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ORIGINAL RESEARCH

Factorial analysis of the Brazilian-Portuguese version of the Work Ability Index, reproducibility and validity of the single item and the short version for online application

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Abstract
Background: The Work Ability Index (WAI) assesses work demands, health status, and physical and mental resources.
Objectives: To evaluate the measurement properties of the WAI, single-item work ability score (WAS), and short version for online applications.
Methods: One hundred three workers completed the 3 versions of the WAI and the Perceived Stress Scale (PSS-10) questionnaire. The reproducibility and construct validity of the 3 versions of the WAI and their concurrent validity with the PSS-10 were tested. Statistical tests were performed with IBM® SPSS 28.0.
Results: The test-retest reliability of the WAI, WAS, and WAI short version ranged from good to excellent. The WAI and WAI short version showed excellent internal consistency. The construct validity of the WAS was moderate and positive and it was excellent and positive for the WAI short version. Concurrent validity of the WAI, WAS, and WAI short version was moderate and negative, and item mental resources were strong and negative. Factor analysis reached an acceptable level for all indexes ($\geq$ 0.90). The analysis with two factors reached an acceptable level for all indexes ($\geq$ 0.90) and was the best model.
Conclusion: The reliability and construct and concurrent validity of the various versions of the WAI were strong to excellent in online applications. Confirmatory factor analysis demonstrated a new grouping of items for the WAI Brazilian version. However, it is necessary to be careful in the choice due to the distribution model of items in health domains and aspects of work.

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Introduction

The Work Ability Index (WAI) was created to assess work requirements, health conditions, physical and mental demands, and current and future work ability.[1-6] The Finnish Institute of Occupational Health developed the WAI so that workers could understand and identify factors that could pull them out of the labor market early.[2,3] In Brazil, the WAI started being applied in 1996 after changes in social security, knowledge about aging of the Brazilian population, and the insertion and/or maintenance of workers for more than 30 years in the workforce.[4-6]

Few studies have evaluated the measurement properties of the Brazilian version of the WAI.[6-9] Those showed that the WAI has good internal consistency,[6] moderate to strong test-retest reliability,[7,8] and poor to moderate criterion validity.[6] Although described in the study by Martinez et al.,[6] the confirmatory factor analysis, from which the authors propose a distribution of questionnaire components in the Brazilian version, does not meet established statistical analysis criteria.[10,11]

The WAI is a questionnaire that measures several dimensions, and it takes time for the worker to complete it, which may result in a loss of interest. This may result in the answers not being accurate, leading to subsequent interpretation errors.[12] The WAI is also complicated to use in large-scale surveys.[13] Therefore, some authors propose using the single-item work ability score (WAS), which corresponds to the worker's current work ability, which maybe an alternative to quickly assess whether there is a possibility of long-term sick leave.[12] The validity of the single item WAI was tested in Brazil in 379 workers, most of whom performing clerical work (n = 227), and showed weak to moderate correlation with the WAI and was not recommended for use by the authors.[9] The single-item work ability score (WAS) tested in other studies showed excellent correlation ($>$0.9) with the WAI.[14,15]

Three studies proposed a short version of the WAI as an alternative to the WAI.[13,16,17] In one of the versions, the items related to diagnosed diseases and difficulty with work due to these diseases were revised[16]; the other version keeps the single-item work ability score (WAS) and questions related to physical and mental demands. A third version removed the item diagnosed diseases and kept the other items of the WAI.[13] Although the short versions have different purposes, all have been reported to be as good as the WAI full length.[13,16,17]

The Portuguese-Brazilian version of the WAI has never had its measurement properties tested for online application. There is no factor analysis of the constructs that make up the WAI in its paper or online versions. The Portuguese-Brazilian version of the WAS was not found to be valid when compared to the WAI, and the WAI-short version was never tested for its validity for a population of Brazilian workers.[18] This study aims to evaluate the measurement properties of reproducibility, validity, and factorial analysis of the various versions of the WAI completed online.

Methods

Study design

This is a study of the measurement properties of the WAI. Data were collected after approval by the Research Ethics Committee of the Universidade Cidade de São Paulo, Brazil under the number (CAAE 36214920.2.0000.0064).

