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Contribution to validation of the Italian version of work ability personal radar

Daniela Converso[1], Ilaria Sottimano[1*], Giacomo Garzaro[2], Gloria Guidetti[1], Enrico Pira[2], Sara Viotti[1]

[1]Department of Psychology, University of Turin, Via Verdi 10, 10124 Turin, Italy
[2]Department of Public Health and Pediatrics, University of Turin, P.zza Polonia 94, 10126 Turin, Italy

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Abstract

Background: *Work ability (WA) is an important construct in Occupational Health. Over the years, various WA detection tools have been developed, and a new one is the Work Ability Personal Radar (WA-PR), capable of investigating all the dimensions that define the complexity of WA. In this new version, not only the physical dimensions are considered but also the psycho-social aspects of work capable of impacting WA. The WA-PR was born in the Finnish context. However, recently, it has also been validated elsewhere. In light of the literature on WA assessment tools, our goal is to contribute to validating the WA-PR in the Italian context.* **Methods:** *Data were collected using a self-reported questionnaire administered to 405 workers in the chemical industrial sector.* **Results:** *Results show that the WA-PR correlate with WAI and other constructs conceptually related to work ability: the need for recovery, stress, and general health.* **Conclusions:** *Data analysis confirms that the WA-PR is a valuable and reliable tool for evaluating work ability in the Italian context.*

1. Introduction

1.1. The concept of work ability and measurement tools

Work ability (WA) is an important construct in the occupational health field, both in practice and research. It was initially defined as a person's physical and mental ability to meet the demands of their job [1]. Initially, the definition of WA was theoretical, but theorization has become complex over time. Recently, some authors have inserted the concept of WA into the job demand-resources model (JDR model) [2], which conceptualizes how well-being at work is available from questions and resources.

Studies show that WA influences work outcomes such as job attitude (satisfaction, commitment), performance, strain (burnout, fatigue), motivation and withdrawal behavior. This theorization would explain the results of some WA studies, highlighting its impact on well-being/malaise at work [3-7]. Furthermore, this theory confirms the centrality and the importance of investigating WA and planning interventions [8].

To detect the construct of WA, in the 1980s, the Finnish Institute of Occupational Health (FIOH) invented the Work Ability Index (WAI), which

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*Corresponding Author: Ilaria Sottimano, Department of Psychology, University of Turin, Via Verdi 10, 10124 Turin, Italy; E-mail: ilaria.sottimano@unito.it

has been translated into 26 languages and is used worldwide [3].

The WAI consists of seven components that constitute individual work ability:

- WAI 1: Current work ability compared with lifetime best (1 item);
- WAI 2: Work ability to job demands (2 items);
- WAI 3: Current diseases diagnosed by a physician (14 disease groups);
- WAI 4: Estimated work impairment due to diseases (1 item);
- WAI 5: Sick leave during the past year (1 item);
- WAI 6: Prognosis of work ability two years from now (1 item);
- WAI 7: Mental resources (3 items).

These seven components are summed, with a total score being classified as poor WA (7-27), moderate WA (28-36), good WA (37-43) or excellent WA (44-49). The cut-off values were derived from the 15th and 85th percentile of the population in 1981 investigated in the first WAI study on municipal workers in Finland [9, 10]. These values have remained unchanged over time.

Some authors have made some criticisms of the WAI: (i) The WAI does not comprehensively cover the concept of work ability, and it focuses too much on health aspects (especially medical diagnosis) [10, 11]; (ii) The WAI combines objective health indicators and perceptual assessments of WA into a unique score [3, 12]. In this direction, several studies identified two or three factors included in the WAI and not only one [12-19]; (iii) The WAI includes scores using different response formats (for example, 0-5 or 0-10), but the scores are summed and converted into ordinal categories. In terms of psychometric proprieties, this is problematic [3]; (iv) The WAI is often administered in different ways (interview with the medical doctor during the visit, self-report questionnaire, etc.) [10]; (v) The WAI is too long, taking about 15 minutes to complete [8, 20].

