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Original article

Importance of an Integrated Assessment of Functional Disability and Work Ability in Workers Affected by Low Back Pain

Fabrizio Russo [1,2], Cristina Di Tecco [3,*], Simone Russo [3], Giorgia Petrucci [2], Gianluca Vadalà [1,2], Vincenzo Denaro [1,2], Sergio Iavicoli [4]

[1] Research Unit of Orthopaedic and Trauma Surgery, Campus Bio-Medico University Hospital Foundation, Rome, Italy
[2] Research Unit of Orthopaedic and Trauma Surgery, Campus Bio-Medico University of Rome, Rome, Italy
[3] Italian Workers' Compensation Authority (INAIL), Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, Rome, Italy
[4] Ministry of Health, Directorate for Communication and International Affairs, Rome, Italy

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ABSTRACT

Background: This study examines the relationship between functional disability and work ability in workers affected by low back pain (LBP) through an analysis of correlations between the Oswestry Disability Index (ODI) and Work Ability Index (WAI). The role of personal and work factors on functional disability/work ability levels has also been studied. LBP is the most common musculoskeletal problem and a major disabling health problem worldwide. Its etiology is multifactorial. Multidisciplinary approaches may help reduce the burden of pain and disability and improve job continuity and reintegration at work.

Methods: A cohort of 264 patients affected by LBP from an Italian outpatient clinic were included in a clinical diagnostic/therapeutic trial aiming at rehabilitation and return to work through an integrated investigation protocol. Data were collected during the first medical examination using anamnestic and clinical tools. The final sample is composed of 252 patients, 57.1% man, 44.0 % blue collars, 46.4% with the high school degree, 45.6% married.

Results: WAI and ODI reported a negative and fair correlation ($r = -0.454$; $p = .000$). Workers with acute LBP symptoms have a higher probability of severe disability than those with chronic LBP symptoms. White collars without depressive symptoms reported higher work ability – even in chronic disability conditions-than those with depressive symptoms.

Conclusion: The study found that ODI and WAI have a convergent validity and this suggests that the two tools measure capture distinctive aspects of disability related to personal, environmental, and occupational characteristics. The most important and modifiable prognostic factors found for ODI and WAI were depressive symptoms, workday absence, and intensity of back pain. The study also found a mild association between age and ODI. The study's findings highlight the importance of using a multidisciplinary approach to manage and prevent disability due to LBP.

1. Introduction

Low back pain (LBP) is a major disabling health problem, with an elevated prevalence worldwide [1]. Its occurrence increases with age so that up to 80% of the population will experience it [2]. LBP represents the most common musculoskeletal problem in the European workforce and the leading cause of absenteeism and years lived with disability (YLD), with essential consequences on work performance, productivity, quality of life, social and public expenses [3] [DOI:https://doi.org/10.1016/S0140-6736(18)30480-X].

Fabrizio Russo: https://orcid.org/0000-0002-8566-8952; Cristina Di Tecco: https://orcid.org/0000-0002-8260-2130; Simone Russo: https://orcid.org/0000-0001-5376-1522; Giorgia Petrucci: https://orcid.org/0000-0003-4324-2600; Gianluca Vadalà: https://orcid.org/0000-0001-7142-1660; Vincenzo Denaro: https://orcid.org/0000-0003-4739-9795; Sergio Iavicoli: https://orcid.org/0000-0002-5956-9723

* Corresponding author. Italian Workers' Compensation Authority (INAIL), Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, Rome, Italy.

E-mail address: c.ditecco@inail.it (C. Di Tecco).

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They are expected to increase over the years with the aging population and the progressive increase in working life due to the extension of the retirement age and life expectancy [4]. Although most patients will recover, some will develop a chronic condition significantly affecting quality of life, leading to physical disability and work inability [5]. It is, therefore, critical to prevent the impact of LBP on functionality and ability over time by offering integrated multifactorial monitoring systems to avoid the effects of chronic conditions in personal, social, and working life.

