ORIGINAL ARTICLE

WILEY Journal of Occupational Health

Validity and reliability of work ability index (WAI) questionnaire among Iranian workers; a study in petrochemical and car manufacturing industries

Mazloumi Adel[1,2] | Rostamabadi Akbar[3] | Garosi Ehsan[1]

[1]Department of Occupational Health Engineering, Tehran University of Medical Sciences, Tehran, Iran

[2]Sports Medicine Research Center, Neuroscience Institute, Tehran University of Medical Sciences, Tehran, Iran

[3]Department of Occupational Health Engineering, Ashtian Health Care Center, Arak University of Medical Sciences, Arak, Iran

Correspondence
Mazloumi Adel, Associate Professor, Department of Occupational Health Engineering, Tehran University of Medical Sciences, Tehran, Iran.
Email: amazlomi@tums.ac.ir

Abstract

Objectives: Maintenance and promotion of employees' work ability is one of the important social goals. This study is aimed at investigating psychometric properties of the Persian translation of work ability index (WAI).

Methods: A total number of 750 employees were randomly selected from car manufacturing and petrochemical industries. Reliability of the questionnaire was determined using test-retest and Cronbach alpha coefficient. Factor analysis was used for assessing construct validity. To determine discriminant validity, the mean score of total WAI was compared between workers with high and low sick leave rate.

Results: Intraclass correlation coefficients for its seven dimensions were estimated higher than 0.7. The questionnaire showed a good internal consistency, Cronbach $\alpha = 0.78$. Factor analysis showed a three-factor structure model for Persian translation of WAI including: mental resources, self-perceived work ability, and presence of disease and health-related limitation. A good level of discriminant validity was observed for all WAI dimensions except the item "work ability regarding work demands."

Discussion: The study findings indicate that the Persian version of WAI questionnaire has good psychometric properties of internal consistency and test-retest showed a good reliability of WAI questionnaire, which is in line with those found in previous studies. Therefore, this tool can be considered as a reliable instrument for assessing work ability.

KEYWORDS
Iranian worker, reliability, validity, work ability index (WAI)

1 | INTRODUCTION

Since the first half of the twentieth century, aging phenomenon has been an important population issue which is rapidly progressing in relatively newly industrialized and developing countries, including countries with large and young populations such as Iran.[1]

In recent decades, Iran has been deeply involved with the process of demographic transition. Based on the United Nations Population Division,[1] Iran is one of the developing countries with largest percentage of increase in shares of 60 years and above in 2011-2050. While the percentage of Iranian people in the 60 years and above was 5.4% in 1975, it will rise up to 10.5% in 2025% and 21.7% in 2050.[2] On the

other hand, the share of potentially active population, aged 15-64 years, which was 56.1% by 1996 will rise up to its highest level in 2040 (71%), and by 2050 the ratio of this age group will be dropped back to 64.7%.[3] This situation will lead to labor shortages and increase the share of work force from middle and older ages.

From the occupational health point of view, ageing process is along with a progressive impairment of health and functional capacity,[4] which causes an imbalance between human resources and work demands. Functional aging is assumed as a decrease in work ability, which may precede chronological aging.[5] It is well known that enhancing work ability of older workers would be helpful in both retaining workers and reducing early retirements.[6]

The concept of work ability is defined as the ability of a worker to perform his/her job, with respect to work demands, health, and mental resources.[7] In this context, identification of simple methods in order to monitor employees' work ability is important.[6] One of the new and relatively inexpensive and uncomplicated instruments for assessing work ability is the work ability index (WAI) questionnaire.[8] The WAI questionnaire has been developed, based on the stress-strain concept and balance model, by the Finnish Institute of Occupational Health (FIOH) in the early 1980s. WAI is widely applied for conceptualizing the work ability[9] by obtaining information related to diseases, functional limitations, sick leave, and mental resources.[6] One of the special features of the WAI is that by evaluating individuals' WA periodically, it is possible to determine the period a worker can continue his/her professional activities, and with its successive follow-up a clear trend of changes in their work ability can be obtained.

This index has been widely applied in occupational health surveys in order to identify workers and working environments that need supportive measures. Also, this tool can be helpful in adopting preventive strategies in any work settings.[10] Today, the WAI questionnaire has gained international application, and it is available in almost 30 languages. This wide use of WAI has provided good possibilities for development of the international networks and databanks in many European (Finland, Germany, and the Netherlands), Asian (Japan, South Korea, and Taiwan), Australian, and South American (Brazil) countries.[11]

In Iran, studies pertinent to employees' work ability are very rare. Recently, some investigations have been done on determining WAI among industrial and health care workers.[12-14] However, validity and reliability of the Persian version of WAI is not well documented, with respect to progressing growth of the aging working population in Iran. As, in the study by Abdolalizadeh et al, which was done under supervision of the main author of the current study, they tried to determine the psychometric properties of Iranian version of WAI questionnaire among health care

workers with age more than 40 years old.[13] Regarding this study, the population and age were limited. Considering these limitations, therefore, current study was aimed to assess validity and reliability of Persian translation of WAI questionnaire among a broader range of jobs as well as age distribution in employees of two large industries in Iran, including petrochemical and car manufacturing companies.