New tools have recently been developed to evaluate WA from a more holistic and subjective perspective [21]. For example, in the literature, the first WAI item is often used as an indicator of subjective WA (the single item measuring work ability with reference to best in lifetime), and it is often called Work Ability Score (WAS) [10, 11, 22]. However, using a single item removes the objective health component of WAI and increases measurement error due to the bias inherent in the respondent's self-assessments [3, 23].

Another solution adopted in the literature to evaluate the subjective dimension of WA is using Item 2 of the WAI in relation to both mental and physical work demands [10, 24-26]. However, some authors criticize the use of Item 2 of the WAI because this item does not capture the organizational factors but only the mental and physical job demands [27].

Another solution to assess WA is the use of some items of the WAI plus one or two additional questions; for instance, Palermo et al. [28] used four items to evaluate WA: two from the WAI and two new ones (their expected WA five and ten years in the future). McGonagle et al. [29] used the first three items of the WAI plus one new item (current WA in relation to social skill demands). Some authors even used six items of the WAI (excluding item 3; for example, the WAI-R) [30].

A new instrument for evaluating WA is Work Ability Personal Radar (WA-PR) [21], which is based on a more comprehensive approach to assessing WA [3]. In this questionnaire, contextual factors are included in the measure of WA. More specifically, the questionnaire refers quite faithfully to the multidimensional model of the WA house [31, 32]. In the house model, the four floors of the house and its nearby environment represent five interrelated dimensions that underlie work ability. Together, the three bottom floors of the house represent "individual's resources" that affect work ability, the fourth floor is conceived of as the "work factor", and the context in which the house is placed is "context life" (Figure 1) [21]: (i) HF: The first-floor concerns health and functional capacity, which are fundamental to WA, and the literature has often emphasized the relationship between physical health and WA; (ii) CO: the second floor of the house illustrates occupational competence consisting of work ability-related expertise, knowledge and skills. Without any skills acquired by experience or training, coping with the job would not be possible;

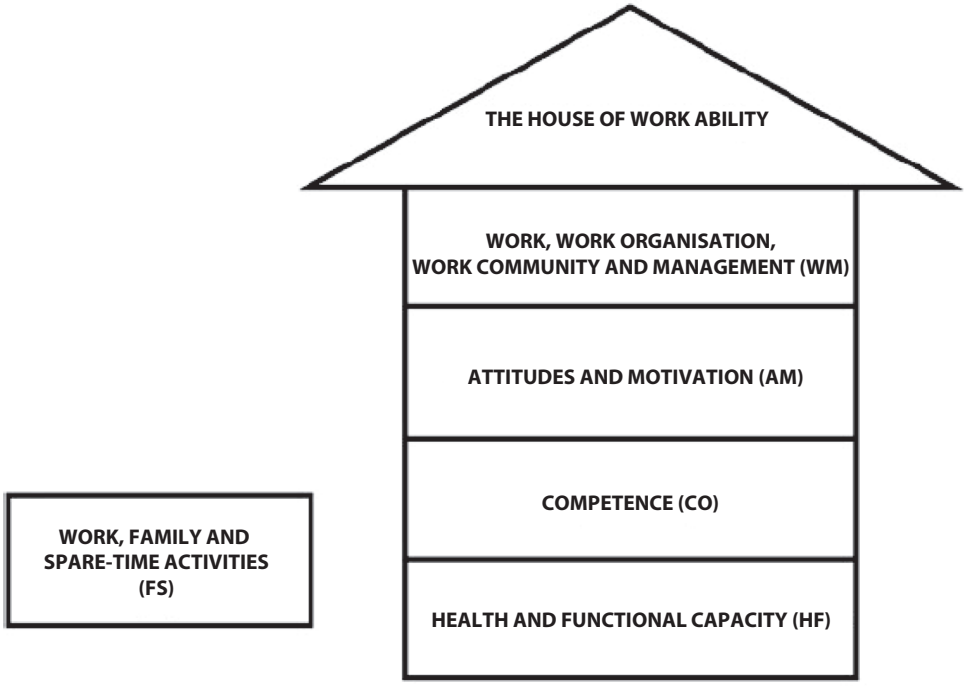

Figure 1. The structures of the house of work ability.

