14	0.95
Complexity	-0.20 $\pm$ 0.62	-0.31 $\pm$ 0.66	-0.24 $\pm$ 0.88	0.64
Privacy	0.08 $\pm$ 0.81	-0.37 $\pm$ 0.90	-0.06 $\pm$ 1.03	0.009
Inclusion	-0.17 $\pm$ 0.68	0.14 $\pm$ 0.62	-0.01 $\pm$ 0.80	0.01
<i>Perceived health</i>	-0.11 $\pm$ 0.62	0.25 $\pm$ 0.74	0.06 $\pm$ 0.70	0.002
<i>Job satisfaction</i>	-0.23 $\pm$ 1.33	-0.22 $\pm$ 0.92	-0.31 $\pm$ 1.41	0.85
<i>Sleep quality (PSQI)</i>	0.25 $\pm$ 2.22	-0.23 $\pm$ 2.68	-0.64 $\pm$ 2.57	0.05
<i>Perceived stress (PSS)</i>	-0.51 $\pm$ 4.58	-1.00 $\pm$ 4.59	-0.90 $\pm$ 5.66	0.82
<i>Demands (MS)</i>	-0.10 $\pm$ 0.68	0.09 $\pm$ 0.83	0.02 $\pm$ 1.00	0.26
<i>Control (MS)</i>	0.02 $\pm$ 0.73	0.08 $\pm$ 0.67	-0.004 $\pm$ 1.04	0.82
<i>Colleagues' support (MS)</i>	-0.01 $\pm$ 0.62	0.08 $\pm$ 0.64	0.01 $\pm$ 0.72	0.68
<i>Management's support (MS)</i>	-0.01 $\pm$ 0.73	0.27 $\pm$ 0.73	-0.07 $\pm$ 0.94	0.04
<i>Role clarity (MS)</i>	-0.14 $\pm$ 0.66	-0.21 $\pm$ 0.76	-0.02 $\pm$ 1.04	0.28
<i>Change (MS)</i>	-0.23 $\pm$ 0.77	-0.09 $\pm$ 1.04	-0.07 $\pm$ 0.98	0.27
<i>Relationships (MS)</i>	-0.11 $\pm$ 0.41	0.12 $\pm$ 0.54	0.17 $\pm$ 0.65	<0.001

Table 3. First-difference linear regression model of WAI. Coefficients are adjusted for gender, occupational role, and potential job changes during previous year. Δ =difference T1-T0.

	Δ WAI	T value	p-value
Δ Technostress	0.10	0.78	0.44
Δ Role clarity (MS)	0.34	0.96	0.34
Δ Change (MS)	0.55	1.66	0.09
Δ Sleep quality	-0.14	-1.14	0.24
Δ Job satisfaction	0.42	1.70	0.09
Δ Perceived stress	-0.11	-1.86	0.05
Δ Perceived health	0.92	1.96	0.05

standards. This finding aligns with previous research in Italy, highlighting how digitalization and higher job demands in the banking sector significantly affect employees' well-being, especially older workers [32]. In contrast, manual workers experienced smaller variations across variables; particularly, they reported less change in perceived health and psychosocial risks, but showed the most pronounced decline in sleep quality compared to administrative and bank employees. This aligns with theoretical expectations, as prolonged exposure to night shift work tends to deteriorate sleep quality over time. Overall, these results highlight the heterogeneity of the workforce and suggest that different occupational roles should be analyzed separately when studying work ability and health.

Although this study did not test specific interventions, we found that improvements in perceived health and decreases in perceived stress mainly contributed to better work ability, regardless of job role. These findings highlight the importance of targeted programs to enhance health and lower stress for all workers, supporting their well-being and, in turn, their work capacity.

This study has certain limitations. First, the one-year follow-up may be too brief to fully capture long-term changes in work ability and related factors among older workers, especially since aging-related trends are usually more noticeable over longer periods. We hope our findings encourage future research with extended follow-ups in aging populations. Second, reliance on self-reported questionnaires introduces potential response bias, as participants might inaccurately report their experiences. To address this, interviews were conducted by experienced occupational physicians with extensive backgrounds as company doctors, who carefully collected responses. However, the observational design limits causal interpretations because no specific interventions were tested to address changes in work ability or well-being.

Despite these limitations, our findings, particularly the decline in work ability, highlight the importance of tailored interventions to support aging workers, including health management and stress reduction programs. While ensuring the health and productivity of older workers is a global priority, there remains a lack of widely available, effective

health programs [36]. Future research with longer follow-ups and more diverse industries will be important to better understand long-term trends and the factors influencing work ability in older workers. Addressing the physical, cognitive, and psychosocial needs of older employees will be crucial for promoting sustainable work ability, enhancing overall job satisfaction, and improving performance and well-being in the workplace.

5. CONCLUSION

This study shows a decline in work ability among older workers over a one-year span, especially in cognitively demanding roles like banking. Improving perceived health and lowering stress were key factors in supporting work ability, highlighting the importance of targeted, occupation-specific strategies to enhance well-being in an aging workforce. Occupational health professionals should focus on early detection of at-risk workers and implement customized approaches, such as stress management programs and health promotion efforts, to help maintain work ability and extend working life.

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