LBP is often considered a biopsychosocial problem characterized by a combination of physical (e.g. BMI, comorbidities) [6], psychological (e.g. anxiety and depression), social (e.g. education), and work-related dysfunctions (e.g. work ability and compensation) [7] that are typically patient-reported [8]. Both individual and professional risk factors are involved in the genesis of LBP [3,7,9]. Since the etiology is multifactorial, identifying a single cause—or even the principal cause of LBP—and the appropriate intervention is challenging. Treatments exclusively directed at the physical component [10] may not stimulate the desired effects [11]. Chronic symptoms indeed might lead to adaptive mechanisms and functional adjustments that may mitigate the risk of severe disability over time [12]. Mental health is an important issue too for work ability and disability that allows to understand individuals' capacity to engage in productive work and their limitations in performing essential job tasks [13]. Thus, a multidisciplinary approach combining medical, psychological [14], and social/work interventions [15] may help in reducing the burden of pain and disability, in identifying effective interventions in the workplace, and support continuity and return to work (RTW).

Studies have suggested that LBP has a negative impact on functional status and work ability in workers [16]. However, the assumption that disability and work ability are correlated has been poorly investigated.

Disability is a recognized outcome of LBP. Many patient-reported outcome measures (PROMs) have been validated to assess patient status and the quality of spine care. The Oswestry Disability Index (ODI) is one of the most widely used PROMs to evaluate disability due to spinal pathology and assess functional outcomes after treatment [17]. Work ability is also a crucial aspect of well-being and health status. The Work Ability Index (WAI) is an assessment tool to identify environmental and personal factors related to the reduction of work ability [18,19] and what needs to be done to eliminate barriers and promote health and wellbeing at work [20].

It is often assumed that patients who feel more disabled and thus report more daily life restrictions due to LBP will be more limited at work. Although theoretically, functional disability should be associated with worse work ability, such an association has not been consistently demonstrated in the literature neither the role of personal characteristics and occupational factors on this association.

Therefore, this study aimed to examine the relationship between functional disability and work ability in workers affected by LBP through an analysis of the correlation between ODI and WAI. The objective was to understand how such two measures, which are widely used respectively in clinical and occupational practice, converge in catching similar but distinctive aspects of inability. Moreover, according to the biopsychosocial model [21], we aimed to investigate whether some bio-psycho-social characteristics and work factors play a differential role in this association, by worsening or improving functional disability/work ability levels.

Accordingly, our hypotheses are the follows:

H1: The two tools, one focused on work ability (WAI) and the other on functional disability (ODI), will demonstrate good convergent validity despite measuring different aspects of the same construct.

H2: Compared to those with chronic back pain symptoms, individuals with acute back pain symptoms are more likely to have more severe disability but also better work ability.

H3: Some aspects of work, including the type of occupation, absences from work, and extended hours, can impact differently the level of work ability and the level of disability.

H4: Higher levels of depressive symptoms will be associated with reduced work ability but not with disability.

H5: Higher levels of depressive symptoms will be associated with reduced work ability, as indicated by lower scores on the WAI. However, we do not expect a significant association between depressive symptoms and disability, as assessed by ODI.

Our purpose is to provide helpful information to draw a multidisciplinary monitoring protocol of the most comprehensive prognostic factors that may influence the RTW to reduce the impact of chronic conditions due to LBP and promote an active personal and working life.

2. Methods

2.1. Participants and procedure

We evaluated a cohort of 264 patients affected by LBP. We enrolled patients affected by LBP due to degenerative disc disease with no signs of radiculopathy. We excluded patients who underwent previous spinal surgeries or affected by LBP due to trauma, tumors, infections. They are included in a clinical trial at Campus Bio-Medico University outpatient clinic between June 2019- March 2021, aiming at rehabilitation, and RTW based on the treatment received. Through an integrated investigation protocol developed by orthopaedics and occupational health experts, data were collected to study prognostic factors that influence RTW and personalize therapeutic interventions. The questionnaire was administered during the first medical examination and is composed of an anamnestic and clinical part filled in by the doctor and a self-report part filled in by the patient. Participants with missing answers in ODI and WAI were excluded ($N = 12$); thus, the analyses were performed on a sample of 252 patients.

2.2. Confounding variables

To exclude or control confounding effect we considered gender, age, education, marital status and occupational sector as confounders. The occupational sector is based on the twenty-one categories from the National industrial classification of all economic activities. Sectors were computed in four macro-categories corresponding to Primary Sector: Agriculture, forestry, and fishing; Secondary sector: Manufacturing; Tertiary sector: Commerce Accommodation and food service activities and Other services.

2.3. Occupational variables

Some occupational characteristics were collected. A categorical variable identified type of work activity (white-collar, blue-collar). Working hours (usual number of hours worked per day in the last six months) and work absences due to LBP were collected (absences from work in the previous twelve months).