(iii) AM: The third floor of the house consists of attitudes and motivations that represent attitudinal factors affecting work ability; (iv) WM: The fourth floor of the house consists of working conditions, work organization, work community and management. This floor has an inevitable effect on a person's ability to work. One way to comprehend work ability within the house model is to examine the balance between personal resources (first three floors) and the demands of the work (fourth floor) [31]. If there is a balance between resources and work demands, the WA is good; conversely, the ability to work will decline if resources are insufficient to deal with demands. Similar conceptualizations of WA have also been presented in occupational health literature, especially the JD-R model [33]. According to the JD-R model, every job consists of (a) Job demands requiring sustained effort and cost (psychological or physical), thereby increasing strain and decreasing motivation; (b) Job resources aiding in accomplishing work goals, thus reducing job demands and increasing motivation and buffering the adverse effects of job demands. Brady et al. [3] argue that the JD-R model offers a valuable framework for investigating the antecedent and outcome of WA: they insert the WA construct like a moderator into the JD-R model, where WA is influenced positively by job and personal resources and negatively by job demands. Similarly, WA affects some outcome variables (e.g. performance, strain, exit intention); (v) FS: the nearby environment and societal surroundings are also incorporated in the house model of work ability and constitute the fifth floor.

All five dimensions are interrelated and dependent on one another (32). There is a feedback cycle and reciprocated causation between the structures.

In this theoretical framework, the WA-PR provides a method for measuring subjective experiences of WA according to the dimensions depicted in the house model. The objective is to achieve versatile assessments based on which more accurate allocations of interventions and promotions of WA may be executed [21].

1.2. Aims of the study

In light of this literature on WA assessment tools, our goal is to contribute to the validation of the

WA-PR in the Italian context. More specifically: (i) we explore the associations between the WAI and the WPWI, WAE and WWI, respectively. Moreover, we examine whether the WPWI, WAE, WWI and WAI correlate with psychological health (i.e., need for recovery, stress level, general health) and physical well-being (i.e., pharmacological therapy, presence of diseases diagnosed by the doctor during health surveillance, back pain and visual disorders); (ii) we explore the psychometric properties of WA-PR.

2. Methods

The sample comprises 405 workers in the chemical industrial sector employed by a production plant in the North of Italy. The survey was conducted in February and March 2019 within a project aimed at assessing the quality of life considering aging at work. The data were collected using a self-reported questionnaire in the presence of researchers, and all subjects were informed about the study's aims. The questionnaire was distributed to the entire staff of the plant, consisting of 450 workers (response rate: 90%). The workers' participation was entirely voluntary, and the research group ensured anonymity in the data collection at the Department of Psychology of the University of Turin. The research conformed to the Declaration of Helsinki. No treatment, including medical treatment, invasive diagnostics or procedures causing psychological or social discomfort, was administered to the participants. Moreover, the contents of the questionnaires were previously approved by the management and security officers of the organization.

The questionnaire has been translated into Italian from its English version and also from its German version. Subsequently, the translation was checked by an English and German native-speaker professional.

The questionnaire contained scales evaluating the Work Ability Index (WAI and WA-PR), need for recovery, stress levels and general health. The questionnaire data were then matched with physical health data from health surveillance. The questionnaire contained the following elements:

- The Work Ability Index (WAI) by Tuomi et al. [34] includes seven sections: (i) current work ability compared with lifetime best (score range: 1-10); (ii) work ability in relation to mental and physical demands (score range: 2-10); (iii) number of current diseases diagnosed by a physician (score range: 1-7); (iv) estimated work impairment due to diseases (score range: 1-6); (v) sick leave during the past 12 months (score range: 1-5); (vi) self-prognosis of work ability for the next two years (score range: 1-4 or 7); and (vii) mental resources (score range: 1-4). The total score ranges from 7 to 49.
- The Work Ability Personal Radar (WA-PR) [21] conceptualizes the construct of work ability more holistically and subjectively than does the WAI. The WA-PR consists of 17 items that are scored on five different subscales of work ability. Its five subscales are based on the theoretical framework of the work ability house: (i) HF: Health and functional capacity (two items, e.g. "how is your state of health in relation to your work?"; (ii) CO: Competence (three items, e.g. "how is your professional competence?"; (iii) AM: Values, attitudes and motivation (5 items, e.g. "are you appreciated in your workplace?"; (iv) WM: Work organization, work community, and management (four items, e.g. "How well is your work organized"; (v) FS: family life and society (three items, e.g. "How well can you combine your work and your family life?" [21, 31, 32]. Each subscale covers one model element and is measured with two to five items. Items are designed to reflect an individual's subjective experience of these components.
- The last version of the questionnaire contains six additional items investigating the subjective perception of work ability. Considering the model of the house, they represent the roof (Work ability estimate) [8]. The answer options range from 0 to 10 (0 represents the worst evaluation, and 10 represents the best evaluation). These five dimensions constitute the Workplace Wellbeing Index (WPWI) factor. A score below 5 indicates poor workplace well-being, a score between 5-6.99 indicates average workplace well-being, a score between 7-8.99 indicates good workplace

well-being, and a score between 9-10 indicates excellent workplace well-being. The questionnaire also contains six items that refer to the WAI and constitute the work ability estimate index (WAE). Also in this case, the answer options range from 0 to 10 (where 0 is the worst evaluation and 10 is the best evaluation). A total WAE score below 5 indicates a poor work ability estimate, a score between 5-6.99 indicates an average work ability estimate, a score between 7-8.99 indicates a good work ability estimate, and a score between 9-10 indicates an excellent work ability estimate. By summing up all the numerical values of 23 items (WPWI: 17 items; WAE: six questions) and dividing the total by 23, it is possible to obtain the Work Wellbeing Index (WWBI). In recent years, some authors have worked on validating the WA-PR in contexts different from the Finnish one [21], such as in Malaysia [35], Holland and Germany [36].

- The scale of need for recovery [37] contains eight items to identify the need workers have to rest at the end of the working day (e.g. "after a day of work, I feel so tired that I cannot do anything else". The answer options range from 0 to 3 (where 0 is never and 3 is always). The total score ranges from 0 to 24, where 0 indicates a low need for rest while 24 indicates a high need for rest.
- The scale of stress by Copenhagen Psychosocial Questionnaire (COPSOQ) [38] contains seven items to identify the stress level of workers and the behavioral symptoms associated with it (e.g. "I did not have time to relax or have fun". The answer options range from 0 to 3 (where 0 is never and 3 is always). The total score ranges from 0 to 21, where 0 indicates a low-stress level and 21 indicates a high-stress level.
- The scale of general health (created *ad hoc*) contains two items to identify psychological health, both in relation to general and working life, respectively ("How do you rate your psychological well-being in relation to your working life?" "How do you rate your psychological well-being in relation to your general life?". The answer options range from 1 to 10 (where 1 is a negative evaluation and 10 is a positive evaluation). The total score ranges from 2 to 20, where 2 indicates a low level of general health and 20 indicates a high level of general health.
- Concerning the medical records, we considered some indicators of physical health: use of drugs, diagnosis of physical health disorder (of any type), back pain and visual disturbances (the most frequent complaints reported by workers).

2.1. Statistical analysis

About Aim 1, the relationships between variables were tested by correlation. It should be noted that correlations among the WAI, WAE, and WWI include autocorrelations because the WAI contains some items of the WAE, and the WWI integrally contains the WAE and some items of the WAI, thus leading to higher coefficients. We used SPSS (version 26) for our analyses.

Regarding Aim 2, the item analysis included mean, standard deviation, and item-scale correlation. In addition, skewness and kurtosis were used to identify any item deviation from the normal distribution; ideal skewness and kurtosis values are comprised in the range ± 1; however, data was considered normally distributed when skewness $<|3.0|$ and kurtosis $<|7.0|$ [39]. Cronbach's alpha was used to assess internal consistency (values above 0.60 are considered acceptable). A CFA was performed to ascertain the psychometric proprieties of WA-PR and the distinctiveness of subdimensions. In particular, the hypothesized model (six-factors: WAE, FS, WM, AM, CO, and HF) was compared with the one-factor model (the null model), where all items were loaded on the same factor. Model fitting was assessed with the ratio of $\chi 2$ to the degrees of freedom (df), the Comparative Fit Index (CFI), the Standardized Root Mean Square Residual (SRMR) and the Root Mean Square Error of Approximation (RMSEA). According to Kline [39], a $\chi 2/df$ ratio of 3 or less indicates a good model fit. For CFI, values higher than 0.90 are considered indicators for good model fit [40]. Values of the SRMR and RMSEA equal to or less than 0.07 indicate a good fit [41, 42].