2 | MATERIALS AND METHODS

2.1 | Subject and study design

This cross-sectional study is carried out among 750 employees, working in two Iranian petrochemical and automotive companies. The participants were chosen based on stratified random sampling. The questionnaires were distributed among the selected samples. However, 712 questionnaires were returned including 67 incomplete questionnaires with the response rate of 86%.

2.2 | WAI questionnaire

The second revised edition of WAI questionnaire was used in the current study. This questionnaire covers 7 items. Items 2, 3, and 7 are consisting of 2, 14, and 3 sub-item, respectively. Each item has a different score, and a higher score indicated better work ability. The WAI scores were calculated according to the standard method provided by the FIOH.[15,16] The first part of the WAI included demographic characteristics such as gender, age, education, vocational/professional training, current and previous job, tasks, job groups, department name, and job demand (mental or physical). The second part of the WAI consisted of 7 items, including(item, score range),current work ability compared with the lifetime best (item 1, 0-10), work ability in relation to the demands of the job (item 2, 2-10), number of current disease groups diagnosed by a physician (item 3, 1-7), estimated work impairment due to diseases (item 4, 1-6), sick leave during the past year (item 5, 1-5),personal prognosis of work ability for 2 years from now (item 6, 1,4 or 7) and mental resources, referring to the workers life in general, both at work and during leisure time(item 7, 1-4). The number in parentheses for each item indicates the scoring range. The total WAI score is calculated by summing up the scores of all items and is ranged from 7 to 49. The total WAI scores are categorized into 4 levels: poor (7-27), moderate (28-36), good (37-43), and excellent (44-49).

2.3 | Linguistic validation

Linguistic validity of the questionnaire was assessed using a forward and backward translation methodology. In the first stage, after getting agreement from FIOH for preparation and translation of the questionnaire, WAI questionnaire was then

translated into Persian language by the authors. Moreover, relevancy, clarity, and simplicity of each item of the Persian version were reviewed by an expert panel consisting of ergonomics and occupational health professors and the changes were incorporated in the questionnaire. In the second stage, the final Persian version was translated back into English by two qualified English translator, blind to the original English version. The prepared English version was sent to be reviewed by the FIOH experts. After some minor corrections, linguistic validity of the questionnaire was confirmed in final version of the translated questionnaire.

In order to validate the conceptual equivalence between the original English version and the Persian version, cognitive debriefing, and to assess the understanding of the instrument by the target population, a pretest was conducted with a sample of 40 respondents. Based on received responses, none of the participants reported any ambiguity in comprehension of the items.

2.4 | Statistical analysis

Data analysis was done using SPSS software, version 16. Reliability was assessed using internal consistency and test-retest analyses. Regarding internal consistency, the Cronbach α coefficient was computed, and a Cronbach's $α ≥ 0.70$ was considered satisfactory. In order to assess the test-retest reliability, 10% of the study population participated in a pilot study. The questionnaires were filled out by the respondents twice, with a 2-week interval, and the Intraclass correlation coefficient (ICC) was calculated, considering ICCs $≥ 0.70$ acceptable for test–retest reliability.

Exploratory factor analysis of principal components followed by a varimax rotation method was used to evaluate factor structure of the WAI, considering eigenvalues greater than 1. Factor loading values of 0.40 or more were taken into accounts indicators of significant factorial contribution. In addition, the same analysis was done to assess factor structure of items 2, 3, and 7, which consisted of 2, 14, and 3 sub-items, respectively.

Using known-group technique, discriminant validity was assessed by comparing items of WAI between workers with high and low sick leave rate (using Mann-Whitney test). According to previous studies,[5,12] sick leave was categorized into 5 groups, including: never been off, up to 9 days, 10- 24 days, 25- 99 days, and 100-365 days. Workers who