2.4. Health-related characteristics

Height and weight were collected to calculate Body Mass Index. The duration (Acute = less than six weeks, sub-acute = from 6 to 12 weeks, chronic = beyond 12 weeks) and intensity of pain (Visual Analog Scale) were collected [19]. We included depression through

the Patient Health Questionnaire-2 (PHQ-2) [22,23] that has a cut-off of ≥3 for depressive symptoms.

2.5. The Oswestry Disability Index

The Oswestry Disability Index investigates disability caused by LBP [24]. It consists of ten items scoring from 0 to 5. The total score is the sum of single items and ranges from 0 to 50. The total score is then multiplied by two to obtain a score ranging from 0 to 100. A higher score on the ODI indicates a more severe disability caused by LBP. This study considers 12 as an optimal cut-off value to differ LBP without disability (score 0-12) from LBP with disability (score 13–100) [22,25].

2.6. The Work Ability Index

The WAI [18] is a prospective index based on questions on physical and mental demands of work and workers' health and resources. The WAI aims to identify early stage health risks and risk of early retirement to implement preventing actions. It consists of the following dimensions: current work ability compared with the lifetime best; work ability about the demands of the job; number of present diseases diagnosed by a physician; estimated work impairment due to diseases; sick leave during the past year; own prognosis of work ability two years from now; mental resources. The questions aim to estimate the current and future work ability and the sickness and related mental deterioration in work performed. The total score lying from 7 to 49 (from low to high work ability) and can be categorised as: 1. poor (7–27), moderate (28–36), good (37–43), and excellent (44–49). We also considered a dichotomy classification for work ability [18]: poor/moderate work ability with a final score in the range of 7–36 and good/excellent work ability with a final score in the range of 37–49.

2.7. Statistical analysis

We performed the analyses using Stata v. 16.0 (StataCorp LP, College Station, TX, USA).

Descriptive statistics were calculated for demographic, work, and clinical characteristics.

We used the Pearson's correlation coefficient with bootstrap method for confidence interval between measures to test the degree to which the ODI and WAI are related (H1). Results were interpreted according to the following method [26]: perfect correlation = ±1; very strong correlation ±0.99 - 0.81; moderate correlation ±0.80 - 0.61; fair correlation ±0.60 - 0.31; poor correlation ±0.30 - 0.01; none = 0.

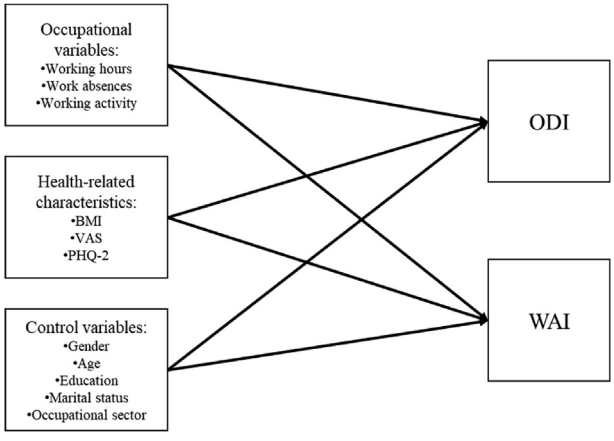

Fig. 1. Posited association between occupational, health-related and control variables, and ODI and WAI.

We also explore the association between the WAI and ODI scores (considering the dichotomy classification for both the variables) with univariate odds ratio (OR). Finally, to test all the other study's hypothesis we introduced multivariate binary logistic regression analyses verifying which occupational and health-related characteristics are associated with WAI and ODI scores (Fig. 1). We consider OR and their 95% confidence intervals (95% CI) in the results of the output model. Sensitivity, specificity, positive predictive value, negative predictive value, correct classification (computed on the predicted values of the logistic model) and the pseudo R-squared -value as a measure of goodness of the multivariate binary logistic regression analyses. Sensitivity measures the model's ability to correctly identify true positive cases, while Specificity quantifies its ability to correctly classify true negative cases.