In addition, the Akaike information criterion (AIC) and the Bayes information criterion (BIC) were used to compare alternative (non-nested) measurement models [39]. The model with the lowest AIC and BIC was considered the best-fitting model. Item factor loading (λ) above 0.40 is considered acceptable [39].

3. Results

The sample comprises 405 respondents (91.8% blue collars and 9.2% white collars). The participants were 62.8% male and 37.2% female, aged 39.8 years and in service for 12.7 years on average (89% with a permanent and 11% with a fixed-term contract). Almost all (98.2%) worked full-time, while only 1.8% of them worked part-time. The factory operates 24 hours per day and 7 days per week: for this reason, 80.5% of the participants worked in shifts.

3.1. Validity

The first aspect analyzed was the relationships between the WPWI, WAE, WWI and WAI. The WPWI correlates substantially in the expected direction, that is, positively, with the WAI (r=0.56); similarly, the WAE correlates with the WAI (always positively: r=0.76). Finally, WWI correlates with the WAI (positively: r=0.64). These correlation effects are moderate and strong, especially for the WAE and WWI. The findings support the assumption that both the WWI and the WPWI, especially the WAE, are closely related to the original WAI. The correlations between the WAE and the WAI, and between WWI and the WAI are partially autocorrelations, thus leading to higher coefficients. In cases of reflective measurement, a corrected item-scale correlation would have to be used, excluding the single item from the scale score before correlating the score with the item. But since each item of the WAI seems to contribute quite special information, not reflecting the variance of a single underlying factor, deleting an item from the WAI could change the measure substantially. To avoid this, we kept the WAI score unchanged [10]. The third aspect is whether the correlational pattern of the WAE, WPWI and WWI with psychological health and stress is similar to that of the WAI. Table 1 shows the correlation coefficients among the WPWI, WAE, WWI and WAI, stress, need for recovery, and general health. As expected, the data show that the WAE, WPWI, WWI and WAI are always correlated in the same direction with the need for recovery, stress, and general health. A stronger relationship is observed between the WAE and general health (r=0.68). Similarly, WWI is strongly correlated with general health (r=0.67), as is WAI (r=0.63).

The fourth aspect is whether the relational pattern of the WAE, WPWI and WWI with physical health is similar to that of WAI (Table 2).

To determine this, we tested the differences among the means of the WAE, WAPWI, WWI and WAI between workers with health diseases (indicators: pharmacological therapy, presence of diseases diagnosed by the doctor during health surveillance,

Table 1. Cross-sectional analyses of the correlation of the WPWI, WAE, WWI and WAI with the need for recovery, stress, and general health.

	WPWI	WWI	WAI	Need for recovery	Stress	General health
WAE	.729**	.845**	.760**	-.549**	-.452**	.678**
WPWI	-	.982**	.559**	-.409**	-.437**	.622**
WWI		-	.642**	-.477**	-.481**	.669**
WAI			-	-.578**	-.505**	.628**
Need for recovery				-	.691**	-.457**
Stress					-	-.526**

** $p<0.01$

Table 2. Analyses of tests of the WPWI, WAE, WWI and WAI with the physical dimensions (pharmacological therapy, presence of diseases diagnosed by the doctor during health surveillance, back pain and visual diseases).

