

Maria Carmen Martinez<sup>1</sup>

Maria do Rosário Dias de  
Oliveira Latorre<sup>II</sup>

Frida Marina Fischer<sup>III</sup>

# Validity and reliability of the Brazilian version of the Work Ability Index questionnaire

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## ABSTRACT

**OBJECTIVE:** To evaluate the validity and reliability of the Portuguese language version of a work ability index.

**METHODS:** Cross sectional survey of a sample of 475 workers from an electrical company in the state of Sao Paulo, Southeastern Brazil (spread across ten municipalities in the Campinas area), carried out in 2005. The following aspects of the Brazilian version of the Work Ability Index were evaluated: construct validity, using factorial exploratory analysis, and discriminant capacity, by comparing mean Work Ability Index scores in two groups with different absenteeism levels; criterion validity, by determining the correlation between self-reported health and Work Ability Index score; and reliability, using Cronbach's alpha to determine the internal consistency of the questionnaire.

**RESULTS:** Factorial analysis indicated three factors in the work ability construct: issues pertaining to "mental resources" (20.6% of the variance), self-perceived work ability (18.9% of the variance), and presence of diseases and health-related limitations (18.4% of the variance). The index was capable of discriminating workers according to levels of absenteeism, identifying a significantly lower ( $p < 0.0001$ ) mean score among subjects with high absenteeism (37.2 points) when compared to those with low absenteeism (42.3 points). Criterion validity analysis showed a correlation between the index and all dimensions of health status analyzed ( $p < 0.0001$ ). Reliability of the index was high, with a Cronbach's alpha of 0.72.

**CONCLUSIONS:** The Brazilian version of the Work Ability Index showed satisfactory psychometric properties with respect to construct validity, thus constituting an appropriate option for evaluating work ability in both individual and population-based settings.

**DESCRIPTORS:** Work Capacity Evaluation. Working Conditions. Questionnaires. Translations. Validity of Tests. Reproducibility of Results. Occupational Health.

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## INTRODUCTION

Beginning in the 1980's, as a result of the ageing of the working population in the context of a restructuring of the production process, issues pertaining to functional ageing have become a priority in the field of worker health.<sup>6,a</sup> Work ability has since then become an important indicator, for it encompasses aspects

<sup>I</sup> Núcleo de Epidemiologia. Hospital Samaritano de São Paulo. São Paulo, SP, Brasil

<sup>II</sup> Departamento de Epidemiologia. Faculdade de Saúde Pública. Universidade de São Paulo (FSP-USP). São Paulo, SP, Brasil

<sup>III</sup> Departamento de Saúde Ambiental. FSP-USP. São Paulo, SP, Brasil

### Correspondence:

Maria Carmen Martinez  
Av. Conselheiro Brotero, 1505, cj. 32 -  
Higienópolis  
01232-010 São Paulo, SP, Brasil  
E-mail: mcmarti@uol.com.br

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of physical health, psychosocial wellbeing, individual competence, and work conditions.<sup>a</sup>

The concept of work ability results from the combination of human resources in the context of the physical, mental, and social demands of work, organizational culture, and work environment.<sup>7</sup> This concept can be formulated as “how well a worker is or will be in the present or near future, and how capable this worker is of performing work given the demands of the job and the health status and mental and physical capabilities of the worker.”<sup>18</sup> Functional ageing is understood as a reduction in work ability, and may precede chronological ageing, depending on the level of demand.<sup>17</sup>

The Work Ability Index (WAI) is an instrument that allows for the evaluation of work ability from the perspective of the worker’s own perception, based on ten questions that address seven dimensions: (1) “current work ability compared with the lifetime best,” with a score ranging from 0 to 10 points; (2) “work ability in relation to the demands of the job,” based on two questions on the nature of work (physical, mental, or mixed) that, when weighted, yield a score ranging from 2 to 10 points; (3) “number of current diseases diagnosed by physician,” obtained based on a list of 51 diseases that defines a score ranging from 1 to 7 points; (4) “estimated work impairment due to diseases,” based on a question with a score ranging from 1 to 6 points; (5) “sick leave during the past year (12 months),” based on a question on the number of absences, categorized into five groups with score ranging from 1 to 5 points; (6) “own prognosis of work ability two years from now,” based on a question with a score ranging from 1 to 4 points; and (7) “mental resources,” based on a score ranging from 1 to 4 points obtained by weighting the answers to three questions. The results of these seven dimensions provide a measure of work ability that ranges from 7 to 49 points. Instructions for calculating the score are available in Tuomi et al (2005).<sup>18</sup>