3. Results

3.1. Demographic, work, and clinical data

The mean age of the participants is 48.62 (SD = 9.93), from 22 to 66 years; 10.71% are under 35, and 69.05% over 45 years old. Fifty-seven percent are female, and 63.89% are married or with a common-law wife or husband. The 33.33% of participants have a university graduate or post-graduate; 44.05% were blue-collar, and 69.05% work in other services. The mean of the Visual Analog Scale

Table 1
Demographic, work, and clinical characteristics of the participants

Characteristic	Total (n = 252)
Average working hours per day, mean ± SD	7.52 ± 1.85
Days absence in the last 12 days, mean ± SD	10 ± 21.02
Working class, *n* (%)	
Blue collar	111 (44.05)
White collar	141 (55.95)
Education, *n* (%)	
Lower/middle school	50 (19.84)
High school	117 (46.43)
University graduate and post-graduate	84 (33.33)
Missing	1 (0.40)
Visual analogue scale, mean ± SD	5.15 ± 2.31
How long suffer low back pain symptoms, *n* (%)	
Acute	21 (8.33)
Sub-acute	13 (5.16)
Chronic	218 (86.51)
PHQ-2, *n* (%)	
Absence of depressive symptoms	230 (91.27)
Presence of depressive symptoms	22 (8.73)
Age, *n* (%)	
< 25	6 (2.38)
25–34	21 (8.33)
35–44	51 (20.24)
45–54	94 (37.30)
55+	80 (31.75)
Sex, *n* (%)	
Female	108 (42.86)
Male	144 (57.14)
Marital status, *n* (%)	
Married or common-law marriage	161 (63.89)
Not married or not common-law marriage	91 (36.11)
Body mass index, *n* (%)	
Underweight	6 (2.38)
Normal weight	115 (45.63)
Overweight	88 (34.92)
Obese	43 (17.06)
Economic activity, *n* (%)	
Agriculture, forestry and fishing	4 (1.59)
Industry	34 (13.49)
Trade, accommodation, and food	40 (15.87)
Other services	174 (69.05)

Table 2
Patients scores ($n = 252$)

Parameter (range)	Mean	Standard deviation	Min	Max
Work Ability Index (7–49)	35.61	6.37	9	47
Current work ability compared with the lifetime best (0–10)	6.80	2.13	0	10
Work ability in relation to the demands of the job (2–10)	7.53	1.36	2	10
Number of current diseases diagnosed by a physician (1–7)	3.60	1.78	1	7
Estimated work impairment due to diseases (1–6)	4.37	1.11	1	6
Sick leave during the past year (12 months) (1–5)	3.93	1.19	1	5
Own prognosis of work ability 2 years from now (1–7)	6.19	1.56	1	7
Mental resources (1–4)	3.19	0.51	1	4
Oswestry Disability Index (0–100)	26.64	16.36	0	78
Pain intensity (0–5)	2.04	1.01	0	5
Personal care (0–5)	0.88	0.96	0	4
Lifting (0–5)	2.36	1.77	0	5
Walking (0–5)	0.88	1.24	0	5
Sitting (0–5)	1.59	1.42	0	5
Standing (0–5)	1.81	1.65	0	5
Sleeping (0–5)	1.10	1.22	0	5
Sex life (0–5)	0.71	1.00	0	4
Social life (0–5)	0.87	1.07	0	5
Traveling (0–5)	1.07	1.16	0	5
Work Ability Index and Oswestry Disability Index	Coeff.	p	95% IC	
			Lower	Upper
Rho Pearson	−0.454	0.000	−0.556	−0.353
Odds Ratio	0.309	0.000	0.167	0.573

was 5.15 (SD = 2.31), 86.51% suffer from chronic LBP, and 8.73% show depressive symptoms (Table 1).

3.2. Convergent validity

Table 2 shows scores of the two outcomes and their specific items. The higher the WAI score is, the better the patient's work ability is, and vice versa; the higher the ODI score is, the more severe disability is.

Therefore, as we expected, WAI and ODI scores show a negative and fair correlation ($r = -0.454$; $p = .000$; Table 2). In addition, the odds that a patient had a good/excellent work ability (WAI score between 37–49) with a LBP with disability (ODI score between 13–100) are about 0.3 times more than the odds that a patient with good/excellent work ability report a LBP without disability ($p = .000$; Table 2). Thus, the two scales show an excellent negative convergent validity.