Participants

A total of 103 workers over 18 years of age from all states in Brazil participated in this study. Workers represented various occupations: health professionals (nurses, doctors, technicians, nursing assistants, physical therapists, speech therapists, pharmacists, dentists), teachers, industry professionals (engineers, architects, technicians), administrative professionals (administrators, lawyers, human resources, information technology, trainees), security professionals, and independent workers. The exclusion criteria were pregnant women and employees on leave for health reasons.

Questionnaires

Work Ability Index (WAI)

The WAI consists of 7 items and 10 questions: 1) work ability compared to lifetime best (one question with score ranging 1−10 points), 2) work ability in relation to the physical and mental demands of work (score weighted by the results of the two questions, ranging from 2 to 10 points), 3) the number of current diseases diagnosed by a physician from a list of 51 diseases (one question with score ranging from 1 to 7 points), 4) estimated absence from work due to disease (one question with a score ranging from 1 to 6 points), 5) absence from work due to disease in the last 12 months (one question with score ranging from 1 to 5 points), 6) self-prognosis of work ability in 2 years (one question with score ranging from 1 to 4 points), and 7) mental resources within this question: do you enjoy daily tasks? Are you active and alert? Are you hopeful for the future? (three questions, score weighting, with ranging from 1 to 3 points). The final score ranges from 7 to 49 points; the higher the score better the work ability, which can be classified as low (7 to 27 points), moderate (28 to 36 points), good (37 to 43 points), or excellent (44 to 49 points).[4-6]

Single-item work ability score (WAS)

The WAS question is the first question (item) of the WAI, which evaluates the "Current work ability compared with lifetime best "(Likert scale 0−10 points).[4-6]

WAI-short version

There are three short versions for the WAI. The version proposed by Hetzel et al.,[16] WAI-r (shortened), revised items 3 and 4; where item 3 is number of current diseases diagnosed by a physician (using a list of 13 diseases or injuries) and item 4 is estimated work impairment due to diseases (is your illness or injury a hindrance to your current job?). The score for this version varies between 5 and 36 points. Ebener and Hasselhorn[17] suggested using the first 2 questions from the WAI: "Current work ability compared with lifetime best" and two items assessing "work ability in relation to the mental/physical demands of the job". Shouten et al.[13] proposed removing item 3 of the WAI. In this study, we used the short version tested by Shouten et al.,[13] which final score ranges from 6 to 42 points.

Perceived Stress Scale (PSS-10)

The PSS-10 was used to evaluate the perception of occupational stress, which indicates the frequency of feelings and thoughts during the last month (last 30 days).[19-21] The PSS-10 consists of 10 items, six positive and four negatives, rated on a 5-point *Likert* scale (1 = never to 5 = very often). The final score is the sum of all items and ranges from 0 to 40 points. The higher the score, the greater the perceived stress.[19-21] The Brazilian Portuguese version has good reproducibility and acceptable construct validity.[19-21]

Procedures

The participants were recruited by the "Snowball" method by emailing the questionnaire link and a brief explanation about the study and dissemination on social networks (WhatsApp, LinkedIn, Facebook, and Instagram). The online questionnaire, developed in Google Forms, contained sociodemographic, anthropometric, and occupational information; the WAI (full length, single-item, and WAI short version); and the PSS-10 questionnaire. The potential participants read the study instructions, provided consent to participate by signing the Informed Consent Form, and then completed the questionnaire. The questionnaire was completed twice: baseline and after 7 days (test-retest).

Measurement properties

Reproducibility refers to the ability of a questionnaire to obtain similar responses in a test-retest experiment under unchanged conditions. It can be calculated using the following tests: kappa, weighted kappa, and intraclass correlation index.[10,11] Internal consistency determines whether items of a questionnaire (or the scales of the questionnaire) measure the same construct. It can be calculated using the following tests: Cronbach's alpha and McDonald's omega.[10-11]

Construct validity refers to the extent to which the score on a given questionnaire represents the actual concept being examined. Construct validity should be assessed from a hypothesis formulation.[10-11] Concurrent validity evaluates how much a new method correlates with an existing one. Both types of validity can be determined using Pearson correlation coefficient (r) (for two continuous measurements) or Spearman's rank correlation coefficient (rho) (for nonparametric variables).