This questionnaire was elaborated based on studies carried out in Finland, where a cohort of workers was followed between 1981 and 1992 to investigate issues of work ability based on the stress-strain theoretical model.<sup>9</sup> According to this model, the distress generated by the physical and mental demands of work can lead to a reduction in work ability and trigger diseases.<sup>9,20</sup> These studies have consolidated the theoretical bases of the major determinants, consequences, and interventions of work ability and served as a basis for the development of the underlying structure of WAI, which allows for evaluation and early detection of alterations and can subsidize the design of preventive measures.<sup>6,7,16</sup>

In Brazil, studies of work ability began to be conducted following the translation and adaptation of the WAI questionnaire for use in this country.<sup>18</sup> Certain alterations were made to the text of the instrument as an attempt to ensure that all questions would be understood and that the questionnaire could be self-administered by any subject who completed at least the fourth-grade of elementary education.<sup>18</sup> The Brazilian version of WAI can be found in Tuomi et al (2005).<sup>18</sup>

Since its adaptation for use in Brazil in the late 1990’s, the WAI questionnaire has been employed in several population-based surveys.<sup>1,5,13,19</sup> However, the psychometric properties of the Brazilian version have not yet been investigated.

The present study was aimed at assessing the validity and reliability of the psychometric properties of the Brazilian version of the Work Ability Index.

## METHODS

We conducted a cross-sectional study whose target population comprised individuals working in the energy transmission, advanced energy distribution stations, and human resources sectors of an electrical utility company in the area of the municipality of Campinas, Southeastern Brazil.

Of the 582 workers that constituted the target population, 39 (6.7%) workers who were on leave, changing function, or on vacation at the time of data collection were excluded. Of the 543 remaining subjects, 22 were in training outside the company, travelling on business, or could not be located, totaling 521 available workers (89.5% of the original population). Of these, 21 either did not respond or refused to participate in the study – a refusal rate of 4.0% – and 25 questionnaires were left incomplete. Our final sample thus included 475 (87.5%) out of 543 eligible workers.

An analysis of losses showed no difference in terms of sex (8.5% losses among women and 12.9% among men;  $p=0.385$ ), work sector (14.6% in the administrative sector; 12.5% in the energy distribution sector, and 10.5% in the energy transmission sector;  $p=0.703$ ), and time in the job (mean 12.9 years in the company among participants and 12.4 years among losses;  $p=0.548$ ). There was a statistically significant difference in age between participants and losses (mean age 37.5 and 39.7 years, respectively;  $p=0.030$ ). We believe that this difference would be unlikely to influence our results, and therefore regard the sample as representative of the studied population.

Data collection was carried out at the workplace, between August and September 2005. For data collection,

<sup>a</sup> Ilmarinen J. Towards a longer worklife! Ageing and the quality of worklife in the European Union. Helsinki: Finnish Institute of Occupational Health. Ministry of Social Affairs and Health; 2006. p.132-48

we employed a questionnaire with items addressing demographic and functional characteristics in addition to the WAI and the *Medical Outcomes Study 36 – Item short form health survey (SF-36)* questionnaires.

To determine the psychometric properties of this version of WAI, we chose to evaluate validity of construct and criterion. Content validity was not evaluated, since this was addressed during the stages of translation and transcultural adaptation of WAI for use in Brazil.

To determine construct validity, we carried out confirmatory factor analysis through principal component analysis, selecting factors with eigenvalues greater than 1 and correlation coefficients greater than 0.50, using the varimax method for matrix rotation. This analysis was aimed at determining whether predicted WAI dimensions would be confirmed in this population.