Table 3 shows the two multivariate binary logistic regression model with WAI and ODI as dependent variables. White-collar workers without depressive symptoms have a higher probability of a good or an excellent work ability, but not a less disability; at the same time, acute LBP symptoms determine a higher probability of severe disability conditions when compared with chronic LBP. The workday absence due to LBP over the twelve months before and the VAS were significant in both the models: lower absences and less intensity of back pain increase the probability of experiencing a better work ability and having less disability. In addition, the logistic model reports a mild association between ODI and age; in particular, subjects under 25 years old more frequently showed a better disability condition. The model with ODI as the dependent variable exhibits a higher sensitivity compared to the model using the WAI. This means that the ODI model is more effective in correctly identifying true positive cases. On the other hand, the WAI model demonstrates higher specificity, indicating its proficiency in correctly excluding true negative cases.

Table 4 reports the multivariate binary logistic regression model with ODI as dependent and WAI as one of the independent variables. Considering the univariate OR in Table 2, we observe that the OR in Table 4 between WAI and ODI adjusted for the explanatory variables included in the regression model is no longer significant.

4. Discussion

This study investigated the relationship between functional disability and work ability in workers affected by LBP through an analysis of the correlation between ODI and WAI - as tools broadly used in both orthopedic and occupational practices—and the role played by some personal characteristics, environmental and occupational factors on this relationship. Our results supported most of our hypotheses.

ODI and WAI demonstrated good convergent validity, with a significant correlation of $r = -0.454$ ($p = .000$) (H1). Individuals with acute pain symptoms have a higher likelihood of developing severe disability compared to those with chronic back pain symptoms. Nevertheless, those with less intense back pain are not more likely to have better work ability, thus the H2 resulted partially confirmed (H2). Some aspects of work, including workday absence and intensity of back pain, have a differential impact on the level of work ability and the level of disability (H3). Higher levels of depressive symptoms resulted associated with reduced work ability but not with disability (H4). Higher levels of depressive symptoms are associated with reduced work ability, as indicated by lower scores on the WAI. However, no significant association has emerged between depressive symptoms and disability, as assessed by ODI (H5).

ODI and WAI come close to having a convergent validity with a significant correlation close to .50. Generally, convergent validity is investigated between two alternative measures of the same construct, and in most cases, findings show that these are rarely perfectly convergent [27]. In this study, we investigated the relationship between two measures catching two correlated but distinctive aspects of disability, functional and work-related, due to LBP. The ODI is a valid, reliable, and responsive assessment tool, and it is considered the "gold standard" to assess permanent low back functional disability due to spinal pathology [28]. The WAI assesses

Table 3
Multivariate regression model of Work Ability Index and Oswestry Disability Index characteristics

	Work Ability Index				Oswestry Disability Index			
	Odds ratio	95% CI		$P > t$	Odds ratio	95% CI		$P > t$
		Lower	Higher			Lower	Higher	
Average working hours per day*	1.121	0.947	1.328	0.186	1.072	0.883	1.303	0.481
Days absence in the last 12 days*	0.924	0.893	0.957	0.000	1.064	1.020	1.110	0.004
Working class (ref. Blue collar)								
White collar	2.196	1.086	4.442	0.029	1.175	0.507	2.726	0.707
Education (ref. Lower/middle school)								
High school	1.517	0.631	3.647	0.352	1.616	0.597	4.376	0.345
University graduate and post-graduate	2.325	0.866	6.241	0.094	1.368	0.442	4.238	0.587
Visual analogue scale*	0.864	0.748	0.998	0.047	1.729	1.442	2.072	0.000
How long suffer low back pain symptoms (ref. Acute)								
Sub-acute	0.612	0.099	3.796	0.598	0.164	0.016	1.660	0.126
Chronic	1.096	0.344	3.494	0.876	0.181	0.036	0.913	0.038
PHQ-2 (ref. absence of depressive symptoms)								
Presence of depressive symptoms	0.170	0.042	0.687	0.013	3.088	0.568	16.804	0.192
Age (ref. 55+)								
<25	1.422	0.167	12.117	0.747	0.120	0.013	1.128	0.064
25–34	2.461	0.616	9.828	0.203	0.320	0.079	1.304	0.112
35–44	1.182	0.482	2.897	0.715	0.464	0.157	1.370	0.165
45–54	1.426	0.657	3.096	0.370	0.451	0.179	1.136	0.091
Sex (ref. Male)								
Female	0.761	0.384	1.507	0.433	1.962	0.858	4.485	0.110
Marital status (ref. Not married or not common-law marriage)								
Married or common-law marriage	1.008	0.514	1.976	0.982	0.591	0.263	1.327	0.202
Body mass index (ref. Normal weight)								
Underweight	5.398	0.447	65.221	0.185	0.410	0.034	5.015	0.485
Overweight	1.270	0.608	2.652	0.525	0.556	0.237	1.309	0.179
Obesity	0.814	0.319	2.072	0.665	0.526	0.178	1.557	0.246
Economic activity (ref. Other services)								
Agriculture, forestry and fishing	4.757	0.079	288.178	0.456	–	–	–	–
Industry	1.117	0.417	2.991	0.825	1.354	0.440	4.166	0.597
Trade, accommodation, and food	1.700	0.676	4.277	0.260	1.506	0.524	4.329	0.447
Constant	0.519	0.051	5.271	0.579	0.764	0.050	11.635	0.846
Sensitivity	80.2%				92.5%			
Specificity	68.6%				38.3%			
Positive predictive value	73.2%				82.3%			
Negative predictive value	76.4%				62.2%			
Correctly classified	74.6%				79.3%			
Pseudo R2	0.26				0.27			