	Pharmacological therapy	**N**	**M**	**SD**	**T**	***P***
WAI	No	190	38.97	5.58	5.53	.000
	Yes	77	33.86	7.29		
WAE	No	244	7.59	1.34	5.02	.000
	Yes	116	6.62	1.86		
WPWI	No	214	7.15	1.47	2.22	.027
	Yes	91	6.74	1.59		
WWI	No	205	7.28	1.36	3.17	.002
	Yes	89	6.70	1.55		
	Physical diseases	**N**	**M**	**SD**	**T**	***P***
WAI	No	146	39.32	5.84	5.15	.000
	Yes	122	35.38	6.71		
WAE	No	175	7.77	1.32	5.90	.000
	Yes	186	6.83	1.69		
WPWI	No	154	7.44	1.39	4.99	.000
	Yes	152	6.61	1.52		
WWI	No	148	7.56	1.29	5.68	.000
	Yes	147	6.65	1.45		
	Back pain	**N**	**M**	**SD**	**T**	***P***
WAI	No	144	39.92	5.59	6.99	.000
	Yes	137	34.80	6.63		
WAE	No	181	7.71	1.35	5.21	.000
	Yes	199	6.89	1.72		
WPWI	No	165	7.33	1.48	3.99	.000
	Yes	158	6.65	1.59		
WWI	No	159	7.46	1.36	4.59	.000
	Yes	152	6.71	1.52		
	Visual diseases	**N**	**M**	**SD**	**T**	***P***
WAI	No	203	38.10	6.33	2.73	.007
	Yes	78	35.70	7.09		
WAE	No	265	7.47	1.47	3.28	.001
	Yes	115	6.84	1.81		
WPWI	No	233	7.07	1.58	1.31	NS
	Yes	90	6.82	1.54		
WWI	No	224	7.19	1.46	1.94	NS
	Yes	87	6.83	1.52		

back pain, and visual diseases) and without health diseases (no pharmacological therapy, absence of diseases diagnosed by the doctor during health surveillance, no back pain and no visual diseases).

Regarding visual diseases, the data showed statistical differences between workers who have visual diseases and workers who do not have visual diseases for the WAI and WAE but not for the WPWI or WWI. These data confirm that the three dimensions of the WA-PR are very similar to the WAI and, precisely like the WAI, are related to physical health indicators, especially pharmacological therapy, physical diseases, and back pain.

Regarding pharmacological therapy, the data showed statistical differences between workers who consume pharmaceutical drugs and workers who do not consume drugs for all work ability indicators considered (WAI, WAE, WPWI, WWI). The t-test is very similar between the WAI and WAE.

Regarding the presence of diseases diagnosed by the doctor during health surveillance, the data showed statistical differences between workers who have diseases and workers who do not have diseases for all work ability indicators considered (WAI, WAE, WPWI, WWI). The t-test is very similar across all work ability indicators.

Concerning the presence of back pain, the data showed statistical differences between workers who have diseases and workers who do not have diseases for all work ability indicators considered (WAI, WAE, WPWI, WWI). The t-test is very similar across all work ability indicators.

3.2. Psychometric properties

3.2.1 Item analysis and internal consistency

Descriptive statistics for the items are shown in Table 3. For all items, the corrected item-total correlation achieved values equal to or greater than r=0.50; the only exception was Item 3 ("How is your professional competence?" belonging to the CO scale, with a corrected item-total correlation of 0.26.

Regarding skewness, Items 1, 2, 3, 7, 8, 10, 12, 14, 20, 21 and 22 were slightly out of the range of -1 and +1; however, all values were between the range of -3 and +3. Similarly, regarding kurtosis, Items 1, 2, 3, 4, 7, 12, 14, 18, 19, 20 and 21 were out of the range of |1| but within the range of |7|.

Regarding internal consistency, all the subdimensions reported acceptable values of Cronbach's alpha, except for CO, which showed a value of 0.56. The computation of alpha after deleting an item indicated that without Item 3, the alpha of the CO scale would see a substantial improvement, reaching a value of 0.62.

3.2.2 Confirmatory factor analysis

Table 4 reports the global fit index of the CFA carried out. Considering the deviations (though not severe) from the normal distribution of some items of the WA-PR, to minimize the risk of finding distortions, Maximum Likelihood Robust (MLR), which is robust to non-normality, was employed as an estimation method.