We carried out discriminant validity analysis by comparing mean scores of groups of workers with high or low sickness-related absenteeism, using the Mann-Whitney test. Information on absenteeism was obtained from the “sickness-related work absence” dimension of WAI. We considered as with low absenteeism workers who reported up to nine missed workdays in a 12-month period, and as with high absenteeism workers who reported missing ten or more days in the same period. These cutoff points were determined based on the question’s response categories (zero days, up to nine days, ten to 24 days, 25 to 99 days, and 100 to 365 days), defined in the structure of the questionnaire.<sup>22</sup>

Criterion validity was evaluated by determining the correlation between WAI scores and health-related variables measured using SF-36, using the Spearman correlation coefficient. WAI includes health-related variables within its scope, and is a predictor of medium and long-term worker health.<sup>18,a</sup> We chose SF-36 as our standard criterion because it allows for an evaluation of overall health based on the subject’s own perception, generating eight scores that range from 0 to 100 points, representing the concepts most frequently measured in health surveys: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health.<sup>3</sup>

WAI reliability was determined by analysis of internal consistency among its items, using Cronbach’s alpha coefficient.

We carried out Kolmogorov-Smirnov analysis to determine adherence of the WAI score to normal distribution, and subsequent statistical tests were chosen based on the result of this analysis. For all analyses, we adopted the 5% significance level. All calculations were performed using SPSS version 10.0 software.

This study was approved by the Ethics Committee of the *Faculdade de Saúde Pública da Universidade de São Paulo*. Worker participation was voluntary and all subjects signed a term of free informed consent.

## RESULTS

The study population consisted predominantly of males (90.9%), married or with partner (75.2%), and with complete secondary (64.6%) or university education (26.7%). Mean age was 36.8 years (sd=8.0), ranging from 18.0 to 56.0 years, with a median of 37.0 years. Work was predominantly of mixed nature (77.9%), with no workers carrying out predominantly physical tasks.

Mean WAI score was 41.8 points (sd=5.1), ranging from 13.0 to 49.0 points and with a median of 43.0 points. This variable was not normally distributed ( $p < 0.0001$ , Kolmogorov-Smirnov test), determining the use of nonparametric tests in subsequent analyses.

Table 1 shows the following results for the different WAI dimensions: for “current work ability compared with the lifetime best,” 86.3% of workers classified themselves in the three highest scores. For “work ability in relation to the demands of the job,” 86.1% of workers placed themselves in the three highest scores. For “number of current diseases diagnosed by physician,” 36.6% of workers reported absence of disease (7 points) and 8.4% reported five or more diseases (1 point). For “estimated work impairment due to diseases,” 57.5% of workers reported no hindrance/disease affecting their work ability (6 points). For “sick leave during the past year (12 months),” 59.8% of workers reported no absence from work due to disease in the last 12 months (5 points). For “own prognosis of work ability two years from now,” 89.1% of workers considered themselves very likely to be able to perform their current activities in two years time (7 points). For “mental resources,” 65.1% of workers were in the highest score in the three mental resources scales (ability to appreciate daily activities, perception of being active and alert, feeling of hope for the future).

Table 2 shows that principal component analysis selected three factors with a cumulative total variance of 57.9%. The first factor (20.6% of total variance) consisted of questions H, I, and J, which represent the “mental resources” dimension. The second factor (18.9% of variance) comprised questions A, B, and C, on the worker’s perception of his or her work ability. The third factor (18.4% of variance) was composed of questions D, E, F, and G, which assess the presence of diseases and health-related restrictions.

<sup>a</sup> Ilmarinen J, Tuomi K, Seitsamo J. New dimensions of work ability. In: Costa G, Goedhard WJA, Ilmarinen J, editors. International Congress Series. Proceedings of the 2nd International Symposium in work ability: assessment and promotion of work ability, health and well-being of ageing workers; 2004 Oct 18-20; Verona, Italy. Amsterdam: Elsevier. 2005; 1280:3-7.

**Table 1.** Distribution of the study population according to score in the different dimensions of the Brazilian version of the Work Ability Index. Area of the municipality of Campinas, Southeastern Brazil, 2005.