* The odds ratio for a continuous independent variable expresses the ratio of the probability that the dichotomous dependent variable will change from one category to the other for an increase of one unit in the independent variable.

the work ability of an individual to identify whether restrictions to work are imminent or in the future [18].

The study also showed that patients affected by chronic LBP have a lower physical disability than patients with acute LBP. Even though the typical course of acute LBP is initially favorable, it is often associated with a high disability [29]. Moreover, higher VAS values were associated with a higher disability and lower work ability and this is in line with other studies [30,31]. According to the 2017 Global Burden of Disease (GBD), LBP is the leading global cause of YLDs globally, peaking in the working-age population, which is greatly affected by its burden [32]. Moreover, besides representing a risk factor for absenteeism and sick leave, it has been widely proven that LBP affects several aspects of work ability [33,34].

4.1. Practical implications

Although the established burden and wide variety of literature on LBP, there continues to be a gap in its multidisciplinary evaluation and effective management. Indeed, addressing the occupational and clinical aspects of LBP can help perform an early diagnosis and promote a personalized intervention [15].

The value added of this study is related to the role found of mental health in worsening work ability rather than disability. Our findings highlighted that depressive symptoms—measured through a recognized valid measure [19]—might be potential determinants or predictors of differences in disability and work ability among patients with back disorders, since findings provided significant evidence of an association between depressive symptoms and observed disparities in work functionality. There is extensive evidence in the literature examining the relationships between psychosocial factors, depression, and MSDs that have demonstrated a predicting role of depression on MSDs [35], and a mediating part of depression in the relationship between psychosocial factors and MSDs [36]. Psychosocial factors and depression might induce inappropriate pain responses that are crucial in the transition to chronic diseases and the development of disability [35]. Thus, these aspects must be included in a multifactorial approach to manage and prevent disability due to LBP. The WAI has shown a significant association with psychosocial factors in previous studies [37–39] which can account to difficulties in maintaining productive employment and performing essential job tasks. This highlights the role of psychosocial factors in worsening the health chronic condition and, in turn, work ability, that has been demonstrated even in heavy physical work [40]. Unlike the ODI, in

Table 4
Multivariate regression model of characteristics associated with Work Ability Index