TABLE 1 The characteristics of the study population and corresponding WAI scores

	Employees		WAI			WAI categories (0.00%)			
	N	%	Mean	SD	P-value	Poor	Moderate	Good	Excellent
Age group (y)									
<30	167	25.9	40.01	4.47	<0.0001	0	20.37	52.69	26.94
30-39	231	35.8	38.39	5.09		1.73	34.64	48.05	15.58
40-49	158	24.5	36.60	6.20		5.69	44.32	33.54	16.45
50-66	89	13.8	37.02	6.41		10.11	32.60	39.32	17.97
Employment									
Blue collar workers	466	72.2	37.53	5.78	<0.0001	4.52	36.05	41.84	17.59
White collar workers	179	27.8	39.87	4.59		0.56	25.15	51.40	22.92
Jon tenure (y)									
<15	358	55.5	39.74	4.67	<0.0001	0.57	23.74	51.95	23.74
≥15	287	44.5	36.24	6.00		6.96	44.59	35.19	13.24
Working schedule									
Day work	198	30.7	38.51	5.20	0.071	2.52	31.33	47.97	18.18
Shift work	447	69.3	38.03	5.73		3.80	33.78	42.95	19.46
Educational level									
Elementary, diploma	106	16.4	34.75	6.04	0.025	11.32	50.01	29.24	9.43
University degree	539	83.6	38.86	5.22		1.87	29.68	47.49	20.96
Marital status									
Single	87	13.5	39.54	4.89	0.148	0	27.59	47.13	25.28
Married	558	86.5	37.97	5.65		3.95	33.87	44.07	18.10

reported up to 9 days' sick leave during the past 12 months were considered as low sick leave group, and those who reported 10 or more days' sick leave, in the same period, was considered as high sick leave group.

Pearson correlation coefficient was employed to assess each item correlation with the total score of WAI item. Correlation coefficient of 0.40 or above was considered satisfactory.[12]

3 | RESULTS

3.1 | Descriptive result

All participants were male with a mean age of 37.4 years old (SD = 9.68 years; age range 23-66 years). They had a mean job tenure of 13.1 years (SD = 9.64), who were predominantly shift workers (69.3%), married (86.5%) with college education (83.6%). Regarding professions of the participants, they were comprised of both blue-collar and white-collar workers. Blue-collars were consisted of gas-field workers (24.80%), maintenance workers (18.75%), laboratory technicians (5.58%), fire fighters (4.18%), painter workers (9.76%), and fabrication and assembly workers (9.14%), while white collar workers (27.8% of the total participants) were mainly office employees such as accountants, engineers, managers, and so on. Considering WAI score, the mean value was 38.1(SD = 5.5), ranged from 21 to 47. Overall, 19.1% of workers were in the excellent, 44.5% in the good, 33% in the moderate, and 3.4% in the poor categories. Table 1 presents the characteristics of the study population, mean WAI scores, and the categorization of WAI with respect to age groups, employment type, job tenure, working schedule, educational level, and marriage status. Statistical analysis showed that the manway score was influenced by age, job tenure, education level, and type of employment. However, working schedule and marriage status had no significant effect on the mean WAI score (Table 1).

Distribution of data was non-normal in this study, as the Mann-Whitney test showed. Therefore, a non-parametric test was used for statistical analysis.

Distribution of study population regarding their scores for each item of WAI questionnaire is presented in Table 2. Additionally, Table 3 shows the prevalence of disease groups in the study population and the corresponding WAI scores. The frequency (and the present) of each diseases was accounted based on age groups and WAI score was respectively calculated for each age group according to the WAI guideline.

As can be seen, WAI scores of employees with diseases diagnosed by a physician decreased in most successive age groups, except for 50-66 years old in a few cases of disease such as Skin disease, Metabolic tumor. Also, blue-collar employees had lower WAI scores in all of the cases of disease groups than white-collar employees.

TABLE 2 Distribution of scores of WAI, separately for questionnaire items

WAI items	Score and response frequency (%)											Total
	0	1	2	3	4	5	6	7	8	9	10	
Item 1	—	—	—	1 (0.2)	1 (0.2)	18 (2.8)	43 (6.7)	111 (17.2)	176 (27.3)	131 (20.3)	164 (25.4)	645 (100)
Item 2	—	—	—	2 (0.3)	16 (2.5)	36 (5.6)	206 (32)	73 (11.3)	245 (37.9)	30 (4.7)	37 (5.7)	645 (100)
Item 3	—	51 (7.9)	46 (7.1)	84 (13)	127 (19.7)	154 (23.9)	—	183 (28.4)	—	—	—	645 (100)
Item 4	—	2 (0.3)	34 (5.3)	77 (11.9)	98 (15.2)	184 (28.5)	250 (38.8)	—	—	—	—	645 (100)
Item 5	—	—	19 (2.9)	144 (22.3)	200 (31)	282 (43.7)	—	—	—	—	—	645 (100)
Item 6	—	21 (3.3)	—	—	143 (22.2)	—	—	481 (74.6)	—	—	—	645 (100)
Item 7	—	39 (6)	155 (24)	234 (36.3)	217 (33.6)	—	—	—	—	—	—	645 (100)

Item 1: Current work ability compared with the lifetime best, Item 2: Current work ability in relation to job demands, Item 3: Number of current diseases diagnosed by physician, Item 4: Estimated work impairment due to diseases, Item 5: Sick leave during the past year (12 mo), Item 6: Own prognosis of work ability 2 y from now, Item 7: Mental resources.