WAI dimension	Score n (%)											Total
	0	1	2	3	4	5	6	7	8	9	10	
Current work ability compared with the lifetime best	1 (0.2)	- (-)	- (-)	3 (0.6)	2 (0.4)	9 (1.9)	10 (2.1)	53 (11.2)	158 (33.3)	136 (28.6)	103 (21.7)	475 (100.0)
Work ability in relation to the demands of the job	- (-)	- (-)	- (-)	- (-)	2 (0.4)	2 (0.4)	21 (4.4)	41 (8.6)	143 (30.1)	113 (23.8)	153 (32.2)	475 (100.0)
Number of current diseases diagnosed by physician		40 (8.4)	30 (6.3)	51 (10.7)	64 (13.5)	116 (24.4)		174 (36.6)				475 (100.0)
Estimated work impairment due to diseases		3 (0.6)	3 (0.6)	13 (2.7)	79 (16.6)	104 (21.9)	273 (57.5)					475 (100.0)
Sick leave during the past year (12 months)		8 (1.7)	11 (2.3)	27 (5.7)	145 (30.5)	284 (59.8)						475 (100.0)
Own prognosis regarding of work ability two years from now		21 (4.4)			31 (6.5)			423 (89.1)				475 (100.0)
Mental resources		5 (1.1)	25 (5.3)	136 (28.6)	309 (65.1)							475 (100.0)

Note: grayed-out cells are blank because these scores do not exist for the respective dimensions.  
WAI: Work Ability Index

**Table 2.** Principal component analysis of the Brazilian version of the Work Ability Index. Area of the municipality of Campinas, Southeastern Brazil, 2005.

Question	Component		
	1	2	3
A – Current work ability compared with the lifetime best		0.690	
B – Current work ability in relation to physical demands		0.684	
C – Current work ability in relation to mental demands		0.812	
D – Number of current diseases diagnosed by physician			0.571
E – Estimated work impairment due to diseases			0.619
F – Sick leave during the past year (12 months)			0.650
G – Own prognosis regarding of work ability two years from now			0.622
H – Enjoying daily tasks	0.807		
I – Activity and life spirit	0.829		
J – Optimistic about the future	0.761		
Variance of the component (%)	20.6	18.9	18.4
Total cumulative variance (%)		57.9	

Mean WAI score was higher among workers with low absenteeism (42.3 points) than among those with high absenteeism (37.2 points), and this difference was statistically significant ( $p < 0.001$ ), distinguishing groups of workers as to their level of disease-related work absenteeism.

WAI showed a statistically significant correlation with the eight dimensions of health status analyzed ( $p < 0.001$ ), with better health status being correlated with higher WAI score (Table 3).

The Cronbach's alpha coefficient for WAI was 0.72. Exclusion of any of the questions did not alter this result (Table 4).

## DISCUSSION

Issues pertaining to work ability have gained in importance in the field of public health due to their individual, social, and economic implications.<sup>a</sup> The contribution of WAI to the study of work ability is related to its

<sup>a</sup> Costa G. Some considerations about aging, shift work and work ability. In: Costa G, Goedhard WJA, Ilmarinen J, editors. International Congress Series. Proceedings of the 2nd International Symposium in work ability: assessment and promotion of work ability, health and well-being of ageing workers; 2004 Oct 18-20; Verona, Italy. Amsterdam: Elsevier. 2005; 1280:67-72.

predictive value in terms of disability, health/disease, and mortality.<sup>17,a</sup>

Our evaluation of construct validity using factorial analysis showed that the questions included in WAI can be grouped into three components that empirically confirm the work ability construct, understood as the ability a worker has to carry out his or her duties, and which is strongly influenced by the worker's physical and mental health.<sup>18,b</sup>

An evaluation of the psychometric properties of WAI in a population of about 38 thousand nurses from ten European countries showed that the factorial structure of WAI had two principal components in eight countries and one principal component in one country. The authors considered the first of these components to represent the subjective evaluation of work ability and the worker's mental resources, and the second to represent self-perceived health status and sickness-related absenteeism.<sup>b</sup>

Still with regard to construct validity, in this study we evaluated discriminant validity based on a comparison between groups with different absenteeism patterns. Workers with limitations in work ability showed greater absenteeism than other workers.<sup>10</sup>

Our results indicate that WAI is capable of discriminating between groups with different patterns of absenteeism. Workers with greater absenteeism showed worse work ability scores than other workers, confirming the validity of the Brazilian version. However, our results differ from those reported in the study of European nurses, where there was no relationship between sickness-related absenteeism and work ability.<sup>b</sup>

Construct validity is considered as the primary form of validation of an instrument designed to measure qualitative data, given that it tests the hypothesis of legitimate and appropriate representation of the construct by the instrument.<sup>8,14</sup> In the present study, the Brazilian version of WAI showed satisfactory construct validity, and higher discriminatory power than versions from other countries.