Factor analysis is a statistical technique that explains observed or measured variables by fewer unobservable hypothetical variables. Its purpose is to assimilate the correlations implicit in the data. It can be employed as Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).[10-11] CFA looks at a study of models for measurement questionnaires, where you already have a theory and the relationships between a set of indicators or observed variables and one or more latent variables. For EFA, a linear regression compares dependent items with latent factors, where the observed variables alternate into common and unique.

Statistical analysis

The test-retest reliability of the WAI versions were analyzed using intraclass correlation coefficients ($ICC_{2,1}$). Reliability can be considered poor ($<$0.40), moderate (0.40$-$0.75), strong (0.75$-$0.90), and excellent ($>$0.90).[10,11] Internal consistency was determined using Cronbach alpha coefficient (α), which is considered positive when between 0.70 and 0.95; low when less than 0.70; and redundant when greater than 0.95.[10,11] Construct validity was assessed by the hypothesis that the correlation between the WAS and the short version of the WAI with the total WAI score would show a moderate to strong positive Pearson test (r). The concurrent validity of the WAI versions was tested based on their association with the score on the PSS-10. The correlation analysis between the mental resources item of the WAI (composed of 3 questions) with the total values of the PSS-10 was classified as strong above 0.70 and moderate from 0.30 to 0.70. The negative or positive value indicates the direction of the relationship and depends on the scoring and classification criteria of the measurement questionnaire used. The validity tests were performed with retest data.[10,11]

The factor analysis was designed according to the WAI orientation, with 7 items including all 10 questions. The first analysis (Table 1) considered the 10 questions through confirmatory factor analysis in three models of three factors each (current work ability and demands; absences at work and future work ability; diseases and losses at work). Model A (Peralta et al.[22] - Argentine version); Model B (Martinez et al.[6] - Brazilian version); and Model C, analysis of this study. The Model C was grouped through an exploratory factor analysis, grouping issues that communicate better with each other.

The second analysis (Table 1) considered the 7-item WAI and two factors (current and future ability; health) in two equal models: Model A (Freyer et al.[23] and Rodriguez et al.[24]) and Model B proposed in this study, through

Table 1 Description of Models A, B, and C, considering the allocation of the 10 questions in three factors (a). Models A and B in the allocation of the 7 items in two factors (b).

Allocation (a)	Model A (Questions)	Model B (Questions)	Model C (Questions)
Factor 1	1, 2, 3, 8, 9 and 10	8, 9 and 10	8, 9 and 10
Factor 2	6 and 7	1, 2 and 3	1, 2, 3 and 7
Factor 3	4 and 5	4, 5, 6 and 7	4, 5 and 6
Allocation (b)	**Model A (Items)**	**Model B (Items)**	
Factor 1	1, 2, 6 and 7	1, 2, 3 and 7	
Factor 2	4 and 5	4, 5 and 6	

confirmatory factor analysis. Model B was grouped after an exploratory factor analysis, which adjusted the items within the two factors. IBM® SPSS 28.0. was used for all analyses ($p < 0,05$).

Results

Of the 103 participants, 82 were female, the average age was 39 years old, and most participants were considered to be of normal weight based on their body mass index. More than half of the participants (57.3%) were married or in a stable relationship. Most had a graduate degree completed or in progress (74.8%) and had incomes of 5 or more minimum wages (Supplementary material).

Supplementary material provides the results of the WAI versions and PSS-10 at baseline and retest 7 days later. The WAI, WAS, and WAI-short versions scores show little variation between the two-time points.

Reproducibility of WAI versions

The test-retest reliability of the WAI completed online was excellent: $ICC_{2,1}$: 0.922 (0.884, 0.947); Cronbach's alpha (0.930). The WAS showed good reliability ($ICC_{2,1}$:0.868 (0.812, 0.909). WAI-short version showed excellent reliability ($ICC_{2,1}$:0.907 (0.865, 0.936)); Cronbach's alpha (0.951).

Validity of the WAS and WAI-short version

The WAS construct validity was tested by correlation with the WAI, which was strong and positive (r = 0.784; $p < 0.001$). The correlation between the WAI-short version and the WAI was excellent and positive (r = 0.957; $p < 0.001$). The concurrent validity of the WAI, WAS, and WAI-short version with perceived stress measured by the PSS-10 showed moderate and negative correlation values (r= −0.625; $p < 0.001$; r= −0.595; $p < 0.001$; r= −0.647; $p < 0.001$). The correlation of the mental resources item of the WAI with perceived stress (PSS-10) was strong and negative (r=−0.701; $p < 0.001$).