TABLE 3 WAI scores based on diseases diagnosed by physician in different age groups and employments

Groups of diseases	Age groups								Employment			
	<30		30-39		40-49		50-66		Blue-collar		White-collar	
	N (%)	Mean WAI	N (%)	Mean WAI	N (%)	Mean WAI	N (%)	Mean WAI	N (%)	Mean WAI	N (%)	Mean WAI
Trauma	28 (4.3)	37.07	61 (9.5)	35.09	53 (8.2)	33.08	14 (2.2)	30.46	147 (22.8)	34.21	15 (2.3)	35.66
Musculoskeletal disease	21 (3.3)	36.52	61 (9.5)	34.04	66 (10.2)	33.43	28 (4.3)	32.39	142 (22)	33.09	35 (5.4)	36.62
Cardiovascular disease	1 (0.2)	38.00	11 (1.7)	35.81	14 (2.2)	32.71	25 (3.9)	35.28	30 (4.7)	34.00	21 (3.3)	35.80
Respiratory disease	16 (2.5)	36.62	32 (5)	36.73	38 (5.9)	33.22	7 (1.1)	32.35	70 (10.9)	34.31	24 (3.7)	36.81
Mental disorder	6 (0.9)	33.58	12 (1.9)	33.79	9 (1.4)	31.77	7 (1.1)	33.07	23 (3.6)	31.86	11 (1.7)	35.59
Neurological and sensory diseases	13 (2)	35.88	33 (5.1)	33.54	41 (6.4)	32.75	40 (6.2)	34.45	93 (14.4)	32.91	34 (5.3)	36.27
Digestive disease	13 (2)	36.57	29 (4.5)	36.37	27 (4.2)	34.22	12 (1.9)	34.54	57 (8.8)	34.83	24 (3.7)	36.81
Genitourinary disease	10 (1.6)	38.50	16 (2.5)	35.00	16 (2.5)	32.81	18 (2.8)	34.00	45 (7)	34.23	15 (2.3)	36.10
Skin disease	11 (1.7)	35.63	22 (3.4)	35.52	18 (2.8)	32.91	3 (0.5)	35.66	39 (6)	34.23	16 (2.5)	36.12
Endocrine and Metabolic diseases	12 (1.9)	37.50	10 (1.6)	38.30	39 (6)	36.04	31 (4.8)	37.17	63 (9.8)	35.83	32 (5)	38.73
Blood diseases	7 (1.1)	36.71	16 (2.5)	38.18	18 (2.8)	37.13	11 (1.7)	35.68	32 (5)	36.65	20 (3.1)	37.80
Tumor	—	—	—	—	2 (0.3)	31.00	1 (0.2)	36.00	2 (0.3)	32.00	1 (0.2)	34.00

TABLE 4 Reliability of Persian version of WAI questionnaire

	Test-retest reliability	Internal consistency	
		Cronbach's α coefficients	
Question	ICC	Item	Sub-item
Item 1: Current work ability compared with the lifetime best	0.83	0.76	—
Item 2.1: Current work ability in relation to physical demands	0.82	0.76	0.77[a]
Item 2.2: Work ability in relation to metal demands	0.83	0.76	
Item 3: Number of current diseases diagnosed by physician	0.88	0.78	0.52[b]
Item 4: Estimated work impairment due to diseases	0.91	0.74	—
Item 5: Sick leave during the past year (12 mo)	0.94	077	—
Item 6: Own prognosis of work ability 2 y from now	0.92	0.75	—
Item7.1: Enjoying daily tasks	0.76	0.76	0.73[c]
Item7.2: Activity and life spirit	0.77	0.76	
Item7.3: Optimistic about the future	0.76	0.76	

[a]Cronbach's α coefficient for 2 sub-items related to "work ability in relation to job demands"

[b]Cronbach's α coefficient for 14 sub-items related to "number of current diseases diagnosed by physician"

[c]Cronbach's α coefficient for 3 sub-items related to "mental resources"

3.2 | Reliability

The Cronbach's alpha coefficient for WAI was 0.78, and exclusion of any of the questions did not alter this result. The Cronbach α coefficient for each item of WAI questionnaire showed satisfactory internal consistency (see Table 4). The ICC showed that the questionnaire had a dependable consistency (ranged from 0.76 to 0.94) between 2-week intervals (see Table 4). Therefore, it is supposed that applying WAI questionnaire will have a good reducibility among different population considering the appropriate Alpha score of 0.78.