The greatest difficulty with respect to criterion validity is obtaining a criterion for comparison considered valid for measuring subjective aspects.<sup>8,14</sup> We regarded health status as a proxy for work ability given its major role in determining such ability. Deterioration and improvement in health status represent, respectively, a risk and the possibility of further developing work ability.<sup>b,c</sup> We

**Table 3.** Spearman correlation coefficients for the Brazilian version of the Work Ability Index, according to health status dimensions. Area of the municipality of Campinas, Southeastern Brazil, 2005.

Dimension	n	r	p
Physical functioning	470	0.44	<0.001
Role-physical	474	0.32	<0.001
Bodily pain	474	0.48	<0.001
General health	473	0.49	<0.001
Vitality	475	0.39	<0.001
Social functioning	475	0.33	<0.001
Role-emotional	474	0.23	<0.001
Mental health	475	0.40	<0.001

**Table 4.** Cronbach's alpha per question for the Brazilian version of the Work Ability Index. Area of the municipality of Campinas, Southeastern Brazil, 2005.

Question	Cronbach's alpha when question is excluded
Current work ability compared with the lifetime best	0.68
Current work ability in relation to physical demands	0.69
Current work ability in relation to mental demands	0.71
Number of current diseases diagnosed by physician	0.74
Estimated work impairment due to diseases	0.68
Sick leave during the past year (12 months)	0.71
Own prognosis regarding of work ability two years from now	0.72
Enjoying daily tasks	0.70
Activity and life spirit	0.70
Optimistic about the future	0.70
WAI (all questions)	0.72

chose to use a self-evaluated measure of health that is a validated strategy for representing health status.<sup>11,16</sup>

All dimensions of health were statistically correlated with WAI. This result is consistent with the theoretical framework of work ability, which is represented as health based on functional ability and presence of diseases, expanded to encompass a global view of health.<sup>16</sup> Though

<sup>a</sup> Radkiewicz P, Widerszal-Bazyl M. Psychometric properties of Work Ability Index in the light of comparative survey study. In: Costa G, Goedhard WJA, Ilmarinen J, editors. International Congress Series. Proceedings of the 2nd International Symposium in work ability: assessment and promotion of work ability, health and well-being of ageing workers; 2004 Oct 18-20; Verona, Italy. Amsterdam: Elsevier. 2005; 1280:304-9.

<sup>b</sup> Ilmarinen J, Tuomi K, Seitsamo J. New dimensions of work ability. In: Costa G, Goedhard WJA, Ilmarinen J, editors. International Congress Series. Proceedings of the 2nd International Symposium in work ability: assessment and promotion of work ability, health and well-being of ageing workers; 2004 Oct 18-20; Verona, Italy. Amsterdam: Elsevier. 2005; 1280:3-7.

<sup>c</sup> Ilmarinen J. Towards a longer worklife! Ageing and the quality of worklife in the European Union. Helsinki: Finnish Institute of Occupational Health. Ministry of Social Affairs and Health; 2006. p.132-48.

significant, the weak correlations may be justified by the fact that each dimension in itself is not capable of explaining the behavior of the overall WAI score, since they are unable to portray the totality of the health-disease process. Furthermore, work ability can be influenced by a multifactorial process in which several elements interact with each other, often in a complex fashion.<sup>6,7</sup>

In SF-36, health dimensions “physical functioning,” “role-physical,” “bodily pain,” and “general health” are representative of physical health, the remaining dimensions representing mental health.<sup>20</sup> Dimensions of physical health were in general more strongly correlated with WAI than dimensions of mental health. Physical health, represented by physical functioning, is regarded as a basis for work ability given its significant role in worker impairment, since it reflects the worker’s performance in light of the demands made by his or her work.<sup>15,a</sup> Mental health is considered as more relevant to work in which demands are predominantly mental in nature.<sup>15</sup>

The criterion validity analysis of the original instrument showed an association between WAI and the adopted parameters.<sup>4</sup> A study of administrative workers in Brazil found statistically significant correlations between work ability and all dimensions of health evaluated.<sup>13</sup> In the European nurse study, evaluation of construct validity using self-reported measures of physical and mental wellbeing showed that WAI score correlated with self-perceived general health status, emotional exhaustion, and disability.<sup>b</sup>