	Odds ratio	95% CI		$P > t$
		Lower	Higher	
Oswestry Disability Index (ref. no disability)				
Disability	0.572	0.250	1.311	0.187
Average working hours per day*	1.111	0.936	1.320	0.228
Days absence in the last 12 days*	0.927	0.896	0.960	0.000
Working class (ref. Blue collar)				
White collar	2.323	1.137	4.744	0.021
Education (ref. Lower/middle school)				
High school	1.550	0.633	3.798	0.337
University graduate and post-graduate	2.387	0.878	6.492	0.088
Visual analogue scale*	0.893	0.762	1.046	0.159
How long suffer low back pain symptoms (ref. Acute)				
Sub-acute	0.513	0.079	3.337	0.485
Chronic	0.950	0.291	3.104	0.933
PHQ-2 (ref. absence of depressive symptoms)				
Presence of depressive symptoms	0.180	0.044	0.740	0.017
Age (ref. 55+)				
<25	1.101	0.127	9.559	0.930
25–34	2.140	0.523	8.761	0.290
35–44	1.003	0.401	2.508	0.996
45–54	1.298	0.588	2.863	0.519
Sex (ref. Male)				
Female	0.768	0.384	1.534	0.455
Marital status (ref. Not married or not common-law marriage)				
Married or common-law marriage	0.950	0.479	1.881	0.882
Body mass index (ref. Normal weight)				
Underweight	5.606	0.452	69.534	0.180
Overweight	1.235	0.586	2.599	0.579
Obesity	0.784	0.306	2.004	0.611
Economic activity (ref. Other services)				
Agriculture, forestry and fishing	6.174	0.128	296.848	0.357
Industry	1.223	0.449	3.329	0.694
Trade, accommodation, and food	1.856	0.722	4.773	0.199
Constant	0.829	0.076	9.111	0.878
Sensitivity	80.0%			
Specificity	69.8%			
Positive predictive value	73.5%			
Negative predictive value	77.9%			
Correctly classified	75.0%			
Pseudo R2	0.27			

* The odds ratio for a continuous independent variable expresses the ratio of the probability that the dichotomous dependent variable will change from one category to the other for an increase of one unit in the independent variable.

this study the WAI demonstrated to catch aspects related to mental health and wellbeing that may impact health at work and RTW.

Based on our findings, we can summarize that the most important and modifiable prognostic factors found for ODI and WAI among patients with LBP are depressive symptoms, workday absence and intensity of back pain (chronic vs acute LBP). There is also a mild association between age and ODI, with subjects under 25 years old more frequently exhibiting a better disability condition. Properly understanding and addressing depressive symptoms in patients with back disorders could have a significant impact on promoting more effective recovery and improving overall quality of life. Further research could delve deeper into this relationship and develop targeted intervention strategies to enhance the management of depressive symptoms and optimize work ability among patients with back disorders.

Although some studies have investigated different PROMs to assess disability and ability [41], this is the first study to analyze the association between WAI and ODI in a clinical setting of workers affected by LBP, giving the background for further integrative research. Indeed, LBP is a multidimensional syndrome affecting physical activity and function, health-related quality of life, and employment status. The causal pathway leading from disease to disability is complex and multifactorial, involving different aspects such as physical, psychological, and environmental/occupational factors. While the multifactorial nature of LBP is well established, evidence-based guidelines for the treatment of this nearly ubiquitous condition and implementation into practice remains challenging. It is becoming increasingly clear that a therapeutic model emphasizing multidisciplinary care and ensuring employability and working life may best treat patients with LBP. We often assume it is just about managing pain; however, factors such as functional disability and work ability impact well beyond pain. Therefore, LBP must be assessed from a multidimensional perspective, including occupational implications. Our study findings highlight the multifactorial complexity of LBP as ODI and WAI correlates to each other but capture distinctive aspects of disability related to a diverse range of factors such as personal, environmental, and work characteristics. The adoption of a multidisciplinary model in studying and managing patients with back disorders has significant implications for clinical and organizational practice. Integrating diverse expertise and professions from various fields such as medicine, psychology, and occupational health enhances the comprehensive management of musculoskeletal conditions. This study recognizes the complexity of back disorders and promotes a holistic approach including physical, psychological, social, and organizational factors, leading to improve patient physical and work ability and their return to work.

4.2. Limitations and future perspectives

Although the cross-sectional design of the study limits the establishment of temporality and does not allow for causal inference, to our knowledge, it is the first study to explore and reveal the association between WAI and ODI offering a benchmark in the design of future prospective studies. Moreover, it is worth noting that the sample is constituted of a cohort of patients affected by LBP included in a clinical trial aiming at rehabilitation, and RTW based on the treatment received. Future studies may consider longitudinal design to investigate causality in the relationships. Our results represent a practical contribution to the identification of an integrated, personalized, and multidisciplinary assessment and intervention protocol applicable in clinical and occupational health practices that combine multifactorial aspects (physical, psychological, and social/work ones) to prevent and reduce pain and disability and promote work ability in patients with LBP.

Ethical statement

The study was approved by the Ethic Committee of Campus Bio-Medico of Rome on December 17th 2019 (n.76/19).

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Conflicts of interest

The authors have no conflicts of interest to declare. **All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report**. We certify that the submission is original work and is not under review at any other publication.

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