The hypothesized six-factor model, which considered all the WA-PR subdimensions as distinct factors, fit the data significantly better than the one-factor model. However, the fit of this six-factor model has not been completely satisfactory since the CFI value was below 0.90. In this solution, all items significantly loaded on their corresponding factor and reported factor loadings (λ) higher than 0.60 (Table 5). The only exception was Item 3, which reported a factor loading of 0.37, which was significant, but below 0.40.

Since both CroCronbach'spha and CFA suggested that Item 3 might compromise the functioning of the scale to which it belongs (CO), an alternative version of the six-factor model was carried out without including Item 3. This model showed an acceptable fit to the data ($\chi 2$=539.74, df=194, $\chi 2$/df=2.78, CFI=0.91, SRMR=0.06, RMSEA=0.07[0.06-0.07]), and each item significantly loaded on its corresponding factor, with a saturation higher than 0.60. All subdimensions significantly and positively correlated with each other, showing an r-value higher than 0.40.

4. Discussion

Our data show that WPWI, WAE and WWI correlated clearly with the WAI and that the three dimensions of the WA-PR correlated in the

Table 3. Item analyses and Cronbach's alphas.

Subscale Item	*M* (SD)	Corrected item-scale Correlations	Skewness	Kurtosis	Alpha if item deleted
HF (α=.66)					
1	7.27(2.08)	.51	-1.13	1.71	--
2	8.00(1.58)	.51	-1.29	3.40	--
CO (α=.56)					
3	7.95(1.46)	.26	-1.34	4.20	.62
4	7.34 (1.97)	.55	-.98	1.53	.21
5	6.43 (2.87)	.41	-.80	-.25	.49
AM (α=.92)					
6	6.32 (2.68)	.78	-.82	-.02	.89
7	7.50(2.17)	.71	-1.25	1.85	.91
8	7.00 (2.29)	.85	-1.01	.90	.88
9	6.60 (2.61)	.88	-.84	.06	.87
10	6.72 (2.53)	.72	-.96	.49	.91
WM (α=.82)					
11	6.63(2.14)	.68	-.91	.84	.76
12	7.29 (2.38)	.71	1.18	1.25	.74
13	6.25 (2.57)	.67	-.76	.12	.76
14	7.30 (2.14)	.52	. -1.19	1.59	.83
FS (α=.84)					
15	6.61 (2.59)	.65	-.92	.36	.84
16	6.90 (2.18)	.80	-.82	.53	.69
17	6.63 (2.26)	.68	-.61	.00	.80
WA (α=.87)					
18	6.88 (1.92)	.58	-.85	1.23	.85
19	8.09 (1.44)	.58	-.95	2.26	.86
20	7.71 (1.88)	.75	-1.12	1.79	.83
21	7.57 (1.80)	.74	-1.07	1.77	.83
22	7.59 (2.17)	.76	-1.03	.96	.82
23	5.79 (2.81)	.64	-.57	-.56	.86

Table 4. Confirmatory factor analyses (CFA): test of alternative models (good-of-fit indices).

	χ^2	df	χ^2/df	CFI	SRMR	RMSEA [CI]	AIC	BIC
M0. One-factor model	1352.27	230	5.87	.71	.10	.11[.10-.11]	36389.94	36666.21
M1. Six-factor model	627.32	215	2.92	.89	.07	.07[.06-.07]	35247.30	35583.63
M1a. Six-factor model (no item 3)	539.74	194	2.78	.91	.06	.07[.06-.07]	33831.54	34155.86

Note: df=degree of freedom. CFI=comparative fit index. SRMR=sstandardizedroot mean square residual. RMSEA=root mean square error of approximation. AIC=Akaike information criterion. BIC=Bayes information criterion.

Table 5. Confirmatory factor analyses (CFA): factor loadings and standard errors.