Factor analysis of the WAI Brazilian Portuguese version

Model C consists of the model proposed by our study after the extraction of three factors in the Exploratory Factor Analysis (Fig. 1).

The Kaiser-Meyer-Olkin test verified sample adequacy for the analysis with acceptable values (KMO=0.81). The

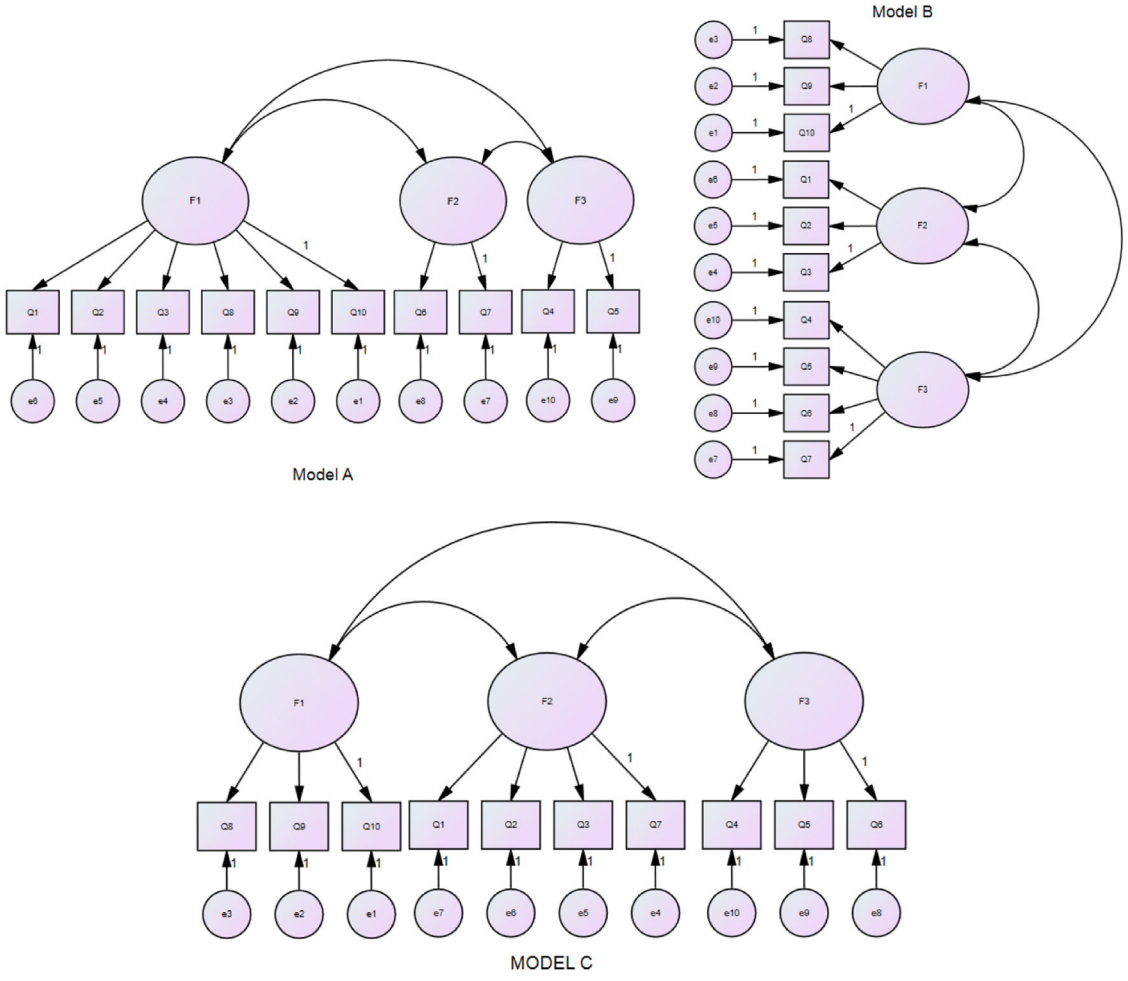

Fig. 1 Exploratory Factor Analysis considering the WAI with 10 questions and three factors (Model A, B, and C).