In the present study, the reliability of the WAI questionnaire was determined using Cronbach’s alpha coefficient. This approach yielded a coefficient of 0.72, considered as satisfactory.<sup>2</sup> Another WAI reliability study carried out among German workers aged 40 years or older showed acceptable reliability based on a test-retest strategy with a four-week interval between each administration.<sup>21</sup> The mean Cronbach’s alpha coefficient in the European nurse study was 0.72, indicating satisfactory internal consistency, with the exception of Slovakia (0.54), possibly due to biased sampling.<sup>b</sup> Other Brazilian studies showed Cronbach’s alpha coefficients for WAI of 0.73 among administrative workers<sup>13</sup> and 0.90 among nursing staff.<sup>5</sup>

The socio-occupational profile of the population of the present study differs from that of the general population in that our subjects have higher levels of schooling and income, are relatively younger, and perform predominantly physical and mental activities. The final mean WAI score was 41.8 points, indicating a high level

of work ability, although this result is subject to the “healthy worker” bias.

Since this population displays very specific characteristics in terms of demographic profile, health status, and occupational placement, the psychometric ability of WAI in this context may not be valid for other Brazilian worker populations, and our results should be generalized with caution.

From this perspective, WAI reliability should be re-evaluated prior to each administration of the instrument. Such precaution is aimed at identifying variations in questionnaire reliability, which may be affected by the breadth of the variable being measured, by the characteristics of the study population, or by the conditions under which measurement is carried out.<sup>12</sup>

One of the limitations of the present study is the definition of cutoff points for the WAI score, which is based on results obtained from Finnish workers aged 45-58 years, using the following criteria: the 15% of workers with worst scores were considered as with “poor” ability, the 15% workers with best scores were considered as with “excellent” ability, and workers with “moderate” and “good” ability were divided by the median score.<sup>9,18</sup> Since Brazilian workers have a different demographic composition, are exposed to working and living conditions that differ from those of Finland, and are likely to be subject to a different pattern of functional ageing, the original cutoff points proposed in the Finnish study may not be valid, and were therefore not adopted in the present study. Thus, we recommend that WAI results be regarded as a score until studies aimed at validating these cutoff points are carried out in the Brazilian setting.

Another aspect to be considered is that current WAI categories may not be valid for young workers, since current reference values may lead to overestimation of results among younger subjects.<sup>9</sup> Another categorization is available that is based on Finnish workers in their 30’s; however, follow-up studies will be required to verify the predictive value of WAI among younger workers.<sup>9</sup>

WAI results can be used at both the individual and collective levels. At the individual level, to identify workers whose functional capacity is compromised, so that support measures can be adopted. At the collective level, to trace the general profile of work ability and to identify factors affecting this profile, so that corrective initiatives may be undertaken.<sup>18</sup> Other positive aspects of WAI are the ease and the short time required for its administration, and its low cost.<sup>18</sup>

<sup>a</sup> Ilmarinen J, Tuomi K, Seitsamo J. New dimensions of work ability. In: Costa G, Goedhard WJA, Ilmarinen J, editors. International Congress Series. Proceedings of the 2nd International Symposium in work ability: assessment and promotion of work ability, health and well-being of ageing workers; 2004 Oct 18-20; Verona, Italy. Amsterdam: Elsevier. 2005; 1280:3-7.

<sup>b</sup> Radkiewicz P, Widerszal-Bazyl M. Psychometric properties of Work Ability Index in the light of comparative survey study. In: Costa G, Goedhard WJA, Ilmarinen J, editors. International Congress Series. Proceedings of the 2nd International Symposium in work ability: assessment and promotion of work ability, health and well-being of ageing workers; 2004 Oct 18-20; Verona, Italy. Amsterdam: Elsevier. 2005; 1280:304-9.

In the present study, WAI showed satisfactory psychometric properties, with good performance in terms of construct and criterion validity, and reliability, constituting an appropriate option for evaluating work ability among Brazilian workers, both at the individual level and in population-based settings.

Further studies should be carried out with other groups of workers in order to increase our knowledge of the behavior of the psychometric properties of the Brazilian version of WAI in different age groups. Until this is done, it will be prudent to evaluate the reliability of this instrument before each use.

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