3.3 | Validity

3.3.1 | Construct validity

Factor analysis with varimax rotation showed that a three-factor structure model was appropriate for the Persian version of the WAI questionnaire (Table 5). The total contribution of the three factors explained 65.02% of the variance. Item 7, reflecting mental recourses and covered by three questions, formed the first factor with 37.6% of the total variance. The second factor was associated with the worker's perception of his/her work ability covered by items 1(current work ability compared with the life time best) and 2(work ability in relation to the demands of the job) with 16.6% of the total variance. Items related to the presence of disease groups and health-related restrictions, including items 3 (number of current disease groups diagnosed by a physician), 4 (estimated work impairment due to diseases), 5 (sick leave during the past year), and 6 (personal prognosis of work ability 2 years

from now), formed the third factor with 10.9% of the total variance.

The results of exploratory factor analysis for assessing factor structure of item 2 showed that its sub-items were loaded onto one-factor. Sub-item "current work ability in relation to physical demands" with a factor loading of 0.9 explained 81.7% of the total variance, and sub-item "work ability in relation to mental demands" with a factor loading of 0.9 explained 18.2% of the total variance. In regard to item 7, a one-factor structure was also found. Sub-items including "enjoying daily tasks" with a factor loading of 0.88, "optimistic about the future" with a factor loading of 0.9, and "activity and life spirit" with a factor loading of 0.81 explained 74.9%, 16.2%, and 8.8% of the total variance, respectively.

Fourteen sub-items related to item 3, were loaded onto six-factor with a clearer situation for following sub-items: birth defects (factor loading = 0.66), tumor (factor loading = 0.64), and neurological and sensory diseases (factor loading = 0.62). The total contribution of six factors explained 53.9% of the variance. The first factor consisted of musculoskeletal disease, cardiovascular disease, respiratory disease, and neurological and sensory diseases (13.1% of the total variance). The second factor was related to endocrine and metabolic diseases (8.9% of the total variance). The third factor was skin disease and other disorders (8.7% of total variance). The forth factor was tumor (8.1% of total variance). Birth defects and skin diseases formed the fifth factor (7.8% of total variance), and the sixth factor was related to genito-urinary diseases (7.2% of total variance). Table 6 shows how much each item correlates with the overall WAI score. As can be seen, all items had an item-total score correlation of 0.40

and higher, revealing the satisfactory consistency between items.[12]

3.3.2 | Discriminant validity

The results of Mann-Whitney test yielded significant differences ($P < 0.001$) in mean WAI scores between workers with high (34.42 points) and low (39.45 points) sick leave rates, discriminating groups of workers with different sick leave rates.

TABLE 5 Exploratory factor analysis of the Persian version of WAI questionnaire using principal component extraction with varimax rotation

Question	Components		
	1	2	3
Item 1: Current work ability compared with the lifetime best	0.05	0.75[a]	0.19
Item 2.1: Current work ability in relation to physical demands	0.15	0.81[a]	0.23
Item 2.2: Work ability in relation to mental demands	0.11	0.83[a]	0.16
Item 3: Number of current diseases diagnosed by physician	0.08	0.10	0.67[a]
Item 4: Estimated work impairment due to diseases	0.16	0.22	0.80[a]
Item 5: Sick leave during the past year (12 mo)	0.01	0.13	0.71[a]
Item 6: Own prognosis of work ability 2 y from now	0.29	0.24	0.55[a]
Item 7.1: Enjoying daily tasks	0.86*	0.10	0.13
Item 2.2: Activity and life spirit	0.87*	0.13	0.13
Item 7.3: Optimistic about the future	0.80*	0.07	0.11
Variance of the component (%)	37.6	16.5	10.9
Total cumulative variance (%)		65.02	

[a]Significant component for each factor (factor loading ≥0.4)

TABLE 6 Item-total correlation between each item and total WAI score

Questions	Correlation coefficient when question is excluded
Item1: Current work ability compared with the lifetime best	0.64
Item 2.1: Current work ability in relation to physical demands	0.65
Item 2.2: Work ability in relation to mental demands	0.58
Item 3: Number of current diseases diagnosed by physician	0. 69
Item 4: Estimated work impairment due to diseases	0.70
Item 5: Sick leave during the past year (12 mo)	0.46
Item 6: Own prognosis of work ability 2 y from now	0.67
Item 7.1: Enjoying daily tasks	0.43
Item 7.2: Activity and life spirit	0.45
Item7.3: Optimistic about the future	0.40

4 | DISCUSSION

Since Iranian population will be faced with the aging phenomenon in the near future, considering valid and reliable tool for monitoring work ability as well as developing preventive strategies among working population is of crucial importance. This research assessed various aspects of validity and reliability of the Persian version of an applicable instrument for measuring work ability, the WAI questionnaire.