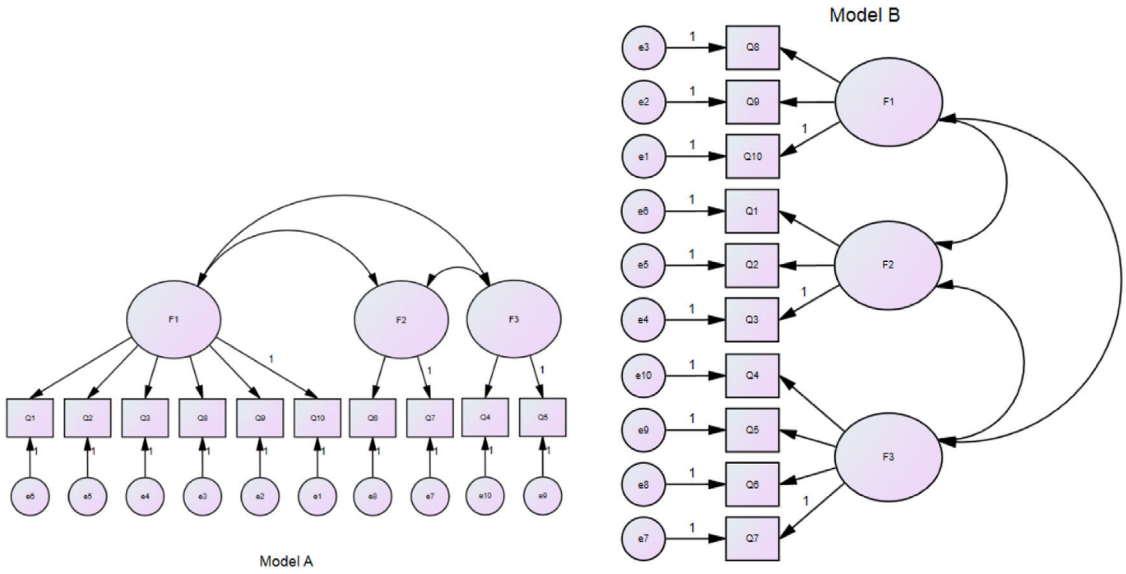

Fig. 2 Confirmatory analysis with two factors (Model A and B).

Bartlett's sphericity test was chi-square (45) = 323.856, ($p < 0.001$). These indicated that the correlations between the questionnaire items were sufficient for the analysis.

The factor extraction criterion by eigenvalues showed the presence of three factors with eigenvalues > 1 related to the 10 questions of the WAI questionnaire, which explains 62.95% of the total variance of the participants' responses. These values were satisfactory because they should explain at least 50% of the total variance of the questionnaire (Supplementary material).

Confirmatory factor analysis

Fig. 2 shows Models A and B with a two-factor analysis where Model B is proposed in this study.

None of the tested models reached an acceptable level for all indices ($\geq$ 0.90). However, there was a better fit of Model C than the others. Yet, Model C, although better than the others, did not provide an adequate fit for the data (Table 2).

The Kaiser-Meyer-Olkin test verified sample adequacy for the analysis with acceptable values (KMO=0.74). The results for Bartlett's test of sphericity were chi-square (21) = 289.750, $p < 0.001$. These indicated that the correlations between the questionnaire items were sufficient to perform the analysis.

The criterion for factor extraction by eigenvalues (eigenvalues>1) showed the presence of three factors with eigenvalues > 1 related to the 7 items of the WAI questionnaire, which explains 64.54% of the total variance of the participants' responses. These values were satisfactory because they should explain at least 50% of the total variance of the questionnaire (Supplementary material).

Models A and B reached an acceptable level for all indices ($\geq$ 0.90). However, there was a better fit of Model B than Model A (Table 3).

When comparing the index data extracted in our study by means of AFC (Table 3). we can observe that the model reached an acceptable level for all indices ($\geq$ 0.90). It presented a better fit when compared to the data extracted by the other studies by Freyer et al.[23](German version) and Rodríguez et al. (Spanish version).[24]

Discussion

The results of this study showed the test-retest reliability of the WAI, WAS, and the WAI-short version ranged from good to excellent, and construct validity was strong and positive. The concurrent validity of the WAI, WAS, and WAI-short version showed moderate and negative correlations. The mental resources item of the WAI had a strong and negative

Table 2 Fit indices for the three PSWQ factor models tested according to confirmatory factor analysis.