Model	MO		M1		M1.a	
	λ	standard error	λ	standard error	λ	standard error
HF						
1	.67	.04	.83	.04	.83	.04
2	.53	.05	.62	.06	.62	.06
CO						
3	.35	.06	.33	.06	--	--
4	.68	.03	.65	.04	.65	.04
5	.75	.02	.73	.03	.73	.04
AM						
6	.77	.03	.82	.03	.82	.03
7	.75	.03	.76	.03	.76	.03
8	.83	.02	.90	.01	.90	.01
9	.87	.02	.92	.01	.92	.01
10	.71	.04	.76	.03	.76	.03
WM						
11	.80	.02	.82	.03	.81	.03
12	.72	.04	.78	.04	.78	.04
13	.69	.03	.75	.03	.76	.03
14	.57	.05	.59	.05	.59	.05
FS						
15	.58	.05	.76	.03	.76	.03
16	.53	.05	.89	.03	.89	.03
17	.50	.05	.79	.03	.79	.03
WA						
18	.71	.04	.66	.04	.66	.04
19	.48	.06	.63	.04	.63	.04
20	.59	.05	.82	.03	.82	.03
21	.65	.04	.79	.03	.79	.03
22	.66	.04	.82	.02	.82	.02
23	.64	.04	.71	.03	.71	.03

expected directions with constructs conceptually related to work ability, both psychological and physical (specifically: need for recovery, stress, and general health).

More specifically, the WPWI, WAE and WWI correlated with the WAI, demonstrating a construct that is almost stackable to the work ability measured by the WAI. In another way, the WPWI, WAE and WWI, exactly like the WAI, correlated negatively with stress and need for recovery and positively with general health. All the WA measures show very similar correlations with need for recovery, stress, and general health. These data confirm two aspects: first, the three dimensions of the WA-PR are very similar to those of the WAI and, exactly like the WAI, correlated with outcomes of psychological health

(in this case, need for recovery, stress, and general health); the second aspect is that the three dimensions of the WA-PR correlated negatively with need for recovery and stress and positively with general health.

Similarly, the WPWI, WAE and WWI, exactly like the WAI, are related with physical diseases. In this direction, low levels of WPWI, WAE, WWI and WAI are related to the presence of pathologies diagnosed by the medical doctor, the use of drug therapy, the presence of back pain and visual disturbances. That the WAI correlates with physical health is not surprising, because it contains at least one item (Item 3) that included medical dimensions, constructs that overlap.

However, it is interesting that even more subjective evaluations of work ability (WPWI, WAE, WWI) are related to the dimensions of physical health.

Generally, our findings confirm that the WA-PR is a useful and reliable tool for evaluating work ability and better reflects the WA home model. In this direction, the tool is useful for individualizing the subjective dimension of the WA and the antecedents that can influence it. In conclusion, the WA-PR is a good tool for assessing work ability in a more holistic view of the same. In this direction it overcomes the limits of the WAI, centered mainly on physical dimensions and diseases and less on the perceived experience of workers, moreover WAI excludes psycho-social aspects of work that are important in the definition of WA.

However, some considerations should be made regarding Item 3. Both Cronbach's alpha and CFA suggested that it compromised the functioning of the CO scale. A possible explanation for this finding would be that Item 3 refers to a distinct content domain when compared with the rest of the items of the scale. While with Item 3, the respondents are asked to assess their own competence, while the other two assess the capability of the job and the organizational context to offer to the worker growth and development opportunities. In other words, it is plausible that the underlying criteria to which respondents refer to give answers to Item 3 on one hand and Items 4 and 5 on the other hand would have been different. Future studies should further verify the results we obtained here regarding Item 3, both in similar (i.e. manufacturing industries) and different occupational contexts (e.g. healthcare or teaching sectors). Future studies should also include additional items both regarding the domain of self-assessment competence and the domain of the opportunity for development in the workplace to better understand whether these aspects can be explained by only one dimension or whether two distinct dimensions are needed.

4.1. Limitations of the study

A first limitation of the study concerns the average age of the people interviewed: the mean age of study sample is under 40 (39.8, which is younger that the mean age of Italian workers). The young age of our study subjects is a limitation because the literature shows that WA is strongly associated with age.

A second limitation could be given by the specificity of the workers and the context considered (shift worker in the chemical sector). This could be considered potential limitation in the generalization of the results.

Institutional review board statement: The study was conducted according to the guidelines of the Declaration of Helsinki.

Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Declaration of interest: The authors declare no conflict of interest.

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