The average WAI obtained in this study (mean age of participants 37.4 years old) was 38.1(SD = 5.5), which is in good level of work ability. Considering participants' occupations in this research, which were mostly physically demanding jobs (72.2% blue collar workers), findings of other similar studies have reported higher value of WAI score comparing the current result. For instance, among Belgium firefighters(mean age of 51.5 years old),[17] and Dutch construction workers(mean age of 51 years old),[18] who were on average more than 10 years older than participants of the present study, mean WAI scores were 40.6 and 40.5, respectively. In addition, the distribution of work ability showed that 36.4% of workers were at the poor-moderate work ability level, which is almost 2.2 times the values reported by FIOH for middle-size industrial enterprises.[8]

In line with previous studies,[13,19] WAI score was related negatively to age and job tenure in a way that it decreased in successive age groups. In this study, the WAI decreased in the age group of 40-49, which placed it at the moderate work ability level. This result is consistent with the study conducted[20] among Finnish police officers who found a steeper slope of WAI score in the age group 40-49 years old.

According to findings, there was a statistically significant difference in WAI score among individuals with different educational levels. A higher educational level is related to a more job skill level and a better social and job opportunity, and consequently better work ability and health status.[13,21]

In this study, blue-collar workers showed higher prevalence of all disease groups and lower levels of work ability comparing to white collar workers. Similarly, the result of research[22] showed an increased risk of all-cause mortality among Japanese male workers engaged in blue-collar jobs than workers in white-collar jobs. Poor work condition existing in blue-collar jobs probably make workers more expose to health-related problems.[23,24] In general, blue-collar workers perform tasks which are predominantly physical or a combination of physical and mental demands, and also have little control over the amount of effort that is required for their job.[23] According to the Finnish Institute of Occupational Health studies, these factors contribute to early exit from work and work disability. In contrast, white-collar workers generally perform resourceful jobs with more challenging tasks and control over their work.[23,25]

In the current study, the results of internal consistency and test-retest showed a good reliability of WAI questionnaire, which is in line with those found in previous studies. In this research, internal consistency, Cronbach $\alpha = 0.78$, was similar to a recent study among Iranian health care workers with Cronbach's $\alpha = 0.77$.[12] In the survey on workers of an electrical company in Brazil Cronbach's coefficient alpha was 0.72.[5] In an extensive international research, conducted on the psychometric properties of WAI among 38 000 nurses from different European countries, Cronbach's coefficient alpha for nurses from 8 countries including Belgium, Finland, France, Germany, Italy, Netherlands, Norway, and Poland was 0.68, 0.79, 0.7, 0.78, 0.68, 0.72, 0.74, and 0.7, respectively.[26] Furthermore, in a large follow-up study, by[27] among 1389 employees in 91 Finnish organizations, Cranach's coefficient alpha were obtained between 0.72 and 0.80. The result of current research and other studies indicate high internal consistency of WAI questionnaire across different languages.

Concerning the test-retest reliability, the results of the present research showed no significant differences between the test and retest scores. Moreover, in the current study it was shown that overall agreement was good (ICC > 0.7). Although other researchers have used different intervals (7, 15, and 28 days) between the test and retest, WAI questionnaire showed satisfactory reliability. The mean scores of WAI and its sub-categories were found to be stable in the three following studies by Silva Junior et al, 2013, conducted among Brazilian nursing workers, within an interval of 7-15 days[18,28] among Dutch construction workers; and in the study among Korean workers within a 4-week interval.[29]

Factor analysis showed a three-factor structure model for the Persian version of WAI, which is in agreement with its original structure and confirms the valid construct of this instrument. WAI items loaded onto three-factors including: "mental resources," "self-perception of work ability," "disease and health-related restrictions." This finding is in accordance with those studies performed in Iran[12] and in Brazil,[5] in the number of factors, their combination, and distribution of changes by the extracted factors.

However, two-dimension models have been also reported in literature for the structure of WAI questionnaire. In an investigation conducted in European countries,[26] among 10 different studied versions of WAI, eight versions had a two-factor structure model and two versions had a one-factor structure model. A two-factor structure model has been also suggested for the Greek[19] and Germany[30] versions of WAI. In all of these above-mentioned studies, the first factor is interpreted as "subjectively estimated work ability" and the second factor as "objective health status."

In the present study, based on the results of factor analysis it was concluded that only one question is sufficient to interpret items 2 reflecting work ability in relation to the demands of the job and item 7 reflecting worker's life in general. On the other hand, there was a clear grouping of 10 out of 14 sub-items related to item 3 onto six-factor, with the strongest role belonged to birth defects, tumor, and neurological and sensory diseases.

Furthermore, a good level of discriminant validity was observed in this research for workers with different sick leave rates, which is similar to recent studies conducted among Iranian nurses[12] and Brazilian electric company workers (Martinez et al 2009). However, This finding is in contrast with those conducted in 10 European populations[26] which found the highest discriminant power for items 1 (current work ability compared with the lifetime best)and 2 (work ability in relation to the demands of the job), and the lowest for items 3 and 5.