Models	X^2	df	GFI	CFI	RMSEA	SRMR	AIC	ECVI	NFI	NNFI
Model A	59.46	32	.88	.90	.09	.67	105.46	1.03	.82	.74
Model B	47.64	32	.92	.94	.06	.70	93.64	.91	.85	.80
Model C	42.29	32	.92	.96	.05	.56	88.29	.86	.87	.82

Fit indices for the three PSWQ factor models were tested according to confirmatory factor analysis. CFI, Comparative Fit Index; GFI, Goodness of Fit Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Residual (SRMR); AIC, Akaike's Information Criterion; ECVI, Expected Cross-Validation Index; NFI, Normed Fit Index; and NNFI, Non-Normed Fit Index.

Table 3 Fit indices for the two PSWQ factor models were tested according to confirmatory factor analysis—a comparison of the Brazilian version tested in this study with the German and Spanish versions.

Models	X^2	Df	GFI	CFI	RMSEA	SRMR	AIC	ECVI	NFI	NNFI
Model A	19.76	11	.95	.96	.08	.66	53.76	.52	.93	.87
The Brazilian version of Model B	14.25	11	.96	.98	.05	.47	48.25	.47	.95	.90
German version	289.60	13	.88	.92	.11	—	—	—	—	—
Spanish version	59.52	—	.96	.98	.06	—	—	—	—	—

Fit indices for the three PSWQ factor models were tested according to confirmatory factor analysis. CFI, Comparative Fit Index; GFI, Goodness of Fit Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Residual (SRMR); AIC, Akaike's Information Criterion; ECVI, Expected Cross-Validation Index; NFI, Normed Fit Index; and NNFI, Non-Normed Fit Index.

correlation with perceived stress measured by the PSS-10. The factor analysis was performed in two stages: the first with 10 questions in three models of three factors each (Models A, B, and C). The model shows acceptable values of sample adequacy, which explains the total variance of the questionnaire. However, none of the tested models reached an acceptable level for all indices. The tested version of Model C is the most complete and recommended. Compared to the others, the second stage has 7 items and two models with two factors each (Models A and B). The results showed acceptable values of sample adequacy, explain the total variance of the questionnaire, and reach an acceptable level for all indices with the better fit of Model B compared to Model A.

The test-retest reliability of the WAI completed online after a 7-day interval was excellent, better than the results obtained in the study by Martinez et al.[6] The test-retest reliability at 4 weeks for the Iranian version of the WAI was excellent. There was no statistical difference between the mean WAI scores on the test and retest.[25]

The WAS showed good reliability and the WAI-short version reliability is excellent. The validity of the single item version was tested by correlation with the WAI, which was strong and positive, different from that found by Cazotti et al.,[9] although the study populations were different. Our findings are consistent with the studies of Ahlstrom et al.[14] and El Fassi et al.[15] The correlation between the WAI-short version and the WAI was excellent, as in the study by Shouten et al.[13]

As expected, for concurrent validity, the WAI, WAS, and WAI-short version showed a moderate and negative correlation with perceived stress measured by the PSS-10.[6] The concurrent validity results associating the mental resources item of the WAI with PSS-10 showed better results due to the more specific construct comparison. No previous study correlates the PSS-10 with the WAI in any form of application.

Regarding the factor analysis of the WAI, the studies of Peralta et al.[22] (Argentina version - Model A) and Martinez et al.[6] (Brazilian version - Model B) presented a model with three factors. However, the models presented different groupings of the questions by factor compared to the model tested in this study (Model C).[6,22] There was a better adjustment of Model C in relation to Models A and B, perhaps due to grouping questions about the current and future work ability, reasons for illness, and what they imply in work and mental resources together. Unlike the other models, Model A grouped questions about current and future work ability and mental resources, work absences, and number of diseases and what they imply for work; and Model B: questions about current work ability, number of diseases and what they imply for work, absences from work, and future work ability and ultimately mental resources.[6,22]

The studies by Freyer et al.[23] (German version) and Rodríguez et al.[24] (Spanish version) tested the CFA and presented a model with two factors, and refer to what we call Model A. Model B consists of the model proposed by our study after the extraction of CFA with different results.[23,24] The second analysis groups the item for current and future work ability and health outcomes in Model A and Model B. This study shows a different grouping of items with the current work ability, diseases, and mental resources along with implications of diseases and absences from work.[23,24]

The sample size of 100 subjects for factor analysis, as occurs in our study, is the minimum to ensure reliable results according to COSMIN guidelines, although this number is still debated.[26,27] A rule to be used to define the sample size varies from 4 to 10 subjects per variable,[27] and the WAI complete version has 7 items and 10 questions.