Besides, all items had acceptable correlation coefficients with total WAI score, which shows an acceptable discriminant power between items. However, a previous research by Radkiewicz P. et al[26] reported a low correlation coefficient for item 5 and suggested it to be excluded from the questionnaire.

A similar result was also found by Abdolalizadeh et al,[12] reporting a lower correlation coefficient ($r = 0.32$) for item 5, when compared to other items. Correlation coefficient for this item was 0.46 in the present study (Table 6). According to the findings in this study Persian version of WAI questionnaire has good psychometric properties. Particularly, it was examined in a wider range of jobs and age distribution among employees in two large industries in Iran. Therefore, this tool can be considered as a reliable instrument for assessing WAI in the future researches.

There was a similar validation study conducted by Abdolalizadeh et al entitled: "the psychometric properties of an Iranian translation of the work ability index (WAI) questionnaire" which was completed under supervision of the main author of the current study, as referenced on 2nd page, in "*Methods*" section, "*Translation and Content Validity*" part of that article.[12] Some discrepancies can be

seen in validity and reliability tests of the two studies, other than the age as well as the job group differences which are reviewed in the introduction of the current paper. Regarding Table 2, the number of population in the current study (645) was almost 3 times more than the Abdolalizadeh's study. Meanwhile, taking item 2 into account, work demand was higher among nurses and health care workers comparing to people work in the car manufacturing and petrochemical companies. Shift work and patient safety are two distinctive features of nursing work which may affect such subjective assessment of work demand in the study of the Abdolalizadeh et al[12] Therefore, it can be concluded that for validation study, having different variation of job and age groups with ofcourse a higher number of sample size can create a new perspective in the analytical study of the questionnaire validation.

What is more, in Abdolalizadeh's study, a overall rating was provided on the reliability study of WAI among nurses. Among 60 people a test-retest analysis was conducted with a score of 0.7 in that study. Whereas, in the current study, the analyses were done with more details considering ICC for all items of WAI as well as sub item of 3 main attribute of WAI questionnaire.

5 | LIMITATIONS

There were some limitations with this study that should be acknowledged. First, the sample population was composed of workers of only one gender. Indeed, WAI and also its attributes might be different among male and female samples due to physiologic as well as psychological differences among this group.

The second limitation of the current research was that although the validity and reliability calculations of the questionnaire seems desirable, one cannot be sure about correct understanding of the questions and concepts by workers in lower level jobs. Therefore, data collection for such groups should be done using practical methods such as interview, direct supervision during questionnaire filling and so forth on.

Third, age distribution was roughly similar among age groups in this study; however, the WAI scores may show another trend among younger people, as proposed by Kujala et al[31] Therefore, it is recommended to examine such trends in the future studies.

Lastly, in addition to the study of psychometric properties of WAI, the recommended interventions presented in WAI package should be taking in to account as the best benefit of applying WAI in various job settings.

For future study it is suggested that similar examinations are conducted among female workers. Also, adopting complete package of WAI among different job and age group would be more beneficial.

DISCLOSURE

Approval of the research protocol: Tehran University of Medical Sciences (TUMS) review board (ethics review committee) has approved the study proposal. *Informed consent*: All the study participants provided informed consent before completing the questionnaire. *Registry and the registration no. of thestudy/trial*: 11140. *Animal studies*: N/A.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

AUTHORS CONTRIBUTION

AM conceived the ideas; AR collected the data and analyzed them; EG analyzed the data; and led the writing.

REFERENCES

1. Pool D, Wong L, Vilquin E. *Age-structural transitions: challenges for development*. Paris, France: Committee for International Cooperation in National Research in Demography; 2006.

2. Darani F, Riji H, Abedi H, Ahmad S, Latif L. How Iranian Families response to the conditions affecting elderly primary health care. *Int J Biol Sci*. 2010;5(6):420-429.

3. Mehryar A, Ahmad-Nia S. Age-structural transition in Iran: Short and long-term consequences of drastic fertility swings during the final decades of twentieth century. Age-Structural Transitions: Population Waves, Disordered Cohort Flows and the Demographic Bonus", Paris, 23–26 February 2004; 2004. Conference proceedings.

4. Ilmarinen J. Aging workers. *Int J Occup Environ Med*. 2001;58(8):546-546.

5. Martinez M, Latorre M, Fischer F. Validity and reliability of the Brazilian version of the Work Ability Index questionnaire. *Rev Saude Publ*. 2009;43(3):525-532.

6. Nygård C, Savinainen M, Kirsi T. Lumme-Sandt K, editors. Age management during the life course. 4th symposium on work ability, Tampere, 6 to 9 June 2010; 2011.

7. Ilmarinen J, Rantanen J. Promotion of work ability during ageing. *Am J Ind Med*. 1999;36(S1):296-305.

8. Tuomi K, Illmarinen J, Jahkola A, Katajarinne L, Tulkki A. *Work Ability Index*, 2nd edn. Helsinki, Finland: Institute of Occupational Health; 2006:177-181.

9. van den Berg T, Alavinia S, Bredt F, Lindeboom D, Elders L, Burdorf A. The influence of psychosocial factors at work and life style on health and work ability among professional workers. *Int Arch Occup Environ Health*. 2008;81(8):1029-1036.

10. Tuomi K, Oja G. *Work ability index*. Helsinki, Finland: HelFinnish Institute of Occupational Health Helsinki; 1998.

11. Ilmarinen J. Work ability-a comprehensive concept for occupational health research and prevention. *Scand J Work Environ Health*. 2009;35(1):1-5.

12. Abdolalizadeh M, Arastoo A, Ghsemzadeh R, Montazeri A, Ahmadi K, Azizi A. The psychometric properties of an Iranian translation of the Work Ability Index (WAI) questionnaire. *J Occup Rehabil*. 2012;22(3):401-408.

13. Mazloumi A, Rostamabadi A, Nasl Saraji J, Rahimi FA. Work Ability Index (WAI) and its association with psychosocial factors in one of the petrochemical industries in Iran. *J Occup Health*. 2012; 54(2):112-118.

14. Rostamabadi A, Mazloumi A, Foroushani AR. Work ability index (WAI) and its health-related determinants among Iranian farmers working in small farm enterprises. *J Occup Health*. 2014;56(6):478-484.

15. Tuomi K, Ilmarinen J, Jahkola A, Katajarinne L, Work TA. Ability Index. Finnish Institute of Occupational Health, Helsinki. Occupational. *Health Care*. 1998;19:17-19.

16. Ilmarinen J. Work ability—a comprehensive concept for occupational health research and prevention. *Scand J Work Environ Health*. 2009; 35(1):1-5.

17. Kiss P, Walgraeve M, Vanhoorne M. Assessment of work ability in aging fire fighters by means of the work ability index preliminary results. *Arch Public Health*. 2002;60(3–4):233-243.

18. De Zwart B, Frings-Dresen M, Van Duivenbooden J. Test–retest reliability of the Work Ability Index questionnaire. *Occup Med*. 2002;52(4):177-181.

19. Alexopoulos E, Merekoulias G, Gnardellis C, Jelastopulu E. Work ability index: validation of the Greek versionand descriptive data in heavy industry 2 employees 2013;3(3):608-621.

20. Sörensen L, Pekkonen M, Männikkö K, Louhevaara V, Smolander J, Alén M. Associations between work ability, health-related quality of life, physical activity and fitness among middle-aged men. *Appl Ergon*. 2008;39(6):786-791.

21. Gould R, Ilmarinen J, Järvisalo J, Koskinen S. Dimensions of work ability: results of the health 2000 survey. 2008:13-20.

22. Hirokawa K, Tsutsumi A, Kayaba K. Mortality risks in relation to occupational category and position among the Japanese working population: the Jichi Medical School (JMS) cohort study. *BMJ*. 2013;3(8):e002690.

23. Schreurs B, Van Emmerik H, De Cuyper N, Notelaers G, De Witte H. Job demands-resources and early retirement intention: differences between blue-and white-collar workers. *Econ Ind Democr*. 2011;32(1):47-68.

24. Schutte N, Toppinen S, Kalimo R, Schaufeli W. The factorial validity of the Maslach Burnout Inventory-General Survey (MBI-GS) across occupational groups and nations. *J Occup Organ Psychol*. 2000;73(1):53-66.

25. Van den Broeck A, De Cuyper N, Luyckx K, De Witte H. Employees' Job Demands-Resources profiles, burnout and work engagement: A person-centered approach. status: published; 2009.

26. Radkiewicz P, Widerszal-Bazyl M; Group N-S, editors. Psychometric properties of Work Ability Index in the light of comparative survey study. *Int Congr Ser*. 2005;1280:304-309.

27. Tuomi K, Vanhala S, Nykyri E, Janhonen M. Organizational practices, work demands and the well-being of employees: a follow-up study in the metal industry and retail trade. *Occup Med*. 2004;54(2):115-121.

28. Silva Junior S, Vasconcelos A, Griep R, Rotenberg L. Test-retest reliability of the Work Ability Index (WAI) in nursing workers. *Rev Bras Epidemiol*. 2013;16(1):202-209.

29. Yang D, Kang D, Kim Y, et al. Reliability of self-administered Work Ability Index questionnaire among Korean workers. *Ergonomics*. 2013;56(11):1652-1657.

30. Martus P, Jakob O, Rose U, Seibt R, Freude G. A comparative analysis of the work ability index. *Occup Med*. 2010;60(7):517-524.

31. Kujala V, Remes J, Ek E, Tammelin T, Laitinen J. Classification of work ability index among young employees; 2005:399-401.