The strength of this study is that it was conducted entirely online, the first to do so, and demonstrated better measurement properties than the paper-based Portuguese-Brazilian version. It is also a study that shows the unprecedented result of a factor analysis with a clustering outcome of WAI issues distinct from other published studies. The version of the WAI that best fits the Brazilian version, in the opinion of the authors of this study, is a version with two factors of Model B of the second-factor analysis due to its result having an acceptable level which are better than those from previous studies.

The limitation of this study is that the majority of participants were in the healthcare area due to the "Snowball" approach of recruitment, where people knew other people with high education. Data collection was performed during the coronavirus pandemic, which may have been reflected in the participants' responses due to the insecurity in relation to health and work. However, even so, we believe that as it is a study of measurement properties, the results reflect the quality of the questionnaire.

Conclusion

The WAI, WAS, and WAI short version presented good to excellent test-retest reliability. The WAS and the WAI short

version proved valid to assess work ability compared to the full WAI. The grouping of items and domains demonstrated an unprecedented confirmatory factor analysis, which is possible to use in new studies. The study indicates that the three versions of the questionnaire can be used. However, it is necessary to consider that the distribution of the items indicates a need to consider the distribution of the constructs.

Conflicts of interest

The authors declare no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.bjpt.2024.101060.

References

1. Cordeiro TMSC, Souza DS, Araújo TM de. Validity, reproducibility and reliability of the Work Ability Index: a systematic review. *Revista de Epidemiologia e Controle de Infecção*. 2017;7(1):57–66. https://doi.org/10.17058/reci.v7i1.7788.
2. Ilmarinen J., Tuomi K. Past, present and future of work ability. People and work research reports. Finnish Institute of Occupational Health, Helsinki 2004;65:1–25. https://doi.org/10.1093/occmed/kqm008.
3. Tuomi K., Ilmarinen J., Jahkola A., Katajarinne L., Tulkki A. Work Ability Index. 2nd revised ed. Helsinki: Finnish Institute of Occupational Health, 1998.
4. Tuomi K., Ilmarinen J., Jahkola A., Katajarinne L., Tulkki A. Índice de capacidade para o trabalho; traduzido por Frida Marina Fischer (Coord.), São Carlos: EdUFSCar, 2010. 59 p. ISBN: 978-85-7600-046-4.
5. Martinez MC, Latorre Mdo R, Fischer FM. Work ability: a literature review. *Cien Saude Colet*. 2010;15(Suppl 1):1553–1561. https://doi.org/10.1590/s1413-81232010000700067.
6. Martinez MC, Latorre Mdo R, Fischer FM. Validity and reliability of the Brazilian version of the Work Ability Index questionnaire. *Rev Saude Publica*. 2009;43(3):525–532. https://doi.org/10.1590/S0034-89102009005000017.
7. Renosto A, Biz P, Hennington EA, Pattusi MP. Test-retest reliability of the Work Ability Index (WAI) in metallurgy workers from Southern Brazil. *Rev Bras Epidemiol*. 2009;12(2):217–225. https://doi.org/10.1590/S1415-790×2009000200011.
8. Silva Junior SH, Vasconcelos AG, Griep RH, Rotenberg L. Test-retest reliability of the Work Ability Index (WAI) in nursing workers. *Rev Bras Epidemiol*. 2013;16(1):202–209. https://doi.org/10.1590/S1415-790×2013000100019.
9. Cazotti AM, Sato TO, Padula RS, Moriguchi C. Limited suitability for single item work ability to replace Work Ability Index: a Brazilian cross-sectional study. *Theor Issues Ergonom Sci*. 2023;24(4):385–400. https://doi.org/10.1080/1463922X.2022.2090026.
10. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007;60(1):34–42. https://doi.org/10.1016/j.jclinepi.2006.03.012.
11. Mokkink B, Prinsen CAC, Bouter LM, Vet HCW, Terwee CB. The COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) and how to select an outcome measurement instrument. *Braz J Phys Ther*. 2016;20(2):105–113. https://doi.org/10.1590/bjpt-rbf.2014.0143.
12. Kinnunen U, Nätti J. Work ability score and future work ability as predictors of register-based disability pension and long-term sickness absence: a three-year follow-up study. *Scand J Public Health*. 2018;46(3):321–330. https://doi.org/10.1177/1403494817745190.
13. Schouten LS, Bültmann U, Heymans MW, Joling CI, Twisk JW, Roelen CA. Shortened version of the Work Ability Index to identify workers at risk of long-term sickness absence. *Eur J Public Health*. 2016;26(2):301–305. https://doi.org/10.1093/eurpub/ckv198.
14. Ahlstrom L, Grimby-Ekman A, Hagberg M, Dellve L. The Work Ability Index and single-item question: associations with sick leave, symptoms, and health–a prospective study of women on long-term sick leave. *Scand J Work Environ Health*. 2010;36(5):404–412. https://doi.org/10.5271/sjweh.2917.
15. El Fassi M, Bocquet V, Majery N, Lair ML, Couffignal S, Mairiaux P. Work ability assessment in a worker population: comparison and determinants of Work Ability Index and Work Ability score. *BMC Public Health*. 2013;13:305. https://doi.org/10.1186/1471-2458-13-305.
16. Hetzel C., Baumann R., Bilhuber H., Mozdzanowski M. Determination of work ability by a Work Ability Index short form ("WAI-r") ASU International. 2014;(10):01–03. https://doi.org/10.17147/ASUI.2014-10-01-03.
17. Ebener M, Hasselhorn HM. Validation of short measures of work ability for research and employee surveys. *Int J Environ Res Public Health*. 2019;16(18):3386. https://doi.org/10.3390/ijerph16183386.
18. Silva FG, Oliveira CB, Hisamatsu TM, et al. Critical evaluation of physical activity questionnaires translated to Brazilian-Portuguese: a systematic review on cross-cultural adaptation and measurements properties. Braz J Phys Ther. 2020 May-Jun;24(3):187-218. *Braz J Phys Ther*. 2020;24(3):187–218. https://doi.org/10.1016/j.bjpt.2019.04.002.
19. Luft CD, Sanches Sde O, Mazo GZ, Andrade A. Brazilian version of the Perceived Stress Scale: translation and validation for the elderly. *Rev Saude Publica*. 2007;41(4):606–615. https://doi.org/10.1590/s0034-89102007000400015.
20. Reis RS, Hino AA, Añez CR. Perceived stress scale: reliability and validity study in Brazil. *J Health Psychol*. 2010;15(1):107–114. https://doi.org/10.1177/1359105309346343.
21. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983;24(4):385–396.
22. Peralta N, Vasconcelos AGG, Griep RH, Miller L. Validez y confiabilidad del Índice de Capacidad para el Trabajo em trabajadores del primer nivel de atención de salud en Argentina. *Salud Colect*. 2012;8(2):163–173.
23. Freyer M, Formazin M, Rose U. Factorial validity of the Work Ability Index among employees in Germany. *J Occup Rehabil*. 2019;29(2):433–442. https://doi.org/10.1007/s10926-018-9803-9.
24. Mateo Rodríguez I, Knox ECL, Oliver Hernández C, Daponte Codina A, The esTAR Group. Psychometric properties of the Work Ability Index in health centre workers in Spain. *Int J Environ Res Public Health*. 2021;18(24):12988. https://doi.org/10.3390/ijerph182412988.

25. Abdolalizadeh M, Arastoo AA, 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. https://doi.org/10.1007/s10926-012-9355-3.
26. Terwee CB, Mokkink LB, Knol DL, Ostelo RW, Bouter LM, de Vet HC. Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist. *Qual Life Res*. 2012;21(4):651—657. https://doi.org/10.1007/s11136-011-9960-1.
27. de Vet HC, Adèr HJ, Terwee CB, Pouwer F. Are factor analytical techniques used appropriately in the validation of health status questionnaires? A systematic review on the quality of factor analysis of the SF-36. *Qual Life Res*. 2005;14(5):1203—1218. https://doi.org/10.1007/s11136-004-5742-3. discussion 1219-21, 1223-4.